CHAPTER V

An Exploration of Vulnerability to Cholera at Zonal and Colony Levels
Having looked at the broader time trends and the relative shifts of cholera incidence and mortality, the discussion now moves on to understand, to the extent possible, the determinants of these trends. This chapter is an effort to identify the inter-zonal and intra-zonal commonalities and differences and the dynamics of the disease and identify determinants of vulnerability of colonies. The first section describes incidence of cholera cases in different municipal zones for the period 1994-2000. Relating these to the relevant characteristics of the zones suggests possible macro-determinants. By identifying the most affected colonies, the causal factors are further analysed.

**ZONAL DISTRIBUTION OF CHOLERA CASES, 1994-2000**

Data is available on the number of notified cholera cases for the 12 municipal zones for the years 1994-2000. Incidence rate of cholera cases has been computed per 100,000 population for each zone (Table 5.1). The validity of this data lies in comparative analysis over space (inter-zonal) and time rather than as figures for real incidence rates.

The zonal incidence of reported cholera cases exhibits a wide range from 2.92 per 100,000 to 64 per 100,000 in 1994; during 1998 it ranged from 2.81 per 100,000 to 488.71 per 100,000 and in 2000 it ranged from 0.91 per 100,000 to 22.40 per 100,000. While all the zones were markedly affected in 1994-95, in 1998 Civil Lines and Rohini Zones were the most affected while others showed minor increases. Over the period 1996-2000 different zones show starkly differing trends. Rohini, Narela and Najafgarh Zones have demonstrated a downward trend. Shahdara (North) and Shahdara (South) Zones too have shown a similar trend. In contrast, a rising trend is visible in 1999-2000 in Central and more so in South Zone. The zones can thus be grouped into epidemiological patterns, as detailed below.
Table 5.1. Incidence rate of cholera per 100,000 for 12 zones: 1994-2000

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<td>60.32 (637)</td>
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<td>48.71 (606)</td>
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<td>73.47 (141)</td>
<td>18.64 (40)</td>
<td>10.89 (28)</td>
<td>36.47 (85)</td>
<td>19.40 (51)</td>
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<tr>
<td>Najafgarh</td>
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<td>46.56 (1883)</td>
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<td>8.91 (38)</td>
<td>15.53 (69)</td>
<td>11.66 (54)</td>
<td>8.91 (43)</td>
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<tr>
<td>Rohini</td>
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<td>13.06 (94)</td>
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<td>44.54 (348)</td>
<td>15.23 (124)</td>
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<tr>
<td>South</td>
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<td>21.20 (135)</td>
<td>9.05 (60)</td>
<td>8.10 (56)</td>
<td>11.53 (83)</td>
<td>18.27 (137)</td>
<td>22.40 (175)</td>
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<td>9.31 (129)</td>
<td>10.11 (146)</td>
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<td>11.55 (181)</td>
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<td>10.86 (121)</td>
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<td>3.27 (42)</td>
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<td>5.80 (81)</td>
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<td>5.11 (37)</td>
<td>3.24 (27)</td>
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<td>4.12 (34)</td>
<td>8.14 (61)</td>
<td>4.03 (19)</td>
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</tr>
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<td>Karol Bagh</td>
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<td>6.03 (52)</td>
<td>2.56 (23)</td>
<td>2.46 (23)</td>
<td>3.49 (34)</td>
<td>6.01 (61)</td>
<td>1.80 (19)</td>
<td>3.71</td>
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<td>3.30 (28)</td>
<td>3.74 (33)</td>
<td>2.07 (19)</td>
<td>2.61 (25)</td>
<td>3.51 (35)</td>
<td>6.25 (65)</td>
<td>2.31 (25)</td>
<td>3.40</td>
</tr>
<tr>
<td>West</td>
<td>2.92 (30)</td>
<td>2.52 (27)</td>
<td>1.43 (16)</td>
<td>1.55 (18)</td>
<td>2.81 (34)</td>
<td>1.27 (16)</td>
<td>0.91 (12)</td>
<td>1.91</td>
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<tr>
<td>Total</td>
<td>21.22 (2022)</td>
<td>18.36 (1823)</td>
<td>7.91 (818)</td>
<td>7.94 (856)</td>
<td>14.97 (1680)</td>
<td>10.79 (1262)</td>
<td>7.30 (889)</td>
<td>12.64</td>
</tr>
</tbody>
</table>

Note: Figures in parentheses indicate number of notified cases.

Source: National Institute of Communicable Diseases and Municipal Corporation of Delhi

High but Declining Trend

Civil Lines has the highest average incidence rates among the 12 municipal zones but a declining trend can be observed, which is also reflected in its contribution to total reported cases (Table 5.2). Narela, Najafgarh and Rohini Zones are also similar high incidence zones and demonstrate declining time trends. Following a high incidence rate in 1994, there was a sharp decline. The peak in 1998 in all these zones was lower than the level of 1994. The percentage contribution of annual cases showed little variation in the case of Rohini and Narela Zones. The proportion of cases reported from Najafgarh Zone, however, declined sharply across the study period.
Intermediate but Declining Trend

Shahdara (North) Zone is situated on the eastern side of River Yamuna. It was an intermediate level zones at the mid-90s but show a declining trend over the study period following a high in 1994. It was one of the worst affected zones during the 1988 epidemic. A number of initiatives were taken after the epidemic to improve infrastructure, particularly for the poorer localities. Between 1994 and 2002 the incidence rate declined from 29.70 per 100,000 to 11.76 per 100,000.

Intermediate but Rising Trend

Central and South Zones are geographically contiguous zones but there was administrative relocation of certain areas from South Zone to Central Zone during 1994-95. They exhibit intermediate levels in the mid-1990s, but have become the zones with highest and third highest incidence rates by 2000. While both started out at similar incidence levels, the incidence rate in Central Zone has remained nearly constant over the years while South Zone clearly demonstrates a strong consistent upward trend since 1997 (Table 5.1). This difference is not clearly reflected in Table 5.2, because of the transfer of areas and population from South to Central Zones. During 1999, South Zone accounted for nearly 11% cases, almost reaching the 1994 level. 2000 saw a further rise upto almost 20% of the total cases reported for that year. While the rise in the percentage contribution of Central Zone can be, in large part, explained by the transfer of certain areas from South Zone, the steady rise in contribution of South Zone despite the transfer of population from it is noteworthy.

Low but Steady Trend

Sadar Pahargunj, Karol Bagh and City Zones are geographically adjacent zones and reported nearly similar incidence rate per 100,000 cases, averaged about 4-6. The figures for 2000 show them settling down below the previous levels. Incidence rate ranged between about 1 to 3 cases per 100,000 population.
Low but Declining Trend

Shahdara (South) Zone is adjacent to Shahdara (North) Zone across the river but have consistently reported lower incidence rates. Even during the 1988 epidemic this zone was relatively less affected. The declining trend during the 1994-2000 period however can be observed here.

There are several key questions that need to be addressed. Why is it that different zones in Delhi have different incidence rates? What are the factors that have led to a general rising trend? Why Sadar Pahargunj and City Zones, despite high population density and varied socio-economic groups have low levels of incidence? What has been the reason for a spectacular decline in incidence of cholera in Shahdara, the hotbed of cholera during the 1988 epidemic? Why is the incidence rising in Central and South Zones?

EXPLAINING ZONAL DIFFERENCES : IDENTIFYING FACTORS OF VULNERABILITY

With these observations of incidence of cholera cases at the zonal level, further disaggregation was attempted. Analysing relevant characteristics of the zones and vulnerable colonies should help in identifying determinants of cholera in Delhi. Further, the spatial distribution of the cholera cases in each zone (by residential addresses in the notification) indicates that there are several areas from where these cases are consistently reported. The details of cholera cases reported from different vulnerable colonies are reported in the Appendix in the Tables A.16 to A.22. Some of these areas are large tracts of land while others are smaller settlement units like urbanised villages or JJ clusters. The key issues that will be examined are:

- settlement types
- economic patterns and occupational activities
- provision of civic services
- population density and predominant activities
- characteristics of the residents
- state of the infrastructure in the field
All zones have all the types of settlement but in varying proportions. Also, changes occurring in economic activity, occupational patterns and provision of civic services has affected the zones differentially. Population density and predominant activities occurring in each zone as well as its settlement patterns, residents' characteristics and infrastructure documented at field level have been presented here for a comparative analysis to derive the probable determinants.

The percentage of cases being reported from these endemic areas in relation to the total cases reported from the respective zones are reported in Table 5.2. Under-reporting differentials from certain areas and/or sub-populations will be a limitation of this analysis and it is recognised that there may exist more such endemic foci in Delhi. The mean contribution of cholera cases reported from these endemic pockets to the annual cases for the respective years, is fairly consistent over the study period and works out to be 76.85% of the total reported in Delhi, with a standard deviation of 2.67%. This clearly establishes that their vulnerability factors need to be analysed in depth to understand the determinants of each zone.

Table 5.2 : Proportion of cases from vulnerable colonies in different zones

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<td>Civil Lines</td>
<td>88.70</td>
<td>82.63</td>
<td>92.79</td>
<td>81.70</td>
<td>90.76</td>
<td>84.44</td>
<td>87.57</td>
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<td>78.43</td>
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<td>84.70</td>
<td>85.71</td>
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<td>69.57</td>
<td>85.19</td>
<td>34.88</td>
<td>73.86</td>
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<tr>
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<td>81.46</td>
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<td>89.66</td>
<td>83.06</td>
<td>64.37</td>
<td>79.92</td>
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<td>73.80</td>
<td>79.44</td>
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Note: All figures in percentage.
A common pattern of settlement types among the vulnerable colonies can be observed across zones. Socio-economic and infrastructure characteristics of these colonies are similar, suggesting the determinants of vulnerability of the resident populations among whom cholera occurs. Availability of infrastructure is dependent on the settlement type – its legal status and the existing norms and policies for the respective settlement type.

Table 5.3: Month wise proportion (%) of cases from the endemic areas

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<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>50.00</td>
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<tr>
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<td>0.00</td>
<td>0.00</td>
<td>100.00</td>
<td>0.00</td>
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<td>0.00</td>
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<tr>
<td>Mar</td>
<td>30.77</td>
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<td>79.17</td>
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<td>63.77</td>
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<td>75.00</td>
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Note: All figures in percentage

It is observed from Table 5.3 that though the absolute number of cases are small, the cases that occur during the winter (November to March) are almost as a rule exclusively from these vulnerable colonies. During the peak season (June to August) there is little variation across the years, ranging between 72.4% to 77.8%. There is, however, considerable variation across the years at the beginning and the end of the peak season – during April, May, September and October. This reflects the expanding endemicity in the vulnerable colonies.

**Civil Lines Zone**

This zone has the highest average incidence rate of all the twelve zones at 33.39 per 100,000 population per year, for the study period i.e. 1994-2000. The incidence of cases is higher during the monsoon than summer (Table A.6). An average of 87% of notified cholera cases during the study period were reported from vulnerable colonies. The incidence rate was 85.7 per 100,000 population during the 1988 cholera epidemic, 60.32
and 42.90 per 100,000 in 1994 and 1995 respectively (with about 60% of the cases caused by the O139 strain). The 1998 incidence level was higher than 1995 at 48.71 per 100,000. Thus the potential conditions for transmission remain even though a marginal decline in infection rates is evident. Multiple features of this zone contribute to its high vulnerability.

This is one of the larger zones of the Municipal Corporation of Delhi, with a mix of all types of settlements. The British residents were located in the Civil Lines area before the new capital (New Delhi) was constructed. The Old Secretariat was the seat of the local government. The coronation of Emperor George V was also held in this area. Yet a new site was chosen for the construction of new capital, the Raisina Hills, as this area was considered to be unhealthy in view of the proximity of the River Yamuna; but habitation has come up in the 'unhealthy' areas as well. The older constructed areas now form the Delhi University (and other academic institutions) and the residence of the elite in north Delhi.

The Grand Trunk Road and the Delhi-Ambala railway line form the south-western boundary of the zone. Densely populated localities along the main roads and highways has occurred with ribbon development (Nath, 1995). The population density of this zone is about 13,500 per sq. km. but there is wide disparity in its distribution with newer unauthorised colonies having relatively less density and older urbanised villages, trading centres and slum clusters having very high density.

There is intense commercial activity in this axis including the Azadpur Mandi (fruit and vegetable wholesale markets) which is expanding over the years and the industries in the large designated industrial areas which are mostly 'manufacturing' in nature. These industries recorded a decline; the net state domestic product at constant prices reduced from Rs. 333,668 lakhs in 1993-94 to Rs. 200,786 in 1999-2000 (Delhi Statistical Handbook, 2000).

