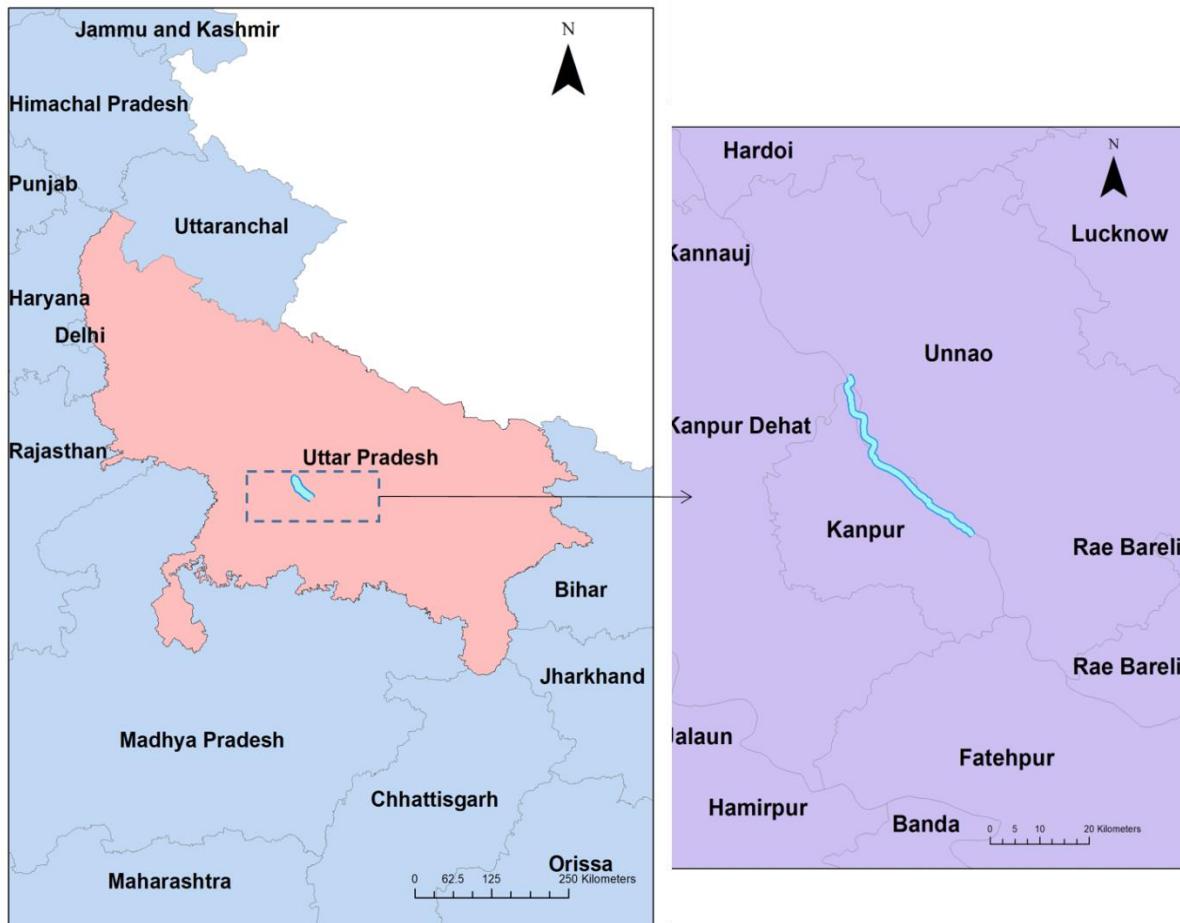


MAPPING OF POLLUTION SOURCES & THEIR IMPACT ON RIVER GANGA

Farrukhababad – Kanpur - Dalmau



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CONTENTS

1. Introduction.....	7
2. Methodology	8
2.1 River Water Sampling.....	8
3. Study Area –I - Kanpur City (09th -11th April, 2019).....	9
3.1 Stretch Wise Monitoring Analysis.....	11
3.1.1 Stretch-1 - Bithoor to Kanpur Barrage (Luv Kush Barrage)	11
3.1.2 Stretch -2 D/S Kanpur Barrage to D/S Shuklaganj	17
3.1.3 Stretch – 3 Downstream Shuklaganj to Deori Ghat.....	23
4.0 Study Area -II- Farukhabad To Dalmau (Rae Bareilly)	37
4.1 Major Sources of Pollution in the stretch.....	38
4.2 Water Quality of River Ganga.....	40
4.3 Water Quality of Tributaries of River Ganga In Farrukhabad – Dalmau Stretch	42
4.4 Water Quality of Tributaries	43
4.5 Drains Monitored in Farrukhabad – Kannauj	43
4.5.1 Drains in Farrukhabad.....	44
4.5.2 Drains in Kannauj.....	45
4.5.3 Drains in Shivrajpur Area, Kanpur discharging into river Noon.....	46
5.0 Conclusion	49
Annexure-I.....	54
Annexure – II.....	55
Annexure-III.....	56

LIST OF TABLES

Table 1 Locations of monitoring and their details	9
Table 2 Drains observed at Bithoor discharging into river ganga	14
Table 3 Details of sampling locations on R. Ganga and its tributaries from Farrukhabad to Raebareli	39
Table 4 Details of drains and flow in Farrukhabad.....	44
Table 5 Analysis report of samples from drain in Kanpur (non-priority drains)	48
Table 6 Analysis results of samples from River Ganga.....	50
Table 7 Analysis results of samples from tributaries in Farrukhabad-Dalmau.....	52
Table 8 Wastewater quality of drains monitored at Farrukhabad and Kannauj.....	53

LIST OF FIGURES

Figure 1 Area of study	7
Figure 2 Graphical details of area of study	8
Figure 3 (A-B) Representation of stretches of river Ganga in Kanpur region along with sampling locations	10
Figure 4 Stretch – I of sampling locations of River Ganga from U/s of Bithoor to Kanpur Barrage	11
Figure 5 pH, FC, DO and BOD values in stretch -1 of river Ganga	12
Figure 6 Sampling location at Murdaha Ghat, Old Bithoor U/s to Bithoor	13
Figure 7 Under construction wetland technology Sewage treatment system on drains at Bithoor	13