The poorer new migrant population groups working in the mandi and industries are resident in slums, urbanised villages and resettlement colonies along the G. T. Road. Another large body of vulnerable population is located between the River Yamuna and the G. T. Road, north of the Outer Ring Road.
Water supply in this zone is at an average of 274 lpcd (DUEIIP, 2001). But there are vast areas without piped water supply and sewers. Water supply is mostly from the plants. However, some areas in the north-western part of the zone are supplied through Ranney Wells.

The vulnerable colonies in the zone consist of several urbanised villages – Chandrawal, Rajpura, Azadpur, Bharola, Sarai Peepalthala and Bhalaswa; JJ clusters in Lal Bagh, Bara Bagh and adjoining areas and in Wazirpur Industrial Area; Jahangirpuri Resettlement Colony and unauthorised colonies adjoining the villages of Jharoda, Burari and Nathupura.

**Urbanised Villages**

Chandrawal Village (also known as New Chandrawal) is a relocated village. The Old Chandrawal village was relocated from the banks of the Yamuna River when the first waterworks was set up in 1889. It is now a densely populated urbanised village with commercial and industrial establishments. The adjoining trading areas also provide employment to the large numbers of tenants in this village. Chandrawal along with the adjoining area of Malkagunj has an approximate population of 15,000 and the annual incidence rate ranges between each year 30-40 per 100,000.

Rajpura Village and its adjoining colony of Gur Mandi has a population of about 10,000 and is located right on the Grand Trunk Road. The population density is high. There are a number of manufacturing units located in the residential buildings. These colonies are bound on the eastern side by the Najafgarh Drain which is a large open channel carrying liquid waste from western areas of Delhi. The subsoil in this area is highly contaminated. There is water scarcity in these colonies. Residents of these colonies are socio-economically well off and many of the households have their own motors to draw groundwater. Contaminated groundwater constitutes a major risk factor for these colonies. These colonies were affected in 1994, 1998 and 1999 with an average incidence rate of 110 per 100,000 per year.
Azadpur Village is located on the crossing of the Ring Road and the G. T. Road and is also next to the Azadpur Railway station. Between the original village and the railway line there is an unauthorised colony (Kaushalpuri) and some jhuggies. These unauthorised settlements started since 1977. The village has a population of about 10,000 while the unauthorised components have a total population of about 25,000.

With increasing population, water scarcity has accentuated in Azadpur. Though there are public hydrants in the slum clusters and household level supply in the village, it is not sufficient to meet the requirement and communities are forced to access groundwater through shallow handpumps. The landlords in the village who have rented out small tenements have installed motors (popularly known as 'borings') and provide the residents with untreated ground water. Moreover the piped supply is also liable to contamination due to use of on-line boosters – both manual (in the slums) and electrical (in the village). There are sewers in Azadpur village. But the rest of the population in the area are accessing open fields along the railway line. In 1994-95, the annual incidence rate was 200 per 100,000. There was a downward trend in 1996-97 and it peaked in 1998 to 236 per 100,000. 1999-2000 saw a sharp decline owing to an augmentation of water supply through tankers.

The two villages of Bharola and Sarai Peepalthala are adjacent to the fruit and vegetable wholesale market and its truck terminals. Some JJ clusters have been recent additions. While the old villages have a total population of 70,000 the slum population is about 35,000. These villages are densely populated and there are a large number of small eating houses and hotels catering to drivers, labourers and traders from the north-Indian states. The environmental sanitation is very poor and open drains are almost as a rule choked and overflowing. Piped water supply and sewers are available inside the village but the slum population is dependant on public hydrants and open fields. The average annual incidence rate in 1994-95 was 11.4 per 100,000. There was a decline in 1996-97 and a sharp rise in 1998 as was the general trend. The incidence rate in 1998 was 27.6 per 100,000. There was no special effort in these villages unlike Azadpur. The incidence rate in 2000 peaked to 30.4 per 100,000.

Bhalaswa Village is a small urbanised village with an estimated population of 40,000 located between Jahangirpuri and the G. T. Karnal Road Bypass. Bhalaswa Diary came
into existence in 1975, on the other side of the GTK Bypass, when some dairies from the city were relocated and the colony has grown over time to a current population of about 15,000. The socio-economic condition of residents of the village and the dairy is poor. Most of them are labourers in the Azadpur Mandi and the Rajasthan Industrial Area opposite Jahangirpuri. Both the village and dairy are located on low lying land and are prone to water logging. The incidence rate in 1994 was comparable with neighbouring Jahangirpuri (32.7 per 100,000). Thereafter, with the general declining trend in Civil Lines Zone the incidence rate halved.

JJ Clusters

Lal Bagh, Bara Bagh and several other JJ clusters are located on a stretch of railway land between the G. T. Karnal Road and the Delhi-Ambala railway line behind the GTK Industrial Area. These clusters came into existence in about 1980 when the industrial areas were set up. The combined population of these clusters is about 65,000. The residents are by and large migrants from Bihar and Uttar Pradesh. They are employed in these industrial areas and the nearby Azadpur. There is an IPP-VIII Centre with health posts inside the clusters to serve this population.

Environmental sanitation of these slum clusters is very poor and the garbage dumps (locally called dhalaos) are generally overflowing. There are a few community latrines that are very poorly maintained. They are connected to septic tanks which again are not cleaned/maintained according to the regulations. As a result the population is generally practising open defecation in a large stretch of wasteland on the other side of the railway line; which in fact is in the Rohini Zone! The children generally defecate in the open near their homes in the drains along the lanes or near the community latrines. These latrines were at one time being maintained by the Sulabh Shauchalaya; but as per the current policy, maintenance is now back with the MCD.

Water supply in these clusters is through public hydrants. Water pressure is low and therefore at many places the community punctures the pipelines to access water. Those who can afford manual hand-operated boosters, have punctured the water pipe lines and
installed these boosters. There are a number of shallow handpumps as well. With open defecation being so high, the shallow water table is highly contaminated.

These clusters were severely affected in 1994-95 with an annual incidence rate of about 104.6 per 100,000 that halved by 1996-97. There was a resurgence in 1998 to the 1994 levels and declined sharply by 2000. The peak incidence is from June to August when 70-90% of the cases occur. Augmentation in water supply through the deployment of a large number of tankers helped to improve the situation. The tanker strategy worked as the Industrial Areas provided wide roads for the tankers. Further, these clusters are long with relatively little breadth; the dwelling units are therefore not far away from the tankers.

Construction of the Wazirpur Industrial Area began in 1972 and the construction labourers set up their huts. The labourers were from Bihar and Uttar Pradesh. Gradually the clusters expanded along the strip of land between the Industrial Area and the railway line (a loop line connecting the Delhi-Ambala line with the Delhi-Rohtak line and serving several industrial areas). The current population is estimated at 50,000. The clusters are served by the IPP-VIII. Water supply is through public hydrants. Defecation is practised generally along the railway lines or in open drains. Environmental sanitation is extremely poor. There are large open drains that are choked almost as a rule. The incidence rate ranged between 6-10 per 100,000 during the study period without much variation.

Resettlement Colonies

Jahangirpuri Resettlement Colony was set up in 1972-73 on the G. T. Karnal Road and has an estimated population of 300,000. The initial communities that were resettled were slum dwellers from Karol Bagh and Mayapuri. A large proportion of the residents are salaried personnel in the organised and semi-organised sectors. The Rajasthan Small Industries Area located opposite Jahangirpuri, between the G. T. Road and the Delhi-Ambala railway line also provide employment. There are several medical institutions of the Delhi Government and MCD including a newly established general hospital.

The resettlement colony has expanded several times over its initial capacity and plan owing to large scale expansion in the number of floors. There are several slum clusters in different blocks of Jahangirpuri. Water supply is from the Delhi Jal Board (DJB) and
most of the households have household level supply. The use of manual boosters is however quite common. In addition, there are shallow handpumps in many households who can afford it. There are no sanitary latrines at the household level. Many families have constructed latrines and connected them to the open drains. Recently, sewers have been installed but many of the sanitary latrines are yet to be connected. There are community latrines attached to septic tanks. The septic tanks are not properly maintained and add to the vulnerability of the community.

Over the years there has been a decline in cholera in Jahangirpuri, particularly after commissioning of the sewers. There were 135 cases of cholera in 1994 – an annual incidence rate of 67.5 per 100,000. In 1995 the incidence rate almost halved followed by further reductions in 1996-97. In keeping with the general trend, incidence increased sharply in 1998 to the 1995 level. Following installation of sewers in 1999, incidence rate reduced to a third of the 1998 level. Cases are now largely reported from the slum clusters that have mushroomed at the periphery of the original resettlement colony. They do not have access to piped water supply (through public hydrants) and sanitary latrines (community latrines). Water is accessed through handpumps and open fields are used for defecation.

Unauthorised Colonies

The unauthorised colonies of the Civil Lines Zone are located on the land of four villages – Jharoda, Burari, Nathupura and Ibrahimpur, across the Outer Ring Road on the periphery of the Civil Lines Zone towards Narela Zone. While the slum clusters were being relocated/resettled from the main city areas to the peripheries, a sub-population among the slum dwellers who had the means purchased land in these areas. The landlords in these villages had become 'colonisers' (in local parlance) and property dealers converting agricultural land to residential plots as property prices were on the rise. The initial settlers were from Uttar Pradesh including the hilly districts. Many of them were salaried personnel employed in government organisations.

The entire area has historically been part of the flood plains of the Yamuna and witnessed floods regularly along with other similarly placed villages upstream in the Narela Zone.
The 1978 flood inundated the entire area and the population was rescued by the army and volunteers with the help of boats. The inundation had also threatened parts of posh colonies like Model Town on the Ring Road. As a result a series of steps were taken to strengthen the west bank of Yamuna and the Outer Ring Road was also constructed on a high embankment that provided direct access to these areas and protected the Kingsway Camp area from floods. Jharoda (closest to the river)-Burari-Nathupura was thus cordoned off from the river. Land prices shot up and newer 'Colonies', 'Enclaves' and 'Vihars' mushroomed with each passing year. The current population of this belt is estimated at about 400,000.

One of the most important factors responsible for the popularity of these unauthorised colonies is the easy access to ground water. The shallow handpumps can easily tap water at little depth from the surface\(^1\). Since 1999, the DJB has augmented tanker supply in these areas; their impact has been limited owing to several factors. Tankers are stationed at the main road only; the lanes are too narrow for them to reach the peripheries. Those living in peripheral parts of the colony often do not prefer to access tanker water. Tankers are there for a limited time and that too there is often no schedule. When the tanker arrives, the residents in a rush to access water quickly, open the lids and put rubber pipes inside to siphon off water. This is a potential source of contamination.

The owners who stay here are relatively better off, who have purchased land and constructed houses. Many of these dwelling units have sanitary latrines also connected to septic tanks which are more often than not constructed and maintained according to specifications, with the result that incompletely treated effluent percolates and contaminates subsoil water. In addition, there are no regular sanitation services as these are unauthorised colonies and there is no official allocation for manpower and vehicles. As a result, solid waste generated is generally dumped into nearby vacant plots and with the first rains they contaminate the subsoil water. There are no proper surface drains in many parts of these colonies. Liquid waste therefore has no outfall and has no other option but to enter the soil.

\(^1\) The Times of India (New Delhi) dated 10\(^{th}\) may, 2003, quoting Central Ground Water Authority put the water table in this part of Delhi at about 6.5 metres in 2002 and it was about a metre during the 1960s and 1970s.
For such a large area with a sizeable population there are no health/medical institutions, except a malaria clinic at Burari. 1994, which was an epidemic year, affected these colonies in a major way with an incidence rate of about 58.1 cholera cases per 100,000 for the year. In 1998, when there was a resurgence, after an overall declining trend, cholera was back in this belt with similar incidence level. As already mentioned, with a quantum jump in tankers to these areas, the incidence rate dropped to about 10 per 100,000.

Thus, the key vulnerable areas in this zone are large slum clusters in the industrial belt housing, the poorest population groups with the state of infrastructure being very poor, and, large unauthorised colonies (with relatively better off socio-economic groups) dependent largely on groundwater accessed through shallow handpumps and lacking sanitary latrines. Despite continuing high population densities, there was a significant decline in cholera in Civil Lines Zone following the 1998 peak when water tankers were deployed in a major way in Lal Bagh, Azadpur and Jharoda-Nathupura areas. The tankers became a part of the local political agenda in a couple of years with active demand from the community. This paid dividends. However, this is not a cost-effective and sustainable solution. In Jharoda village, pipelines have already been laid and limited supply has begun. Piped water supply is also available in Burari and Nathupura villages; but the benefit is limited only to the village and is not available to the residents of the unauthorised colonies, that constitute more than 90-95% of the population in these areas. Jahangirpuri has benefited from the installation of sewers and there has been a decline in the incidence of the notified cholera cases.

**Narela Zone**

Narela Zone has very few vulnerable areas and yet reported the second highest average incidence rate during 1994-2000 at 33.39 cases per 100,000. During 1995 and 1996, Narela reported the highest incidence rates among all the zones. In 1998 the incidence rate was the third highest after Rohini and Civil Lines Zones. Thereafter, there has been a
steady decline in the incidence rate across the years to a low of 8.50 cases per 100,000 during 2000, ranking it sixth among the zones.

Narela Zone is essentially a rural zone. There are a few industrial areas and the resident population is by and large indigenous. There have been several changes recently that are making an impact on the cholera scenario. With the indigenous population gradually shifting from agriculture, agricultural land has been sold out as residential plots and several unauthorised colonies have come up with little infrastructure. Further, some of the landlords have constructed godowns and industries, particularly in those villages that are close to the National Highway 1. All this has led to the influx of migrants.

Consequent to a judgement of the Hon'ble Supreme Court in 1998, a large number of industries in residential and non-conforming areas of Delhi are being relocated in newly designated industrial areas (that are under construction) in Narela Zone. This is going to bring about changes similar to that witnessed in the neighbourhood of other industrial areas throughout Delhi. There being no planned provision for housing and other infrastructural facilities for industrial workers, it is only to be expected that adjacent villages will become congested and unauthorised colonies will grow leading to increased vulnerability for cholera.

Several JJ clusters from different parts of Delhi are being relocated in Narela on land acquired from villages. Some of these resettlement colonies have been properly planned and constructed by HUDCO while in case of others, relocated families have been allotted land and dumped in the open fields exposing them to conditions that are conducive to the outbreak of water borne diseases. Population density is about 743.38 per sq. km. and is increasing as newer colonies are being established.

DJB water supply is at an average of 32 lpcd (DUEIIP, 2001). The supply is from Ranney Wells which have recently been augmented by additional deep tubewells. The water supply situation in the zone improved after the commissioning of the pumping station at Holambi during 1998 and supply of adequate water to Narela (town) and the adjacent villages. The entire zone is without sewers. Most of the houses in the villages have septic tanks.
The proportion of annual cases reported from vulnerable colonies averaged 61.70% for the study period. There are wide fluctuations in the proportion of annual cases being reported from vulnerable colonies during the study period. In 1996, as many as 92.5% of the total notified cases were reported from vulnerable colonies. By 2000, there was a sharp drop to only 11%. The vulnerable colonies in this zone are mostly located in the urban agglomerations of Narela, Alipur and Bawana. Lampur Village and the Brick Kilns represent special cases.

**Urban Agglomerations**

Narela is the largest urban agglomeration in the Narela Zone. It is a congested town and a thriving trading centre for grains and agricultural products. There is a designated industrial area as well. Though there is DJB piped supply, there are several pockets of water scarcity. Since 1999, several slum clusters are being relocated in this area. As water and sanitation services were deficient in the initial stages of relocation, cholera cases were reported from these resettlement colonies. About 15 to 20 cases are reported each year from Narela, without much variation.

In addition to Narela, the two other urban agglomerations of the zone – Alipur and Bawana also constitute hot spots. The villages that are located along the Alipur-Narela (Bakhtawarpur, Holambi, Hiranki and Bakoli villages) and Narela-Bawana (Bajeetpur, Ghogha and several other smaller villages) roads reported sporadic cases. Slum clusters have also been relocated in Holambi. The ones that have been relocated in Holambi were poorly planned. Plots were allotted but infrastructure was grossly deficient. The communities that were relocated were left in the open fields; water tankers and mobile latrines were provided. But there was no physical structure to live in. Several cholera cases have been reported from these colonies.

**Lampur**

Lampur village located near Narela is a special case. The Delhi Government has its Beggar Home here. The village is small with four institutions. There are four homes in the same campus – three for beggars and the destitute; and one for foreigners waiting for
deportation. Water supply is through deep tubewells fitted with chlorinators. Focal outbreaks occur every 2/3 years. On each occasion, the cause has generally been traced to a fault with the chlorinators.

Brick Kilns

The worst affected communities in 1994 and 1995 were the migrant labourers in the Brick Kilns that used to dot the countryside in Narela. Following a court ruling these kilns shifted to Haryana in 1996. The living conditions in these kilns were poor with the community drawing drinking water from shallow handpumps and defecating in the adjacent fields. The cases would typically occur as small focal outbreaks affecting children and adults as well. Several of them were food borne following community feasts.

There has been a decline in clustered cases in Narela and sporadic cases in the rural villages following the operationalisation of the Holambi Reservoir in 1998-99. There are several Ranney wells in the Yamuna corridor in Narela Zone. Water is sent from these Ranney wells to the Holambi Reservoir where it is chlorinated and distributed through piped network. The shifting of the brick kilns from Delhi to Haryana (following a court decision) has also contributed to the overall decline in incidence of cholera in Narela.

Najafgarh Zone

Najafgarh Zone has demonstrated a consistent declining trend in the incidence rate of cholera during the study period, from 59.64 per 100,000 in 1994 to 8.91 per 100,000 with an average annual incidence rate of 23.55 per 100,000 population, the third highest among the zones.

Najafgarh Zone is rural for large tracts, with no vulnerable pockets in the rural segments. There are three belts in Najafgarh Zone that have experienced growth in terms of settlements and population – Nangloi-Mangolpuri-Sultanpuri area, Palam-Dabri area and the settlements surrounding the airport complex. The settlements in the Nangloi-Mangolpuri-Sultanpuri are resettlement colonies that were set up during the Emergency
They are primarily residential colonies with industrial areas in their vicinity and also several unorganised trading centres. The Palam-Dabri Road is an important axis in south-west Delhi where a large number of unauthorised colonies were set up in the early 1980s and were regularised over time. The Airport and the Cantonment are large providers of employment in this zone. Consequently, several urbanised villages have become highly congested and constitute vulnerable areas from where cholera is regularly reported. The average population density in the zone is about 1126.52 per sq. km. but with wide variations between highly congested urban areas and the rural areas.

Average water supply in the zone is about 74 lpcd (DUEIIP, 2001). Some of the rural villages do not have piped water supply. Those that have water supply are serviced through deep tubewells. Sewers are available in the urbanised parts of the zone. The resettlement colonies have community latrines while the unauthorised colonies and rural villages mostly have individual septic tanks.

In Najafgarh Zone, an average of 73.86% of annual cases were reported from the vulnerable areas during 1994-2000. The contribution of vulnerable colonies to the annual cases in the zone was 65% in 1994 and rose to 85% in 1995. Between 1996 and 1999 vulnerable colonies in Najafgarh Zone were contributing about 80-90% of the total zonal cases each year. In 2000, this proportion reduced sharply to about 35%. The vulnerable colonies include a group of resettlement colonies in Mangolpuri, Sultanpuri and Nangloi; unauthorised/regularised colonies in the Palam-Dabri belt and a group of urbanised villages – Mahipalpur, Rangpuri and Nangal Dewat.

**Resettlement Colonies**

Mangolpuri-Sultanpuri and Nangloi are located on either side of the Delhi-Rohtak railway line and the Delhi-Fazilka National Highway. Mangolpuri, Sultanpuri and J. J. Colony-Nangloi are resettlement colonies. The slum residents of Minto Road and Delhi Gate were relocated to these colonies. While a large portion of the resettlement colonies was located on low-lying waste land, some land was also acquired from Mangolpur Khurd and Nangloi villages. Over time, several JJ clusters have come up in both these two villages. Several unauthorised colonies have also been 'promoted' by the landlords of
Nangloi village; some more have mushroomed on waste land beyond Sultanpuri. Mangolpuri Industrial Area and Peeragarhi Industrial Area (near Nangloi) provide employment. Nangloi has always been a traditional trading centre for this part of rural Delhi and adjacent areas of Haryana. Good road transport facilities and a railway station at Nangloi has attracted a large body of tenants employed in different areas of Delhi.

DJB water supply is available in all these localities except in the unauthorised colonies. However, the quantity of water available is inadequate for the population which is currently estimated at about 400,000. As a result either shallow handpumps have been sunk at individual initiatives and cost or the water pipelines are punctured to install manual boosters. The JJ clusters are solely dependent on public hydrants while there is no DJB supply in the unauthorised colonies. There are community sanitary latrines in resettlement colonies; but they are often in a poor state of maintenance. Open defecation by children is quite common in resettlement colonies. In addition, many households, particularly those on the ground floor, have made structures for 'sanitary latrines' that drain directly into the open drains. With water pipelines crossing through the open drains, the risks of contamination remain very high. The residents of the JJ clusters are either using the community latrines of the resettlement colonies or are practising open defecation. At a few clusters, mobile latrines have been provided; but they are often in a poor state of maintenance. The unauthorised colonies generally have individual sanitary latrines connected to dug wells.

The annual incidence rate of cholera in 1994 in these colonies was 46.4 cases per 100,000 population. There was a marginal decline during 1995. There was a sharp decline since 1996 when the annual incidence rate dropped to 1.27 per 100,000. There has been a further decline over the subsequent years of the study period. During 2000, this rate was down to 2.7 per 100,000. Availability of adequate safe water from the Haiderpur plant has made a great difference. Cases are now generally confined to unauthorised colonies. The contribution of this belt to the total case load of Najafgarh has undergone considerable change during the study period. During the peak period of 1994 and 1995, this belt reported 51% and 61% of the total cases in the Zone respectively. Though there was drastic reduction in the incidence of cholera in Najafgarh Zone by 1996 and 1997, this belt contributed 68% of the cases in each of the years. The share of this belt to the total cases of the Zone declined sharply between 1998 and 2000, from 51% to 26%.
Unauthorised/Regularised Colonies

The Palam-Dabri belt consists of villages – Palam, Dabri, Nasirpur, Bindapur and Matiala – and unauthorised colonies promoted on the land of these villages since the early 1980s. This belt is also adjacent to the Airport and the Cantonment and is surrounded on three sides by the upcoming Dwarka township. Over the years, these colonies have attracted a large body of population – particularly, those employed with the defence and aviation services. Road transport facilities to south Delhi where offices of the organised sector are located has also contributed to the growth of the middle class population in this belt. The current estimated population of this belt is about 200,000.

To start with, the only source of water supply was groundwater accessed through shallow handpumps or in a small proportion of households through 'borings'. All houses have sanitary latrines – some with dug wells and others drain the liquid waste into open drains. None of these houses have proper septic tanks. To complicate matters, there is no outfall for the liquid waste and wastewater, that flows in the open drains. Vacant plots are used to dump solid waste and in many cases liquid waste also flows into them. Otherwise, the liquid waste keeps going round in circles in the drains, many of which are not paved! Either way, most of the liquid waste enters the subsoil water – the only water source. The irony is that the Sulabh Shauchalaya has its headquarters on the Palam Dabri Road at Mahavir Enclave, one of the earliest colonies in this area that was regularised in the late 1980s. The Sulabh Movement despite its national and international acclaim had missed all that was happening at its backyard for nearly two decades now. These colonies began to be regularised gradually. With regularisation came piped water supply, roads and paved drains. Some of these colonies are yet to be regularised.

In 1994, annual incidence rate was 8 per 100,000 population. In 1995, despite a downward trend in Najafgarh Zone, the rate increased to 12.5 per 100,000. Since 1996, at the initiative of one of the local MLAs (there are two assembly constituencies in the belt), water supply was extended to many more colonies from the Uttam Nagar – Najafgarh Road line. Tankers were deployed in many of the areas. Cases declined to zero in 1997. During 2000, sewers were laid in a few of these colonies; again the sewers had no outfall as they were not connected to the trunk sewers. Water supply without sewers brought
about a new problem. The water pipes passed through open choked drains and were a new route of infection. In 1994 and 1995, this belt accounted for about 4% and 7% respectively of the cases reported from the vulnerable areas. Between 1998 and 2000, the corresponding figures increased to 12.5% and finally to 20%.

Urbanised Villages

Mahipalpur, Nangal Dewat and Rangpuri villages are located on the National Highway 8 (Delhi-Jaipur), close to the airport. These villages have become major commercial centres and have also attracted a number of tenants. Each year an average of about 4-5 cases are reported without much variation during the study period.