Figure 8 Sampling location at Pariyar bridge near Laxman Ghat, Bithoor.....	14
Figure 9 Kanpur (Luv Kush) barrage.....	15
Figure 10 Noon River at Bithoor on Kalyanpur-Bithoor Road (before confluence with river Ganga)	15
Figure 11 Stretch 2 of study area in river Ganga D/S Kanpur Barrage to D/S Shuklaganj	17
Figure 12 Values of pH, FC, DO and BOD at Stretch 2	18
Figure 13 Sampling location at U/s Shuklaganj.....	19
Figure 14 Sampling location at Gola Ghat Kanpur.....	20
Figure 15 Sampling location at Shukla Ganj d/s.....	20
Figure 16 Sampling location D/s Shukla Ganj.....	21
Figure 17 Stretch 3 of study area in river Ganga D/S Kanpur	23
Figure 18 Values of pH, FC, DO and BOD at Stretch 3	24
Figure 19 River Ganga and under construction pumping station near Shitla Bazar, Kanpur	25
Figure 20 River Ganga near Jajmau bridge at Kanpur city.....	26
Figure 21 Wajidpur pumping station in Jajmau area, Kanpur	27
Figure 22 Breach in irrigation channel near Jana village, Kanpur.....	28
Figure 23 Irrigation channel views in Jajmau-Chakeri region carrying treated effluent from Jajamu CETP and STP.....	29
Figure 24 Deori Ghat sampling location with RTWQMS in view	29
Figure 25 DO value at different locations of river ganga at Kanpur	30
Figure 26 BOD value at different locations of river Ganga at Kanpur	30
Figure 27 FC value at different locations of river Ganga at Kanpur.....	31
Figure 28 pH value at different locations of river Ganga at Kanpur.....	31
Figure 29 Overall study stretch view from Farrukhabad to Dalmau and position of tributaries in stretch.	37
Figure 30 Position and number of drains in Kanpur stretch discharging into river Ganga.....	38
Figure 31 View of Dhinapur drain in Farrukhabad carrying coloured effluent	45
Figure 32 Industrial effluent from Shivrajpur drain meeting Noon river near Tikkapurwa	46
Figure 33 Network of irrigation channel in Chakeri region of Kanpur	48

1. Introduction

River Ganga is part of the Ganga-Meghna-Brahmaputra River system. The Ganga River basin is spread over 8,62,769 km² and drains about 26% of the geographical area of India (Central Water Commission - WRIS, 2014). The River flows through five states of India before it drains into the Bay of Bengal. The River flows as River Ganga after confluence of River Bhagirathi and River Alaknanda at Devprayag.