Rohini Zone

The average annual incidence rate for the period 1994-2000 places Rohini as the zone with the third highest incidence rate at 22.5 new cases per 100,000 population. It ranked fourth during 1994 when the incidence was at a peak in all the zones. However, the interesting feature about time trends in Rohini Zone is that, during the study period, it reported the highest incidence rate in 1998 – 44.5 cases per 100,000. All other zones reported a lower incidence rate in 1998 than 1994 though both were high incidence years. The incidence rate in Rohini during monsoon is about 3-3.5 times that during the summer.

Rohini Zone was carved out of Civil Lines and West Zones in 1990. The residential colonies of this zone are by and large middle class in nature. The vulnerable settlements, several large JJ clusters, are located mostly around the G T Karnal Road including a few urbanised villages and an industrial area. To a much lesser extent, there are a few unauthorised colonies along the Kanjhawala Road. Commercial activity is low and the land use pattern is largely residential in nature. A key cause of the vulnerability of the slum clusters is the proximity to sanitary land fill (SLF) sites. In fact some of them have come up on low lying land that were used as SLF sites earlier. The population density of the zone is about 8847.83 per sq. km.
While the SLF site remains the major source of the infection, the Haiderpur Water Treatment Plant that started functioning from the mid-1990s has probably played a key role in the reduction of incidence levels. The average water supply in this zone is about 274 lpcd (DUEIIP, 2001). Most of the areas are also served by sewers. An average of about 80% of the annual reported cholera cases occur in the vulnerable colonies. They consist of urbanised villages – Shalamar, Haiderpur, Samaipur, Badli, Libaspur and JJ clusters around them. In addition, JJ clusters in Sawan Park, unauthorised colonies in Budh Vihar and Wazirpur JJ Colony (Resettlement Colony) are also vulnerable colonies in the zone.

**JJ Clusters**

The most critical vulnerable belt in Rohini Zone are a group of urbanised villages, their extensions and surrounding JJ clusters. These are located around the G. T. Karnal Road stretching from Shalamar Village through Haiderpur Village to Samaipur, Badli, Libaspur, Shahbad-Daulatpur and Siraspur Villages. Employment is provided at several nearby industrial areas (including one at Badli), industries in the villages and the transport industry at the Sanjay Gandhi Transport Nagar.

The hallmark of these areas is that, other than the original villages, all the settlements have come up on what were previously sanitary landfill sites. On account of improper waste disposal at these sites, the groundwater in these areas is highly contaminated. While the unauthorised colonies have no water supply or 'skeletal supply' through tankers, the slum clusters are supplied through public hydrants. Though there is household level water supply in the villages large scale tenancy has led to conditions of scarcity. The communities are therefore acutely dependent on groundwater. The use of boosters is also high in certain localities.

The slum clusters in these areas came into existence at around 1982 when the industrial areas were being set up. The wholesale market at Azadpur and the truck terminal boosted the growth of the slums. Many of the residents were already living in different slum clusters in Delhi. They shifted to these areas as the *jhuggies* were available at cheaper rates. Moreover, newer avenues of employment were also available with the Narela area, particularly along the G. T. Karnal Road, beginning to commercialise around the late
1980s and the beginning of the 1990s. The availability of excellent road transport have also contributed to rapid expansion of these pockets. Simultaneously, the villages also got congested with increasing commercialisation and tenancy. In the later phases, unauthorised colonies began to promoted by the landlords for the economically better off groups who purchased land to build their own houses.

The estimated population is about 200,000. The environmental sanitary conditions of this belt is extremely poor. In addition to domestic solid waste, industrial solid waste is also poorly disposed and often found dumped in these areas; the hazards are different and potentially even more serious. The area is low-lying and is prone to water logging during rains. Water supply is through public hydrants for the JJ clusters. Availability of water is insufficient and communities are acutely dependent on shallow handpumps. The villages have household level water supply but often need boosting. They are sewered and have sanitary latrines. The unauthorised colonies have no other source than groundwater. The JJ clusters have community latrines at few places; but open fields are the commonest places for defecation.

Annual incidence rate for cholera for these clusters in 1994 was 71.4 per 100,000 population – one of the highest for Delhi. The incidence rate did not decline in 1995. The rate reduced to about one-third by 1996 and continued at this level in 1997 as well. However, despite an overall low endemicity, this period was marked by an increase of cases in Shahbad where construction had begun in the campus of the Delhi Engineering College (which was shifting from its previous location at Kashmere Gate) and cholera cases were regularly being reported from among the construction labourers. There were several diarrhoeal disease related deaths among infants and children. The construction was over by 1998-99 and these cases subsided.

Though 1998 saw an upward spike of cases in each zone and almost each of the localities, for Rohini Zone, this was an extraordinary year. The annual incidence rate in Haiderpur alone was 212 per 100,000 population and the zonal annual incidence rate of 44.5 per 100,000. In Samaipur-Badli the rate was 380 per 100,000. In the JJ clusters of Shalimar Bagh, the rate was 214.3 per 100,000.
In 1994, this belt accounted for 75% of the cases from the vulnerable areas and that in turn accounted for 52% of the total cases of Rohini Zone. In 1996, though incidence rate declined about two-and-a-half times in Rohini Zone, the contribution of this belt was at a similar level – 53%. In 1998, cases from this belt constituted 76% of those from vulnerable colonies and 68% of the total cases of the Zone. The situation improved in 1999-2000 with large scale deployment of tankers in the affected areas. However, despite a general decline, incidence did not decline in Siraspur as the population in the newly formed unauthorised colonies increased and there was no extra inputs in this pocket.

In 1998, a new sanitary landfill site was started at a new site which is bound on the east by the G. T. Karnal Road, on the west by the Delhi-Ambala railway line, on the south by the Outer Ring Road and on the north by the Sanjay Gandhi Transport Nagar. It is no secret that the sanitary landfills are not run according to specifications and that there is little that is 'sanitary' about them. They are merely dumping sites with complete disregard to the bio-hazards that accompany such sites. The Public Interest Litigation filed in the Hon'ble Supreme Court in the case B. L. Wadhera vs. MCD and others details the state of affairs in such dumping sites. Ground water is highly contaminated both bacteriologically and chemically as has been demonstrated in the public interest litigation.

Sawan Park consists of several small JJ clusters located on the fringes of Ashok Vihar Phases II and III along the Delhi-Ambala railway line opposite Lal Bagh and Bara Bagh of Civil Lines Zone. Water supply is through public hydrants and defecation is practised along the railway tracks. In 1994, the annual incidence rate was 328.6 per 100,000 population. This was three times the incidence rate of Lal Bagh and Bara Bagh. The principal reason for greater vulnerability is the fact that the water-sanitation situation in these clusters is far worse than Lal Bagh and Bara Bagh. The incidence rate remained unchanged in 1996 and during 1996-98 at about 100 per 100,000 annually. The real decline in incidence came in 1999 when tankers were deployed and the public hydrant network also expanded. There was only one case in 2000.

Unauthorised Colonies

Budh Vihar is an unauthorised colony on the Kanjhawala Road. It is situated on the banks of a major open drain that provides an outfall for the liquid waste. The colony was
established in the mid 1980s. The initial group of residents were mostly salaried individuals including some retired personnel from the armed forces.

During 1994 the colony was still developing. There were few paved roads. The only source of water was shallow handpumps. There were 'sanitary latrines' with dug wells. Water logging was the norm during the monsoons. There were vacant plots into which solid waste of the adjacent households would be dumped and in many cases would act as a means of liquid waste disposal as well.

In 1994 annual incidence rate was 52.5 per 100,000 population. By 1994, Budh Vihar was large enough to have two 'phases'. Phase-I is located on the Kanjhawala Road, has all the shops and the offices of the property dealers who double up as local politicians as well. Phase-I thus developed faster than Phase-II. The roads developed even faster. DJB water was also made available through public hydrants from which illegal household connections were later drawn. DJB tanker supply also began from 1995. The incidence of cholera reduced in Phase-I. Other than the odd sporadic case, cholera in Budh Vihar became confined to Phase-II, where the incidence rate remained at comparable rates till 1998. In 2000, which per se was a year with the least cases in Rohini Zone during the study period, there was only one case from Phase-II.

Resettlement Colony

Yet another vulnerable area of Rohini Zone is the Wazirpur JJ Colony; a resettlement colony that was set up in 1974. The residents of slum clusters of Mayapuri were relocated here. Later, migrants from Haryana, Uttar Pradesh and Bihar have moved in. A dead end of an irrigation 'canal' lies along the western boundary of the colony providing water for some of the daily needs. This water per se is stagnant and highly polluted due to liquid waste from the colony draining into it. There are a number of JJ clusters along the bank of this canal. A sizeable number of residents of these clusters are hawkers selling fruits and salad vegetables in Azadpur and adjacent business areas. These fruit and vegetables hawked locally are washed in this canal. As these items are consumed raw, it is not difficult to imagine that they are sources of infection for cholera and a variety of other waterborne infections. The annual incidence rate during the peak phase of 1994-95 was
about 20 per 100,000 population. In 1998, this rose to 28.7 per 100,000. During 1999-2000, there was a decline to about 8 per 100,000.

Though Rohini is one of the highly endemic zones, 1998 was an exceptionally bad year. The belt that is highly endemic for cholera is Haiderpur-Samaipur-Badli-Siraspur. The beginning of a new sanitary landfill area meant doom for the communities in these areas. Though the situation is 'under control' with the help of tankers, this is not a permanent and sustainable solution and there can be a flare-up at any time.

South and Central Zones

The reasons for considering these two zones together as far as discussion of vulnerable colonies go have already been explained earlier. 1994 and 1995 were peak incidence years following the introduction of Vibrio cholerae O139. In 1994, the incidence rate at South Zone was 36.8 per 100,000. The incidence rate in Central Zone for that year was only 6.9 per 100,000. In 1995, the incidence rate was similar in both the zones – 20.8 per 100,000 in Central Zone and 21.2 per 100,000 in South Zone. Between 1995 and 1998 there was little difference in incidence rates in the two zones. Since 1998, the incidence rate in South Zone has risen sharply to 22.40 per 100,000 in 2000; Central Zone has remained more or less at the same level. During the 1988 cholera epidemic, the incidence rates in South and Central zones were 10.9 and 3.8 per 100,000 respectively. In contrast the average incidence for the study period was 18.20 per 100,000 in South Zone and 12.30 per 100,000 in Central Zone.

South and Central Zones are among the larger zones of the MCD. Geographically, they extend from the Southern Ridge (of the Aravalli Hills) to the River Yamuna. While a few colonies were set up in connection with rehabilitation of the Partition refugees, bulk of the growth occurred since the 1970s. Affluent colonies, office complexes, markets, hospitals and academic institutions are the hallmark of these zones along with good roads and public transport. Much of the land was provided by villages. The urbanised villages acquired a lot of wealth in the process. There was investment in household industries and real estate (for sale as office space or tenancy for residences). With the corporate sector
setting up offices in the large office complexes, the tertiary sector boomed in these two zones, more so following the liberalisation of the economy in the 1990s.

Going by the net state domestic product (at constant prices) by industry of origin (Delhi Statistical Handbook) for Delhi, construction increased by nearly 40%, financing, insurance, real estate and business services by more than double and personal services by about 58%. The proportion of tertiary sector workers among total workers in Delhi increased remained nearly constant at 64% to 66% through 1961 to 1991. From 64.72% in 1991 it rose to 69.58% in 2001 (Economic Survey of Delhi, 2002). Much of this increase can be expected to have occurred in these two zones given the profile of their economic activity.

The population density in South and Central Zones are 4237.29 and 21485.71 per sq. km. respectively. In terms of area, about two-thirds of South Zone consists of rural villages. The population density of the urban areas of South Zone are therefore much higher.

Large areas of South Zone and Central Zone suffer from low per capita supply of water. The DUEIIP (2001) puts the availability of water at 29 litres per capita per day (lpcd) in the Mehrauli Zone of the Delhi Jal Board. In the rest of the Central and South Zones this figure is 148 lpcd against an optimum supply of 150-225 lpcd. The Economic Survey of Delhi 2001-2002 pointed out that all the water production centres are located in the north and water has to travel a long distance to the south resulting in loss of pressure; the colonies located at higher elevations in these two zones are thus the worst hit. The document further observed that "little attention has been paid in the last three decades to create a production centre of adequate size in these zones.