This study has been carried out to identify and assess the impact of discharge of pollution load on the River. The drains either discharge into River Ganga directly or they discharge indirectly through tributaries which ultimately discharge into River Ganga. At present, CPCB monitors identified drains having more than 1 MLD flow. These drains are also named as Priority drains. The drains having less than 1 MLD flow are monitored by State Pollution Control Boards.

Three major tributaries river confluence into River Ganga:

- **Ramganga (LB) - 75 km u/s to Bithoor**
- **Garra (LB) – 65 km u/s to Bithoor**
- **Kali East (RB) –50 km u/s to Bithoor**

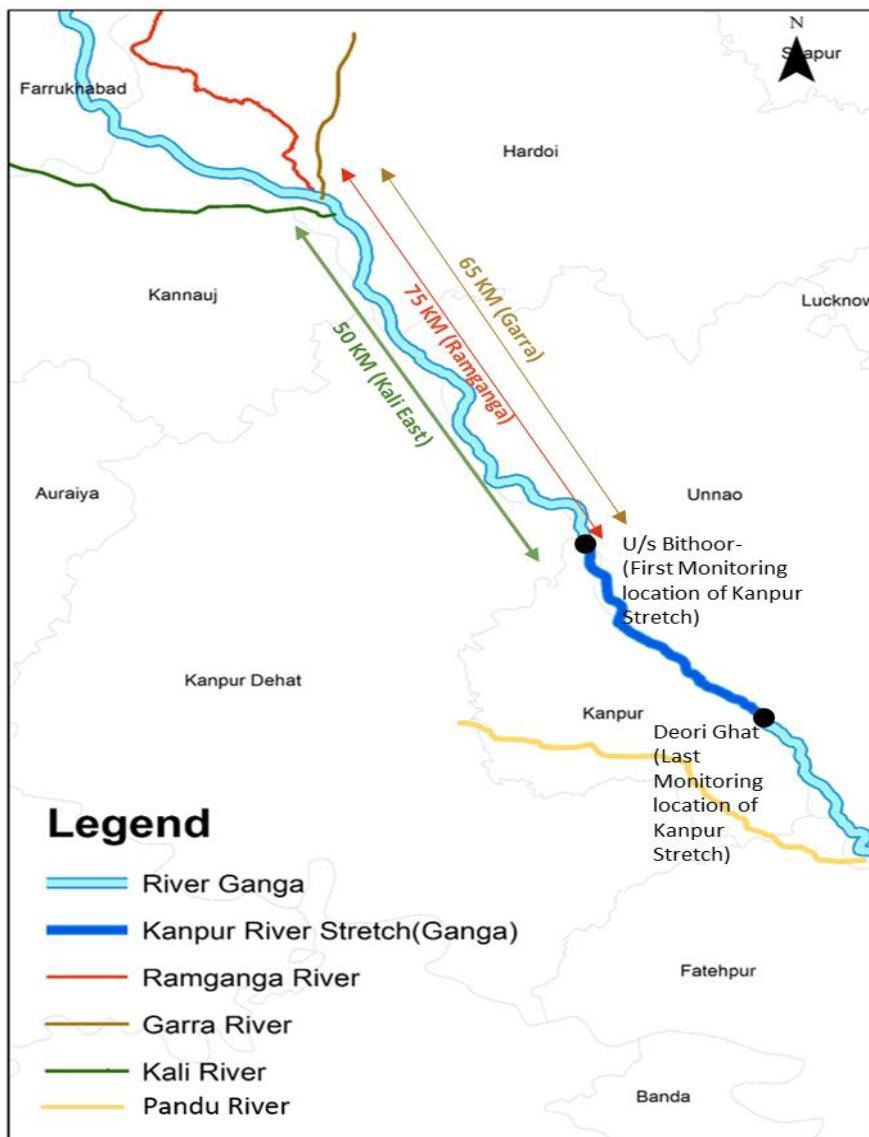


Figure 1 Area of study

2. Methodology

A bottom to top approach is adopted to carry out this study. Initially monitoring was carried out on a city scale basis i.e. for Kanpur city and its nearby areas to understand the impact of all possible sources of pollution even from small drains (having flow less than 1 MLD). After studying the water quality of River Ganga along Kanpur city, the joint team of CPCB and UPPCB carried out monitoring of River Ganga stretch from Farrukhabad to Dalmau (Rae Bareilly) on a regional scale to assess the impact of major pollution sources including tributaries which confluence into River Ganga along this stretch.

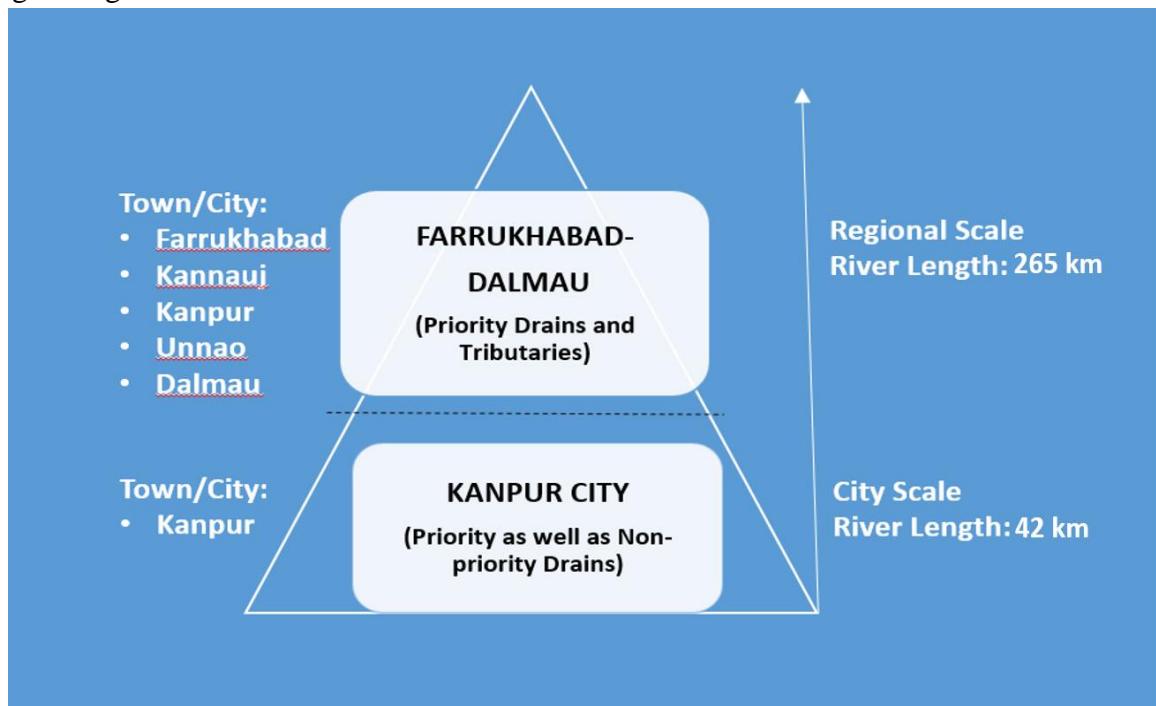


Figure 2 Graphical details of area of study

A joint team of CPCB & UPPCB monitored stretch of River Ganga along Kanpur District (Bithoor to Deori Ghat) and Farrukhabad to Dalmau (Rae Bareilly) during April-July, 2019.

2.1 River Water Sampling

Water quality data in terms of parameters viz. Temperature ($^{\circ}\text{C}$), pH, Total Dissolve Solids (TDS, mg/l), Dissolve Oxygen (DO, mg/l), Biological Oxygen Demand BOD (BOD, mg/l), Chemical Oxygen Demand (COD, mg/l), Turbidity (NTU), Total Phosphate (TP, mg/l), Chloride (mg/l), Fluoride (mg/l), Nitrate (mg/l), Ammoniacal Nitrogen (mg/l), Total & Faecal Coliform (FC, MPN/100ml) was analysed. Samples were stored in bottles and preservatives were added in order to preserve the samples to perform various tests in lab. The DO was measured on-site during the sampling only. Other parameters were measured at laboratories of CPCB (Head Office, Delhi and Regional Directorate, Lucknow). The sampling and analysis of water quality of River Ganga were performed following the procedure methods laid down in the guidelines of CPCB (Guidelines of water quality programme, 2008).