Great concern has been expressed about the fast depleting groundwater level in south Delhi. These zones had adequate groundwater upto about 6 metres till the late 1980s. The Delhi Jal Board remains the largest extractor of groundwater in these two zones. Of a total of 2,111 DJB deep tubewells in Delhi 1,409 are in these two zones. In the unauthorised colonies located in the riverine areas of Central Zone, there are large numbers of shallow handpumps.

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2 A Times of India Report quoting Central Ground Water Authority
3 Personal communication
An average of about 76% of the annually notified cases were reported from the vulnerable colonies in these two zones. Though the vulnerable areas in South and Central Zones are apparently varied and spread out, yet there are certain commonalities in the risk factors that make these colonies vulnerable to cholera. These commonalities are therefore considered before taking up a case-by-case discussion.

Except for the few peripheral unauthorised colonies, the hallmark of all the other settlements is high population density and overcrowding. The urbanised villages have one room units (generally with common toilets) built specifically for renting out. There are adequate employment opportunities in the industries in the designated industrial areas, unauthorised industries in the urbanised villages in addition to other jobs in the tertiary sector, both formal and informal.

The environmental sanitation conditions are poor in these colonies. There is scarcity in areas of piped supply because of an adverse demand-supply situation, particularly in summers. The colonies situated at higher elevations on the rocky elevations of the Southern Ridge have water scarcity, being at the tail end of the piped network.

To augment the water supplied from the water treatment plants the Delhi Jal Board operates a large number of tubewells in these areas. These tubewells are fitted with chlorinators. These tubewells are ironically in many instances sources of contaminated water supply. The supply of bleaching powder is irregular. Maintenance of chlorinators is poor and breakdowns are common. 'Contracting' of the tubewells and chlorinators by the operators is common. The room (the pump house) is given out on rent and in turn the tenant merely switches the pump on and off and is technically incapable of handling the chlorinator. The keys of the pump house are often left with the local residents also, particularly in the urbanised villages, who are not able to operate the chlorinator. Rampant use of on-line boosters on the main line is common in the well-to-do areas. The use of manual boosters by puncturing the pipe lines is also equally prevalent in the low income settlements.

Unauthorised colonies which lack piped water supply, access water through different options. Shallow handpumps is the commonest source, particularly, in the riverine belt.
Colonies situated on the rocky belt access groundwater through either, Mark II handpumps installed by the Delhi Jal Board or through electric motors in individual households who can afford it. Water is also purchased by the residents in some of the colonies (Badarpur area) from private tankers who in turn draw ground water through motors. In addition there are private piped networks whereby an 'entrepreneur' draws water through a motor and supplies adjacent households through pipes laid on the surface; there are several such networks in Sangam Vihar and Tughlakabad Extension. There are instances where DJB water is privately sold. Privately owned tanks are filled by DJB tankers and this water is then sold to the neighbourhood through networks of rubber pipes travelling across lanes and over roofs. Groundwater has been tested from all these sources and has consistently proved to be unfit for human consumption (Dasgupta, 2002); this includes the DJB Mark II handpumps also, which, like the shallow handpumps have been painted red at several places by the DJB as a mark of warning!

Unauthorised colonies have no sewers at all. Sanitary latrines are connected to septic tanks/dug wells and the waste water often tracks down to the subsoil. Open defecation is also practised. Urbanised villages and regularised colonies pose a peculiar problem. The sewers have been installed much later in the narrow lanes and by-lanes. As a result, water pipelines, joints and valves often lie in close vicinity of the sewers and intermittent supply of water leads to sucking in of contaminated matter even when there are minor cracks in the pipe line. Use of on-line boosters also lead to contamination if the water pipe lines are in contact with sewage (Zerah, 2000). During summer owing to overall lack of water and reduced flow, sewers get surcharged leading to an increase in the probability of sucking in contaminated matter into the water pipelines.

The vulnerable colonies of South and Central Zones include the Resettlement Colonies in Ambedkar Nagar, Dakshinpuri, Madangir, Khanpur, Deoli and Tigri; unauthorised colonies in Sangam Vihar and Badarpur area; one regularised colony – Govindpuri; JJ clusters in Govindpuri and Okhla Industrial Areas; urbanised villages – Chiragh Dilli, Garhi, Jamroodpur, Kotla Mubarakpur, Madanpur Khadar, Hauz Rani, Masjid Moth, Mehrauli, Lado Sarai, Neb Sarai and Shahpur Jat.
Resettlement Colonies

The resettlement colonies of South and Central Zones are – Ambedkar Nagar, Dakshinpuri, Madangir, Khanpur, Deoli and Tigri, in one contagious belt. These colonies were established between 1970 and 1972 to relocate the slum populations from I.N.A., R.K. Puram, Ansari Nagar and East of Kailash areas. Majority of the residents in these colonies, currently, are salaried personnel in government and private sectors. The current population in these areas is estimated at 300,000. This includes several slum clusters that have grown in the peripheries of these resettlement colonies. Also included in this belt are Khanpur, Deoli and Tigri villages, whose land was acquired for these colonies.

Annual incidence rate in these colonies was 14.2 per 100,000 in 1994 that rose to 23.4 per 100,000 in 1995. It is important to remember that unlike other zones where the incidence of cholera declined in 1995 as compared to 1994, in case of South and Central Zones (combined), incidence rose by about 25%. There was a decline in cases between 1996 and 1998. In 1999 and 2000, cholera was back in this belt with incidence rates similar to the 1994 level. Scarcity of water remains a problem in these colonies. Further, at many points water pipelines pass through open drains along the lanes and by-lanes rendering the households vulnerable to water borne infections.

Unauthorized Colonies

Adjacent to these resettlement colonies is Sangam Vihar, one of the largest unauthorized colonies and proudly claimed by the local promoters and property dealers as the “largest unauthorized colony of Asia!” This colony is located on rocky terrain that constitute part of the southern ridge. Construction of houses began around 1985 and the current population is estimated at about 200,000. The early group of settlers were migrants belonging to Haryana, Uttar Pradesh, Bihar, Bengal and Kerala. They were already residing in Delhi for several years and had accumulated a certain amount of capital to buy a plot of land and construct their own house.

There are still many vacant plots to the extent that this colony does not suffer from any congestion except for a few arterial roads. Water source is almost as a rule groundwater. As the terrain is rocky, handpumps have to be sunk deep and this is relatively a more
expensive venture than in many other areas of Delhi. Water is therefore purchased either from individuals who have sunk deep bore pumps and laid down private pipe networks, or, from private tankers who sell untreated groundwater. As the colony is unauthorised there is no provision for sewers, drains or paved roads. Gradually, over the last five years, some development activity has taken place through the utilisation of funds allocated to the MLAs and Municipal Councillors. A small proportion of houses located along the Mehrauli-Badarpur Road have access to public hydrants.

Annual incidence of cholera was nearly uniform during 1994-99 with an average annual incidence rate of about 12.5 per thousand population. During 2000, the incidence rate was only about 25% of the previous level. There were efforts by the Delhi Jal Board that possibly explain this improvement - large scale deployment of water tankers and the sinking of Mark II (deep bore) handpumps.

Badarpur is located on the Mathura Road near the Faridabad (Haryana) border. This is the commercial hub of the entire area with the Badarpur Thermal Power Station of the National Thermal Power Corporation dominating the skyline. With the power plant and transport industry as major employers, this area has been populated by large numbers of people. They include many who work in the industries of Faridabad. Land belonging to the villages of Badarpur, Tajpur, Mithapur, Jaitpur, Jasola and Ali were sold off as residential plots and large unauthorised colonies came up stretching from the Mathura Road (National Highway No. 2) to the River Yamuna. The estimated population in these areas is about 500,000.

For the unauthorised colonies there is no piped water supply. Groundwater is either accessed by handpumps or bought from the private tankers. The unauthorised colonies have 'sanitary latrines' with dug wells or they use the open fields for defecation. Tajpur is located on a portion of the ridge. There was a large stone quarry here that was mined for building material; the village is therefore also called Tajpur Pahari. There is no mining activity now but the abandoned mining pits act as natural drainage for the colonies that are situated on the heights above the pits. Incidence rate was 7 per 100,000 population in 1994 and it increased sharply to 11.4 per 100,000 in 1995. Since 1996, the incidence rate remained at about 8 per 100,000 with little variation across the years.
Regularised Colonies

Govindpuri began as an unauthorised colony while Kalkaji was a planned colony; both set up in the aftermath of the Partition. Later Govindpuri was regularised. Both these colonies remain essentially residential. Kalkaji benefited from the development programmes of the DDA while Govindpuri expanded in a haphazard manner. Water and sewer pipelines were installed later in the narrow lanes of the colony leading to numerous potential points for contamination where the water pipelines pass through sewers.

JJ Clusters

The Okhla Industrial Area is a large industrial area located on the Delhi-Agra railway line that has been built on the land from Tehkhand Village. Employees of these industries are generally residing in different colonies of this vulnerable belt and the poorest of them live in several large slums that are located within the Industrial Area. There are several large slum clusters in Govindpuri also. The Okhla Industrial Area, the Tughlakabad Container Terminal of the Railways and several other large factories provide employment to residents of these clusters.

The DJB piped water supply in these areas is dual. The supply from the Okhla plant has to be augmented with the help of deep tubewells with its own set of problems as detailed above. Moreover, on account of the rocky terrain, there are some water-deficient 'hotspots' (within these vulnerable areas) that are located against the gradient. In addition tankers of the DJB also augment the water supply.

Urbanised Villages

The urbanised villages in South and Central Zones (Chiragh Dilli, Garhi, Jamroodpur, Kotla Mubarakpur, Madanpur Khadar, Hauz Rani, Masjid Moth, Mehrauli, Lado Sarai, Neb Sarai and Shahpur Jat) are highly vulnerable for cholera. Building activities are unregulated in these urbanised villages. There are large numbers of tenants with very little per capita space and often with one toilet for several families. Open drains are covered to maximise space. There are large numbers of one/two room industrial-cum-residential
units; many of them deal in garments meant for export. There is intense commercial utilisation of space.

Environmental sanitation is poor. Street foods and drinks are sold in unhygienic conditions. There is acute shortage of piped water supply which is almost as a rule through DJB deep tubewells with chlorinators and its attendant problems as elaborated above. There is large scale use of use of deep bore motors and on-line boosters to augment water supply. Because of unreliable and inadequate water supply, storage of drinking water is high and domestic contamination is common. Water and sewer lines passing in close proximity/crossing each other in narrow lanes are additional vulnerability factors.

Cholera situation in these urbanised villages is best described as endemic with focal outbreaks. The conditions outlined above favour the endemicity of cholera which is the case for all of these villages. The focal outbreaks are generally due to public health engineering faults either in the pipelines or in the tubewells.

**Shahdara (North) Zone**

There has been a general decline in the incidence rate of cholera cases in Shahdara (North) Zone during the period 1994-2000. The incidence rate has shown a steady decline from 29.7 per 100,000 in 1994 to 7.2 per 100,000 in 1997 and further down to 4.6 per 100,000 in 2000. Though the 1988 epidemic of cholera (with an incidence rate of 55.7 per 100,000) took a major toll in different areas of Shahdara, the study period (1994-2000) shows that the average incidence rate of Shahdara (North) is 11.76 new cases per 100,000. The peak incidence is during the monsoon – July and August.

Shahdara has traditionally been a trading centre (Gupta, 1981) even before the British arrived in Delhi. The rail link established by the colonial rulers further boosted the commercial activities and established easy access to United Provinces (Uttar Pradesh). The zone witnessed an accelerated phase of growth during the 1970s when the local Member of Parliament Shri H. K. L. Bhagat was the Congress Minister of State for Works and Housing. Dupont et al (2000) considered that he had "undoubtedly played a
major role in both official and unofficial developments in the colonies"; as a result resettlement colonies and unauthorised colonies were set up housing large numbers of socio-economically weaker groups. A number of small household industries mushroomed in the area. Industrial Areas were also set up to provide employment to the increasing numbers of people. The 1988 cholera epidemic hit the resettlement and unauthorised colonies the hardest. The unauthorised colonies and slum clusters also depict a ribbon development along the Yamuna Pushta and the Wazirabad Road. There were a large number of unregulated and polluting industries in this zone that were closed down following the directions of the Court during 1998.

The population density of the zone is 17,200 per sq. km. with pockets of high population density of socio-economically poor groups in resettlement and unauthorised colonies. The average availability of water in the zone is 130 lpcd (DUEIIP, 2001). The number of shallow handpumps is high as poorer communities often do not have the means to afford the piped supply. Large areas of this zone are without sewers. Many of the colonies have community latrine blocks that are operated either by the Municipal Corporation of Delhi or the Sulabh Shauchalaya.

During the study period the proportion of reported cases from vulnerable colonies has remained steadily above 80% with an average of 84.31%. The vulnerable colonies of the zone include several resettlement colonies - Brahmpuri, Gokulpuri, New Seelampur, Seemapuri (Old and New), Nand Nagri and Sunder Nagri; JJ clusters in Shastri Park area; urbanised villages - Khajuri Khas, Bhajanpura, Dayalpur and Gamri; and, unauthorised colonies in Sonia Vihar and Karawal Nagar areas.

Resettlement Colonies

The Resettlement Colonies of Shahdara (North) include Brahmpuri, Gokulpuri, New Seelampur, Seemapuri (Old and New), Nand Nagri and Sunder Nagri were set up in 1974. Residents of slum clusters from Jama Masjid, Turkman Gate, Daryagunj, Ajmeri Gate, Minto Road, Kashmiri Gate, Sunder Nagar and Friends Colony were relocated here. The total population of these colonies is currently estimated at about 800,000. The better-off residents of these colonies are skilled wage workers in government and organised sectors. A sizeable proportion of the population is self-employed. Slum clusters have
come up in the fringes of these colonies and the residents of these clusters are generally employed as labourers in small unregulated industries and the transport/goods sector.

These colonies have access to piped water supply, largely through public hydrants and household level connection for a smaller proportion of residents. The quantum of piped water supply is inadequate to meet the demand. Therefore shallow handpumps installed at private initiative and cost are abundant. The superficial table of groundwater is unfit for human consumption without any purification and therefore constitutes an important risk factor for cholera. Sanitary latrines are available in the form of community latrine blocks. It is not uncommon to come across 'sanitary latrines' constructed at the household level. They simply empty into the open drains along the lanes. With water pipelines often crossing these drains, the risk of waterborne diseases (and cholera) is compounded. In addition open defecation is not uncommon particularly by small children. The open drains are generally in a state of poor maintenance. The environmental sanitation is generally poor and average at best.

Among these colonies, the incidence rate of Brahmpuri did not decline in contrast to the general trend of the Zone. Throughout the study period it remained at the same level with hardly any fluctuations. Though this area was a recipient of the Bhagirathi Plant water supply, the demand outstrips the supply. As a result, the use of shallow handpumps remains high.

In case of Gokulpuri (and its adjoining area of Mustafabad that consists of unauthorised colonies set up at about the same time) the rate of decline was slower than the Zone as a whole. The real decline started in 1996-97. But in 1998, when there was an upward in most of the areas, the decline in this area continued. A possible reason could be that piped water supply came in later than many of the other areas in the zone.

Nand Nagri and Sunder Nagri gained notoriety during the 1988 epidemic as a hotspot. In 1994, the incidence rate was about 20 per 100,000 from these two colonies, almost double from its two neighbouring villages – Mandoli and Saboli, and unauthorised colonies around the villages. Incidence in the resettlement colonies halved by the next year. Incidence of cholera cases in Mandoli and Saboli also declined over the period 1994-2000. The decline continued and in 2000 there were only 2 cases in the entire year from
the resettlement colonies and only one from the villages. The improvement in water supply, on account of the Bhagirathi plant has worked wonders for this area.

The annual incidence rate in Old Seemapuri and New Seemapuri in 1994 was about 73/1000. The cases in Seemapuri are located more in the slum clusters than in the resettlement colony. These slums are among some of the poorest areas in Delhi with skeletal infrastructure. The sanitary conditions are appalling in some areas. While the annual cases halved in the Zone, cases in Seemapuri actually registered a rise in 1995. There was a sharp decline in 1996-97 and like the Gokulpuri area there was no rise even in 1998. Only 5 cases were reported in 2000; they were all confined to the slum clusters and none belonged to the resettlement colonies.

New Seelampur area was badly affected in 1994 with an annual incidence rate of about 42.7 per 100,000. There was a steady decline till 1997. In 1998, this area demonstrated the maximum increase in number of cases compared to other vulnerable colonies, with an annual incidence rate of 8 per 100,000. The incidence rate in 1999 remained at the same level and marginally declined in 2000. New Seelampur holds a strategic position in as much as being the gateway to Delhi from the Shahdara side. With excellent transport connections, this colony enjoys a prime position both as residential and commercial areas. The population density is one of the highest in east Delhi and hygienic conditions one of the poorest with a whole range of unregulated commercial activities including food trades. The use of shallow handpumps is high as the piped water supply is inadequate to meet the demand.

Adjacent to New Seelampur is the Shastri Park – Taj Colony vulnerable belt. This belt along the eastern bank (the pushta in local terminology) is followed by the Gamri-Dayalpur-Bhajanpura belt and then across the Wazirabad Road the Khajuri Khas-Sonia Vihar belt.

**JJ Clusters**

During 1974-75 several slum clusters came up on the G. T. Road near the Old Bridge which gradually grew into a colony called Shastri Park. With the construction of the ISBT Bridge, transport and communication facilities for these clusters improved and they expanded rapidly.
along the G. T. Road, another group of slums developed into the Taj Colony. The population of these group of colonies is about 45,000. The residents of these colonies are migrants from Rajasthan, Gujarat, Bihar and Uttar Pradesh. The population is socio-economically poor with most of the males working as labourers.

Water supply is through public hydrants. The network of these hydrants is by and largely confined to the main roads. The clusters slope away from the main road towards the river bed. The peripheral parts of the colony are prone to water logging and occasional flooding from the Yamuna. The households that are located away from the main road often do not access the public hydrants and instead rely on shallow handpumps. Open defecation has led to contamination of groundwater in these colonies. The sanitation services are also poor, particularly in the peripheral parts of the colonies.

The annual incidence rate in 1994-95 was about 32.5 per 100,000. After a drop in 1996, the incidence rate was back to this level in 1997. In September 1997 Shastri Park was brought under the coverage of water tankers by the Delhi Jal Board, a practice that continued throughout 1998. As a result, cholera cases declined. The construction of Metro Rail in this area resulted in disruption of roads and the withdrawal of tankers. Shastri Park was particularly badly affected with a high incidence rate of 225 per 100,000. The tankers were brought back and the situation improved in 2000. Interestingly, till 1996, the cases in this belt were confined to the months of June-September, with a preponderance towards September. Since 1997, about 25% of the cases were reported during October-December till 1999. In 2000, all the cases were reported during October.

Urbanised Villages

Khajuri Khas, Bhajanpura, Dayalpur and Gamri villages with an estimated population of 35-40,000 were cholera endemic areas. They benefited greatly from the enhanced water supply from the new plant. Incidence rate declined from 60 per 100,000 in 1994 in this belt to only 5 per 100,000 in 2000.

The estimated population in the Maujpur and Ghonda villages is about 35,000. The annual incidence rate in 1994 in this belt was an average of about 35 per 100,000. There was a rapid decline in the incidence of cholera since 1995 with additional water being
available from the new plant. Even during the 1998 spurt of cases in other areas, Maujpur-Ghonda was not badly affected. However, in the last week of May and early June in 1999, there was a focal outbreak in the area owing to contamination on account of leakage in a water pipe and 8 cases were reported in about 16 days. Following repairs, the outbreak was controlled.

Unauthorised Colonies

Within a kilometre of the Wazirabad Barrage lies Khajuri Khas village. Since 1977-78, land of this village was sold off as residential plots and several unauthorised colonies grew in this area. The Khajuri area is protected by a spur. In between this spur and the previous spur (towards the river), Sonia Vihar, an unauthorised colony, began to grow since the second half of the 80s. At the time of the 1994 epidemic, Sonia Vihar proved to be most vulnerable and the incidence rate was nearly 500 per 100,000 as the colony was still katchi (meaning, raw/undeveloped, in local parlance), than its neighbour Khajuri Khas and the extensions. Sonia Vihar, at that time consisted of spread out houses with a large proportion of available plots still vacant. The current population of Sonia Vihar is about 20,000. The migrants were largely from Bihar, Bengal and Uttar Pradesh. The only source of water supply was shallow handpumps and defecation, almost as rule, was in the open fields. the colony being low lying and on the flood plains of the Yamuna hardly has any outfall for wastewater.

Moreover, the incidence was confined to just two months – July and August. The incidence rate had halved by 1995 and the cases were spread over four months, June-September. There was a gradual reduction till 1997 and the incidence rate was about 200 per 100,000 in 1998; cases were reported from April to October. By 1999, one case was reported in November as well. Cholera become truly endemic in Sonia Vihar. With the deployment of tankers in 1999-2000, the incidence of cases declined but the environmental situation remains unhealthy.

Moving north-northeast from Wazirabad Barrage along the Wazirabad Road are two villages Karawal Nagar and Johripur and their unauthorised extensions. Uttar Pradesh lies on this side of the Wazirabad Road and there are several colonies in Delhi that have to be
accessed through U.P.; so peculiar and convoluted is the nature of growth and expansion in this part of Delhi.

The unauthorised colonies in these areas began to be established during the late 1970s and the peak growth took place in the first half of the 1980s. The residents were generally migrants from Uttar Pradesh including its hill districts. Later pockets of Bihari and Bengali migrants also developed, particularly in the Karawal Nagar area. Many of them were working in Delhi for quite some time in salaried positions including the government and organised sectors. Some of them were small traders. There were entrepreneurs who set up small industrial units which in turn acted as a 'pull factor'. With the Wazirabad Road providing bus services to different parts of Delhi those working in industries in other parts of Delhi and Ghaziabad (U.P.) have also been shifting to these colonies, living in rented accommodation or purchasing plots and constructing their own houses.

The population in the Karawal Nagar is about 250,000. A large proportion of the population in these colonies are dependant on groundwater through shallow handpumps. The liquid waste is drained through open drains into several larger drains. The general sanitary conditions are poor and water pipelines passing through choked open drains pose additional risks. The annual incidence rate in 1994 was about 75 per 100,000. The rate halved by 1995, in tune with the general decline in the zone and this trend continued till 2000.

In Shahdara (North) Zone, 83% of the cases in 1994 occurred in July-August. In contrast, only 63% of the cases occurred in these two months in Civil Lines Zone, its neighbour across the river. The contribution of these vulnerable colonies remained at an average of 84.28% and ranged between 81.14% and 87.74%. though there was a sharp decline with the commissioning of the Bhagirathi plant, the contribution of these vulnerable colonies to the total case load of the Zone did not register any decline.

**Shahdara (South) Zone**

Even during the 1988 epidemic, the areas that presently constitute Shahdara (South) Zone were not much affected. Average incidence rate for the period 1994-2000 is 5.5 cases per
100,000. Annual incidence rate, like Shahdara (North), has also shown a steady decline from 7.8 per 100,000 in 1995 to 2.5 per 100,000 in 2000. This zone was carved out of the erstwhile Shahdara Zone in the aftermath of the 1988 cholera epidemic. Following the 1947 Partition, large groups of population were rehabilitated near the Old Yamuna Bridge. Later, several resettlement colonies were also located in this zone. Industrial areas were also set up. Industries also came up in adjoining areas of Uttar Pradesh including NOIDA and Sahibabad providing employment to large numbers of people. Large cooperative group housing societies for the middle class were also set up in some parts of the zone leading to the growth of tertiary services sector. The economy of several urbanised villages boomed. All this led to the settling down of large populations of poor migrants in settlements that now form the vulnerable colonies as far as cholera is concerned. The population density of the zone is 20529.41 per sq. km.

Despite the Bhagirathi plant, the average water supply in the zone is about 130 lpcd (DUEIIP, 2001), and the supply is not uniformly distributed throughout the zone. Shallow handpumps are there in large numbers among the poorer communities where water supply is inadequate. Some of the better off households have their own bore-wells while group housing societies have deep tubewells. A much larger proportion of areas in this zone is served by sewers compared to its neighbour – Shahdara (North) Zone.

An average of 74.31% of the annually reported cases are reported from the vulnerable colonies. What is of concern in this zone is the fact that there has been an increasing trend in the incidence of cases in the vulnerable colonies 1998 onwards with a maximum of 83.33% of cases being reported from vulnerable colonies in 2000. The vulnerable colonies in this zone consist of resettlement colonies – Old Seelampur, Trilokpuri, Kalyanpuri and Khichripur; regularised colonies in Kailash Nagar, Gandhi Nagar, Laxmi Nagar and Shakurpur areas; urbanised villages – Patpargunj, Mandawali; and, unauthorised colonies surrounding the Kondli and Gharouli Villages.