Samples for BOD and bacteriological analyses were stored at a temperature below 4°C and in the dark after sampling. Samples collected for chemical oxygen demand (COD), ammonical nitrogen, total oxidised nitrogen and phenol analysis were preserved below pH 2 by addition of concentrated sulphuric acid. Samples for the analysis for the presence of metals, were acidified

with concentrated nitric acid. After labelling and preservation, the samples were placed in an insulated ice box for transportation.

3. Study Area –I - Kanpur City (09th -11th April, 2019)

The samples of River Ganga were taken at 10 locations. Out of these 10 locations, 07 locations were National Water Monitoring Programme (NWMP) Stations whereas 03 locations were non-National Water Monitoring Programme (non-NWMP) stations. An NWMP station are stations where monitoring is done manually on monthly basis. For present study seven NWMP locations and three Non-NWMP locations were selected in a manner that:

- a. One non- NWMP location, at U/s Bithoor city considered as a control point;
- b. One non-NWMP location at d/s Kanpur Barrage to assess the self-cleaning of River (as there is no discharge of drains upstream upto 10 km);
- c. One non-NWMP location at d/s of Kanpur city to assess the cumulative effect of the pollution load of the whole city.

Considering two aspects i.e. no. of sampling locations and length of River stretch, the stretch of river at Kanpur is divided into three parts as given below:

Table 1 Locations of monitoring and their details

Stretch	Monitoring Locations	NWMP (Yes/No) with Code	Location
Stretch -1	U/s of old Bithoor	No	26°37'32.39"N 80°16'9.17"E
	Bithoor	Yes, (1146)	26°37'1.27"N 80°16'27.41"E
	D/s Kanpur Barrage	No	26°30'25.24"N 80°19'5.38"E
Stretch-2	Bathing Ghat Bhairoghat	Yes (10154)	26°29'40.70"N 80°19'37.31"E
	U/s of Shuklaganj (as Kanpur u/s Ranighat)	Yes (1067)	26°28'49.91"N 80°22'18.23"E
	d/s of Shuklaganj	Yes (10155)	26°28'5.64"N 80°23'11.21"E
	Bathing ghat, Golaghat, Kanpur	Yes (10156)	26°27'58.28"N 80°22'34.18"E
Stretch- 3	Bathing Ghat Jajmau Bridge, Kanpur	Yes (10157)	26°26'5.50"N 80°24'31.72"E
	Kanpur d/s (Jajmau Pumping Station) located at Jana Village	Yes (1068)	26°24'19.86"N 80°27'8.48"E
	R. Ganga at Deori ghat	No	26°22'40.60"N 80°29'25.97"E