Resettlement Colonies

Old Seelampur is a resettlement colony that was set up along with other resettlement colonies of Shahdara (North) Zone. This colony was constructed on the agricultural land of the Seelampur Village. Later there were unauthorised extensions (called Shanti...
Mohalla on the peripheries of the resettlement colony. There are a number of small unregulated industries in these unauthorised settlements.

In 1994 the incidence rate was about 18 per 100,000 and most of the cases were reported between June and November. There was a steady decline in the incidence of cases in this colony to zero cases in 1999. There was no spurt in 1998 either. There was a focal outbreak in two blocks in September 2000 with 4 cases being reported.

Trilokpuri, Kalyanpuri and Khichripur are three resettlement colonies adjacent to each other. They were established during the Emergency (1975-77). The initial group of settlers were those relocated from slums of south Delhi. The picture in these resettlement colonies is no different from that of the other resettlement colonies of this batch. The total population of these colonies is about 70000. During 1994-97 the average incidence rate was about 15 per 100,000 each year. However, with no improvement in the water-sanitation situation, the incidence rate doubled during 1998-2000. Further, over the years, slum clusters have come up in all the three resettlement colonies. Most of the reported cholera cases are from the slums where the population is dependent on shallow handpumps for water.

Regularised Colonies

Kailash Nagar and Gandhi Nagar areas were set up after the Partition and migrants of poor socio-economic status from the erstwhile West Punjab settled down here. These colonies are located next to the G. T. Road and the Delhi-Shahdara line at the eastern end of the Old Yamuna Bridge, which is a double-decker bridge carrying the railway line and the road and is the oldest link between Delhi and the eastern states of India. The governmental support that was received by colonies like Lajpat Nagar and Malviya Nagar was conspicuous by its absence in these parts of Delhi.

These colonies are located on the eastern embankments of the river. On account of the bridge and the strategic road and rail links, the embankment was built high and the waste water from these colonies had a natural gradient towards the river. Over time the colonies grew into a vibrant market of readymade garments and population increased. With increased wealth and increasing population, four and five storied buildings came up.
Throughout 1980s, export of garments to the erstwhile USSR boosted the economy further. Following the collapse of the USSR, the export component declined but the wholesale market continues to cater to domestic needs.

Unfortunately, despite a vibrant local economy, the basic services did not improve much in these colonies with big houses along narrow lanes. Each house has piped water supply. The 'sanitary latrines' empty into open drains that finally drain into a major drain at the end of the colonies, away from the river, and, against the gradient. The untreated liquid waste from this major drain is finally emptied by a pump, without treatment, into the river at a point close to the Old Bridge. Environmental sanitation is poor. Solid waste is lifted and carried outside with the help of buffalo carts.

The current population is estimated at 200,000. The annual incidence rate in 1994 was 4.7 per 100,000 population. 1995 witnessed a collapse in the drainage system. The 14 cholera cases (double that of 1994) was only the tip of the iceberg. There were nearly 450 cases of viral hepatitis E as identified during house to house surveys. Thereafter there was a slow decline in the incidence of cholera cases.

Further downstream along the river Shakurpur and Laxmi Nagar (that started as unauthorised colonies and were later regularised) form a contagious belt of vulnerable colonies. The population of this belt is about 30,000. Shakurpur and Laxmi Nagar are large business areas that are densely populated with poor sanitary conditions. The incidence rate ranged from, 6-8 per 100,000 population during the period 1994-2000 with little fluctuations.

Urbanised Villages

Patpargunj and Mandawali are urbanised villages that have witnessed phenomenal growth with the growth of industries and real estate in the village. The current population is about 150,000. The agricultural land has been sold off as residential plots and large colonies have grown over the years since the 1970s. The proximity of this area to the commercial hub of New Delhi, ITO and Connaught Place, have boosted growth enormously. Though basic infrastructure is available in these villages they are unable to meet the demand. On-line boosters and handpumps are essential to meet the demand for water. The population
residing in these villages and colonies are low-middle income groups. Some of them are well-to-do traders and entrepreneurs. The incidence rate was about 5.3 per 100,000 in 1994 and it nearly doubled in 1995. With no change in ground conditions, there has been no decline of cholera in this belt during the study period.

Unauthorised Colonies

The nineties have witnessed a spurt in the growth of unauthorised colonies in the quadrangle bounded by NOIDA (Uttar Pradesh), the NOIDA Road (running parallel to the Yamuna), the Ghazipur Canal and the National Highway 24 Bypass (to Hapur, Uttar Pradesh). The land in this belt is low lying and accessing of water through shallow handpumps costs little. The Ghazipur Canal offers an easy way out for (untreated) liquid waste. The industrial and commercial activities of NOIDA and adjacent areas of Sahibabad and Ghaziabad (Uttar Pradesh) are sources of employment for most of the residents of these colonies. The availability of good roads and an efficient road transport have led to further stimulation of growth. The agricultural land of the two villages in this area – Kondli and Gharouli – have been sold off as residential plots. Simultaneously, these two villages have also become congested with rise in tenancy and expanding markets. The current estimated population in this belt is about 80,000. The majority are salaried employees and others are small traders.

In 1994, the annual incidence rate was 38.3 per 100,000. This was the most severely affected belt in the Zone and there was a marginal decline in 1995. After a brief respite in 1996-97, cholera was back in 1998 and continued at similar levels till 2000 at an annual incidence rate of 14.5 per 100,000. There have been little inputs in these colonies to improve water supply and waste disposal services.

The contribution of the vulnerable colonies to the total case load of Shahdara (South) Zone is quite high at an average of about 75% throughout the study period. In terms of the number of cases the 1998-99 peak is nearly identical to the 1994-95 levels. It was only in 2000 that the total cases in the Zone was at a low of only 36. Of the vulnerable areas, the newly established unauthorised colonies and the resettlement colonies continue to be
critical with these two colonies alone accounting for nearly 81% of the cases of the entire zone.

**Sadar Pahargunj Zone**

The average annual incidence for the period 1994-2000 was 5.7 cases per 100,000 with a high of about 11 per 100,000 in 1994, when a major outbreak occurred at Nabi Karim. The peak months were observed to be August and September. Cases continued to be reported through October as well though at lower incidence levels. Cases have been reported in November every year since 1998.

The characteristics of this zone is similar to that of its neighbour – the City Zone. This zone is a mix of residential and market areas. The resident population is comparatively of lower socio-economic status than the majority of population in the City Zone. In addition to wholesale markets there are small manufacturing units. The slaughter house is located here and trades associated with meat, hide, leather and other related products form an important component of the economy here. This industry has recorded a decline following the reduction in the number of animals slaughtered at the slaughter house as per the stipulations of the High Court (Delhi Statistical Handbook, 2000). The population density is as high as 98,250 per sq. km.

Average water supply is adequate at 205 lpcd (DUEIIP, 2001). There are however, pockets of water scarcity; shallow handpumps and on-line boosters are present in these areas. The entire zone has sewerage services.

The vulnerable area is only one large unauthorised colony, Nabi Karim, that has been regularised.

**Regularised Colonies**

The population of Nabi Karim is about 10,000. The wholesale business areas, small industrial units and, the railway goods yard are located here and are major sources of employment.
Nabi Karim began as an unauthorised colony near the Lahori Gate Railway Station on a graveyard. The resident population is socio-economically poor. During the past several decades, the area has witnessed setting up of industries, particularly, of bags, suitcases and folding furniture. The colony is located at a relatively higher elevation and water does not reach those households located at higher gradient. Further, the leakage of old and corroded pipes in these old areas also lead to contamination. The average life of a service pipe is 10-15 years and that of the main lines range from 50-100 years. The service pipes are rarely changed by the owners unless there is a major problem. On its part, the DJB manages to change annually about 90-100 km of pipeline against a target of 400 km. In fact, during routine surveillance of water quality, these areas often report absence of residual chlorine at the consumer end. There are several slum clusters in this area where piped water supply is only through public hydrants and the communities are dependent on shallow handpumps.

These areas were severely affected in 1994 when there was a focal outbreak on account of the old corroded pipelines. Owing to some urgent action by the DJB, the situation was rectified and cholera was under control in this area till 1998, when about 2 to 4 cases were being reported annually. The situation worsened in 1999 when availability of water became a problem with very little allocation for the area though ironically it is situated within 2 km of the Idgah Reservoir of the DJB. There were 34 cases in 1999 and 19 in 2000.

With water scarcity being acute there are booster pumps in a majority of the households that accentuate water contamination. Shallow handpumps are also in use in a number of households. There are pumps installed to draw out ground water as well and some of them function as community sources rather than individual sources. At a few places the community has installed large overhead tanks which are filled up from these pumps and utilised throughout the day. The groundwater that is extensively being used is however not treated and renders the community vulnerable to waterborne diseases. The DJB is in the process of constructing a reservoir for this area to improve the availability of water. But even as a stop-gap measure, the water supply cannot be augmented through tankers as the lanes are extremely narrow.
Since 1998, there is a sharp rise in the contribution of vulnerable colonies to the cases load for the zone. In 1997, only 22.22% of the cases were reported from the vulnerable colonies; the corresponding figures for 1998, 1999 and 2000 are 50.00%, 60.29% and 63.64% respectively. Nabi Karim holds the key to the incidence pattern of cholera in Sadar Pahargunj Zone. The decreasing trend for 1994-97 and the rising trend for 1998-2000 are identical for Nabi Karin and the Zone. However, the contribution of Nabi Karim to the total cases in the Zone has grown stronger over 1998-2000, with Nabi Karim alone accounting for 58% of the cases against 11% in 1997.

**Karol Bagh Zone**

The average annual incidence for 1994-2000 was 3.7 cases per 100,000. The peak incidence rate was observed during July.

Karol Bagh Zone is a transition between the 'old generation' zones (like City and Sadar Pahargunj Zones) and the 'new generation' zones (like Rohini, or Central and South Zones) and shares some characteristics of both. Historically, the areas where population spilled over from the walled city (Ritu Priya, 1993) comprise the older residential areas of Karol Bagh Zone which have developed into large markets over time. In the peripheral parts of the zone, industrial areas have been established later and these have attracted migrants. The Central Ridge (of the Aravalli Hills) passes through this zone. The population density of the zone is 33,115.82 per sq. km.

Water supply is adequate in most parts of the zone with an average supply of 337 lpcd (DUEIIP, 2001). Supply is from the plants and there are only 26 DJB tubewells in Inderpuri, Todapur, Anand Parbat, Baljeet Nagar and Naraina areas. Shallow handpumps are few in number except in the vulnerable colonies. Almost the entire zone has sewers for liquid waste disposal.

The colonies situated on the higher elevations constitute some of the vulnerable pockets of the zone. The mean proportion of cases from these endemic pockets is 63.04%. The vulnerable colonies include JJ clusters adjoining the railway line in Daya Basti and Patel
Nagar Stations; urbanised villages – Shadipur and Naraina and Baljeet Nagar and Inderpuri Resettlement Colonies.

JJ Clusters

There are a string of JJ clusters on railway land between Daya Basti and Patel Nagar stations on the Delhi-Rewari line. The annual incidence rate in these slums ranges from 22 to 28 per 100,000. There is another group of clusters along the Najafgarh Road (Shivaji Marg) that run parallel to the railway line. The Najafgarh Road/Rama Road Industrial Area is located on this stretch of the road. The industries and a number of fringe trades and services are major employers for the population in these areas, about 75,000 in number. These JJ clusters are densely populated and environmental sanitation is very poor with virtually little service provided to these areas.

Water supply is through public hydrants only in the clusters that lie along the main road. These clusters are at the tail end of the mains that supply this area. Further, the supply is against the gradient as the land slopes upwards towards Anand Parbat (a portion of the Central Ridge). Considering the population, the available water supply is grossly inadequate and that too at very low pressure. In the lanes that have the water lines the pipelines are punctured at regular intervals and rubber pipes are attached to them. The ground is dug out and containers are placed there for filling. The meagre safe supply therefore ends up being contaminated. The local population thus relies largely on shallow handpumps. With open defecation along the railway lines the ground water is also highly contaminated.

Urbanised Villages

Shadipur Village is an urbanised village that is now integrated with the commercial areas of adjoining Patel Nagar. The village is densely populated with a large proportion being tenants. The buildings have been haphazardly expanded to create extra space. The rented out portions are small one-room units with one common toilet for several families. The available water supply is inadequate. Many of the houses have installed on-line boosters.
Naraina Village is another small urbanised village strategically located on the Ring Road bordering the Cantonment area and close to affluent South Delhi. Like many other urbanised villages, the landlords have constructed one-room units for letting out. The tenants belong to the lower middle income group and are largely from the southern states. They are mostly civilian employees of the armed forces or are employed in the corporate sector offices of South Delhi. This village with a population of about 20,000 reported an incidence rate of 0.2 to 0.4 per 100,000 annually.