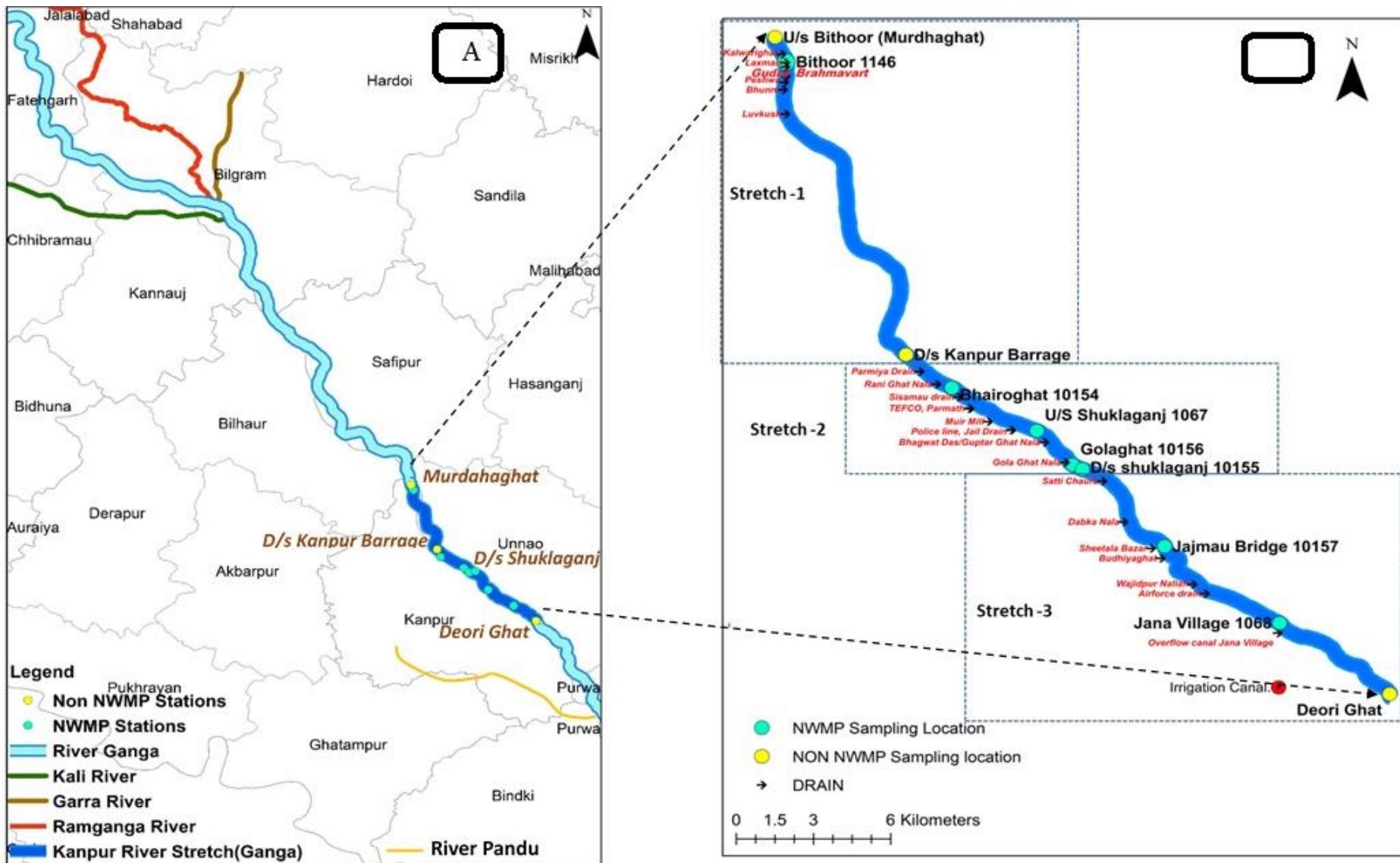


Figure 3 (A-B) Representation of stretches of river Ganga in Kanpur region along with sampling locations