Resettlement Colonies

Baljeet Nagar is a resettlement colony that was set up in 1977. The residents of slum clusters from Turkman Gate and Matia Khan area were relocated in this colony. The population of this colony is about 6,000. The incidence rate ranged from 6-11 per 100,000.

Inderpuri is another resettlement colony that was set up in 1975. The resettlement colony adjoins Todapur village that borders the ridge. The estimated population of these settlements is about 25,000. The resettlement colony, like other resettlement colonies have become over populated considering their initial plans and provision of basic services. A large proportion of the residents of this colony are salaried employees. There are some residents who work as manual labourers in the adjoining wholesale iron market (Loha Mandi) and the Naraina Industrial Area. No cases were reported during 1996 and 1997. In 1999, Karol Bagh Zone experienced the largest number of cholera cases ever.

City Zone

Annual incidence rate for cholera in City Zone (with an average of 3.4 per 100,000 for the period 1994-2000) ranged between 2.7 per 100,000 population to 6.2 per 100,000. The peak period was from June to August.

This is one of the most densely populated zones. The zone approximately corresponds to the walled city and its extensions. Trade and commerce has flourished in these areas for
centuries. Large wholesale markets abound the zone. There are residential areas as well; overcrowded *katras* and *havelis* are unique to this zone. However, many trader families have moved out over the last several decades as population density increased and newer residential areas developed, particularly in north and west Delhi. Trading is further facilitated by major railway station and the inter-state bus terminuses that are also located in this zone. As a result, large numbers of people are moving in and out of this zone daily, including from neighbouring states. The population density of the zone is 80,000 per sq. km.

Almost the entire zone is served with sewers. Open drains are few and there are hardly any instances of pipelines crossing open drains. Water supply is good at 272 lpcd (DUEIIP, 2001). There are no tubewell supplies and the entire supply is from the plants. Owing to the adequate piped water supply, shallow handpumps are also fewer in number.

The only major vulnerable area in City Zone is a group of JJ clusters that stretch along the Yamuna river bank (the Yamuna *Pushta*, in local parlance), the detail field situation of which is described below.

**JJ Clusters**

A large number of slum (JJ) clusters are located along the west bank of the Yamuna, popularly known as the Yamuna *Pushta*. They are virtually located on the Yamuna bed. The first settlers of this colony arrived around 1965 and most of the growth took place in the second half of the seventies, ironically at a time when slum relocation was undertaken with great vigour, particularly, during the Emergency\(^5\). The initial settlers were from Bihar and Uttar Pradesh though in the later phases of its growth the majority of the migrants were refugees from Bangladesh, both Hindus and Muslims. The current population is estimated at 100,000. These communities are socio-economically one of the poorest in Delhi with most of the males working as rickshaw pullers and labourers in the trading areas of the walled city.

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\(^5\) Some clusters from among these were relocated to areas in Shahdara during the Emergency.
The older parts of the colony are served by public hydrants and the newer parts (closer to the river) rely on shallow handpumps as the only source of water. These clusters are also prone to flooding when the water level in the river rises which accounts for the high incidence rate during the monsoons. There are no sanitary latrines and the overall environmental sanitation is also very poor. These clusters are a major centre for drug peddling and there are a large number of drug addicts in the clusters as well. Several NGOs have recently started providing de-addiction and rehabilitative services. The India Population Project-VIII (IPP-VIII) also has a Centre serving the cluster.

The incidence rate for these clusters was as high as 1.5-1.7 per 100,000 during 1998-2000, a nearly two-fold rise over the incidence in 1994. The incidence rate for these clusters is however lower than that of the zone as a whole. Despite the presence of the IPP-VIII Centre and their outreach family welfare services, there was no positive impact on a disease that affects children.

Therefore the incidence of sporadic cases in City Zone dominates the overall picture rather than endemicity in vulnerable colonies. The contribution of cases from vulnerable colonies to the case load of the zone from being 50% in 1994 has declined steadily to 33.85% in 1999. In 2000 though the proportion of cases in vulnerable colonies shot up to 60%, the contribution of the zone declined to 2.81%.

**West Zone**

Cholera cases reported from this zone are few in number and are sporadic in nature. The average incidence rate is 0.91 per 100,00 population. There are no discernible spatial or time trends. There are thus no endemic pockets in this zone.

The localities in West Zone are essentially a post-Independence phenomenon. A few colonies came up to rehabilitate the refugees of the partition. Other colonies were developed by the Delhi Development Authority (DDA), including group housing societies and individually owned houses. The resident population in these planned colonies are either salaried employees or businessmen and essentially belong to the middle and upper income groups. Schools, hospitals and transport facilities are
adequately available in these zones and meet the local needs. Urbanised villages and resettlement colonies are a few each in this zone. The few unauthorised colonies that came up in the post-Independence phase have been regularised and also have adequate infrastructure. Slum clusters are confined only along the Delhi–Rewari railway line. There are a few industrial areas in this zone but no major trading centres or wholesale markets.

The population density of the zone is 15192.77 per sq. km. Water supply is adequate at an average of 202 lpcd (DUEIIP, 2001). The group housing colonies have their own private deep tubewell supply. The DJB also has deep tubewell supplies in several colonies. The zone has sewerage services in most of the areas.

Table 5.4: Determinants of Vulnerability in Zones

<table>
<thead>
<tr>
<th>Zone</th>
<th>Avg. Inc. Rate (Per /100000)</th>
<th>% of Cases from Vul. Colonies</th>
<th>Predominant Economic Activity</th>
<th>Pop. Density (per sq. km.)</th>
<th>Per Capita Piped Water Supply (lpcd)</th>
<th>Pop. Having Access to Sewers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Civil Lines</td>
<td>33.39</td>
<td>86.94</td>
<td>Small and medium industries, wholesale markets, trading</td>
<td>13,500</td>
<td>274</td>
<td>60%</td>
</tr>
<tr>
<td>Narela</td>
<td>32.05</td>
<td>61.70</td>
<td>Agriculture, agro-based industries</td>
<td>743</td>
<td>32</td>
<td>Nil</td>
</tr>
<tr>
<td>Najafgarh</td>
<td>23.55</td>
<td>73.86</td>
<td>Agriculture, industries, services</td>
<td>1,127</td>
<td>74</td>
<td>25%</td>
</tr>
<tr>
<td>Rohini</td>
<td>22.50</td>
<td>79.92</td>
<td>Trading, transport, services</td>
<td>8,848</td>
<td>274</td>
<td>90%</td>
</tr>
<tr>
<td>South</td>
<td>18.20</td>
<td>77.19</td>
<td>Services, small scale industries, trading</td>
<td>4,237</td>
<td>148</td>
<td>50%</td>
</tr>
<tr>
<td>Central</td>
<td>11.76</td>
<td>86.94</td>
<td>Small and medium industries, wholesale markets, trading</td>
<td>21,486</td>
<td>130</td>
<td>10%</td>
</tr>
<tr>
<td>Shahdara (North)</td>
<td>12.30</td>
<td>64.31</td>
<td>Trading, small scale industries</td>
<td>17,200</td>
<td>130</td>
<td>30%</td>
</tr>
<tr>
<td>Shahdara (South)</td>
<td>5.48</td>
<td>74.31</td>
<td>Services, trading</td>
<td>20,529</td>
<td>50%</td>
<td>100%</td>
</tr>
<tr>
<td>Sadar Pahargunj</td>
<td>5.42</td>
<td>45.43</td>
<td>Wholesale markets, trading, services, small scale industries</td>
<td>98,250</td>
<td>205</td>
<td>90%</td>
</tr>
<tr>
<td>Karol Bagh</td>
<td>3.71</td>
<td>63.04</td>
<td>Wholesale markets, trading, services, industries</td>
<td>33,116</td>
<td>337</td>
<td>90%</td>
</tr>
<tr>
<td>City</td>
<td>3.40</td>
<td>43.30</td>
<td>Wholesale markets, trading, services</td>
<td>80,000</td>
<td>272</td>
<td>90%</td>
</tr>
<tr>
<td>West</td>
<td>1.91</td>
<td>0.00</td>
<td>Trading, services, small scale industries</td>
<td>15,193</td>
<td>202</td>
<td>90%</td>
</tr>
</tbody>
</table>

Note: 1 – DUEIIP, 2001; 2 Personal Communication with Delhi Jal Board
The foregoing section discusses in some detail vulnerability factors that affect at zonal and colony levels. Table 5.4 summarises the key features of each zone.

To sum up, it becomes evident that the availability of civic services has been inadequate for the less privileged. The growth in provision of housing, water and sanitation facilities has failed to keep pace with the demands of increasing numbers, attracted by the growth in economic activities and opportunities. The fallout is seen in the growth of unauthorised colonies, squatter settlements and extension of laldora in urbanised villages. These settlements have emerged as endemic areas for cholera in Delhi.

Civil lines and Rohini Zones have relatively lower population densities, higher per capita availability of water (274 lpcd), higher coverage of sewers (60-80%), and yet, high incidence rates of cholera. Though the "averages" in terms of availability of services, seem to be on the higher side, yet, there are wide disparities among population groups within the zones, including the level of services available to them. In the 2001 Census, North West District which corresponds to the vulnerable belts of Civil Lines, Rohini and part of Narela zones experienced the second highest decadal growth rate (+60.12%) and, much of this growth comprised of population groups of low socio-economic status employed mostly in the unorganised and semi-organised sectors. Therein lies the explanation why 87% and 80% of the cholera cases from Civil Lines and Rohini Zones respectively, are being reported from the vulnerable colonies of these zones.

Across the River Yamuna, Shahdara (North) Zone has experienced similar levels of population growth (+62.5%) during 1991-2001. Shahdara (South) Zone had a growth rate of (+41.61%). Per capita water availability is 130 lpcd and sewerage services are poorer than in Civil lines and Rohini Zones. Yet the incidence rates are much lower. Although the average per capita availability of water in absolute terms is lower, lesser disparities within these zones imply that even the poorer sections actually receive far larger quantities of water than in some other zones with higher average availability. As explained earlier, the rate of decline of incidence in Shahdara North and South zones is

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6 The Central Bureau of Health Intelligence in a surveillance of outpatient data of 20 dispensaries of northern Delhi found that 35% of the patients presented with water-related diseases notably diarrhoea, typhoid and viral hepatitis (DUEIIP, 2001), indicative of high prevalence of waterborne diseases.
largely attributable to the commissioning of the Bhagirathi water treatment plant. However, sewerage services will need to be augmented to fully reap the benefits of added availability of water.

City, Sadar Pahargunj and Karol Bagh Zones have good availability of services. In particular, availability of sewerage services is high for all segments of the population. Despite being zones with the highest population densities, these zones have actually experienced a decline in the population growth rate during 1991-2001. In the backdrop of an average growth rate of (+46.31%) the Central district that roughly corresponds to these three zones, recorded a decadal growth rate of −1.91%. The incidence rates of cholera are among the lowest of all the zones.

The two zones that have demonstrated a definite rising trend in incidence rates towards the second half of the 1990s are South and Central Zones. The apparently low population density of South Zone is misleading as nearly two-thirds of the zone comprises of rural areas with very low population density. In the post liberalisation period, during the 1990s, there was phenomenal growth of the tertiary and services sector based activities in these zones. This growth in economic activity corresponded with a high decadal growth rate of population of +50.27%. The vulnerable colonies of these zones comprise of urbanised villages and colonies located along the Mehrauli-Badarpur Road. The proportion of vulnerable population is more in the South Zone than in Central Zone. The residents of these vulnerable colonies belong to lower middle socio-economic groups. Along with a high population density in these colonies, there is a high proportion of tenancy occupation. There is acute water scarcity and high levels of contamination because of a combination of factors operating at both the colony and household levels. Large disparities exist in the availability of water between these vulnerable colonies and the rest of the zone. The per capita availability of water is only 29 lpcd in these vulnerable colonies, as compared to a zonal average of 148 lpcd.

In this chapter the vulnerability issues have been focussed upon at the colony level. In order to better understand the role of behavioural factors and practices in determining vulnerability at the household level, a primary survey was conducted. In the next chapter findings from this survey along with data from the secondary sources are analysed to gain insights on these aspects.