3.1 Stretch Wise Monitoring Analysis

3.1.1 Stretch-1 - Bithoor to Kanpur Barrage (Luv Kush Barrage)

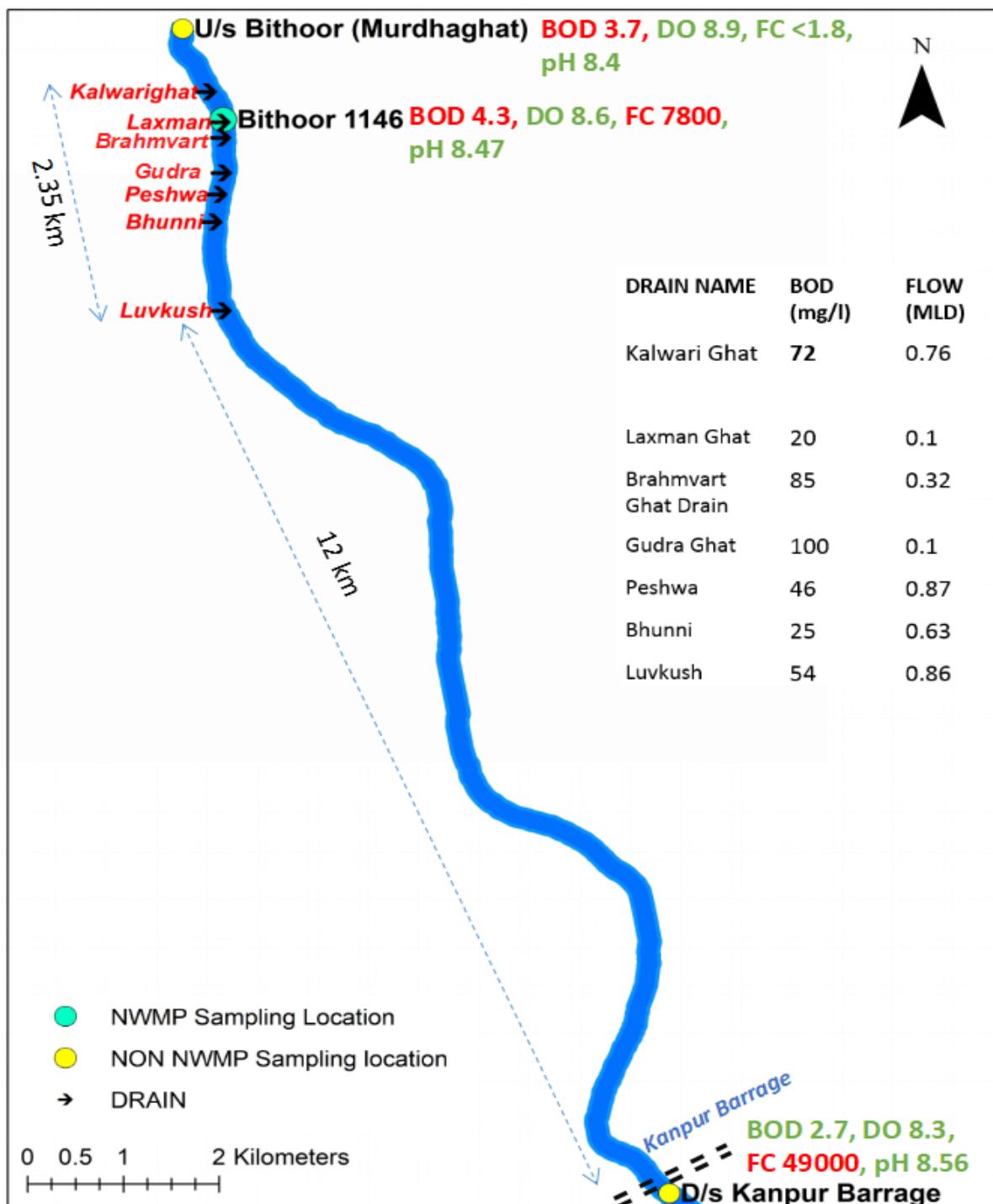


Figure 4 Stretch – I of sampling locations of River Ganga from U/s of Bithoor to Kanpur Barrage

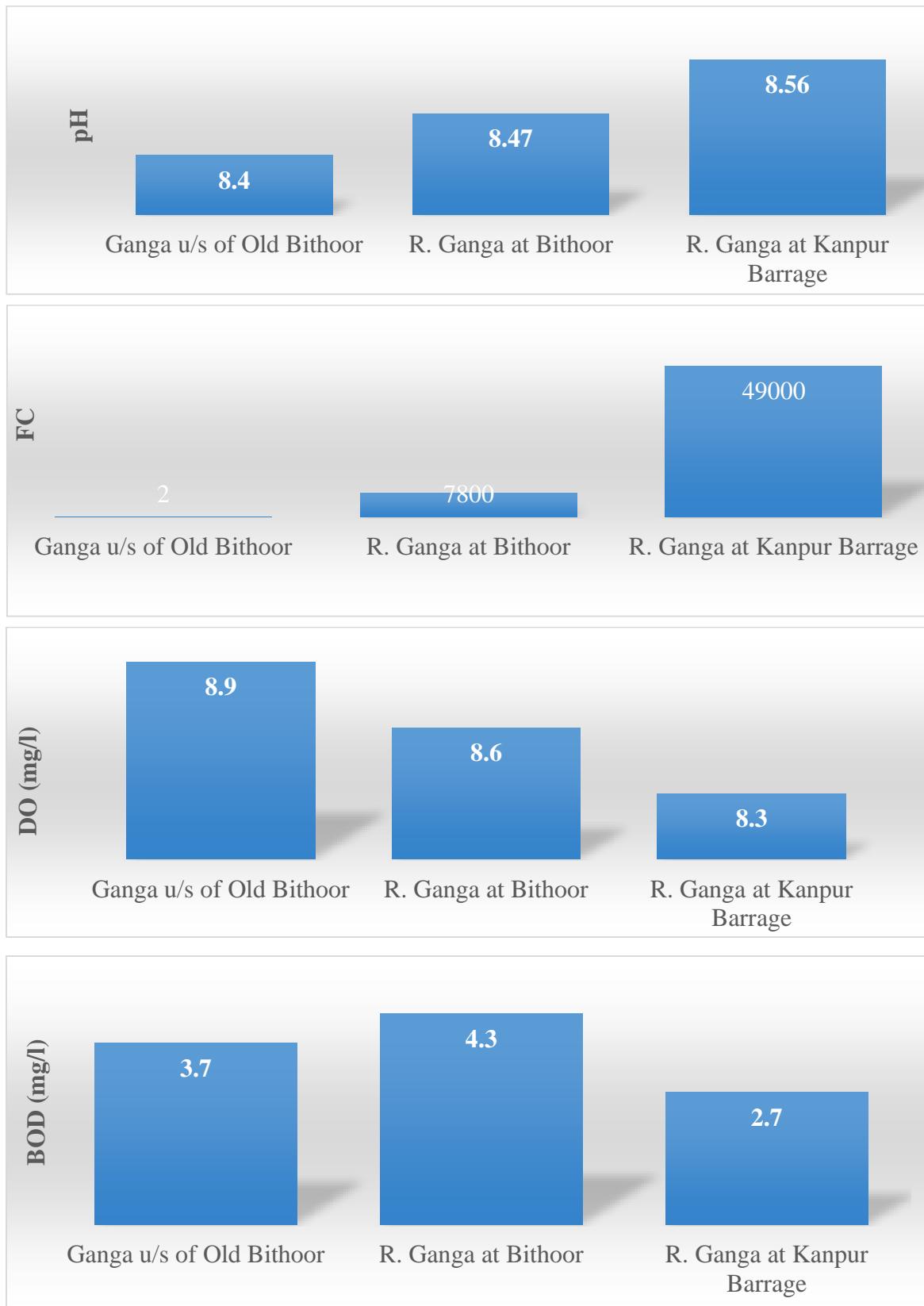


Figure 5 pH, FC, DO and BOD values in stretch -1 of river Ganga

Murdaha Ghat – Non NWMP (Latitude: 26.625618, longitude: 80.26945)

- Murdaha Ghat, (U/s old Bithoor) represents upstream location of Bithoor. This station is considered as a control station. The control station is referred to a station which represents the initial water quality of River before entering into a city.



Figure 6 Sampling location at Murdaha Ghat, Old Bithoor U/s to Bithoor

- The values indicate low faecal contamination at this location but with slightly high organic content.
- DO (8.9 mg/l) as well as FC (<1.8 MPN/100ml) values are found to be complying w.r.t. bathing standards. However, the BOD value is found to be non-complying as against the bathing water quality standard of 3 mg/l.

Bithoor (NWMP Location - 1146) (Latitude: 26.616477, Longitude: 80.272820):

Samples were collected under the Pariyar Bridge and it was observed that seven small drains at Bithoor discharges into River Ganga out of which two drains discharge upstream and five drains discharge downstream to the sampling location. It was also observed that a new STP based on wetland technology system is under construction for all the seven drains in Bithoor.



Figure 7 Under construction wetland technology Sewage treatment system on drains at Bithoor

Table 2 Drains observed at Bithoor discharging into river ganga

S.No.	Drains (Bithoor d/s to u/s)	Estimated Flow
1	Luv-Kush Nala	220 KLD
2	Bhannu Nala	600 KLD
3	Peshwa Nala	100 KLD
4	Gudhara ghat drain	30 KLD
5	Brahmawat ghat drain	50 KLD
6	Laxman ghat drain	30 KLD
7	Kalwari ghat drain	270 KLD



Figure 8 Sampling location at Pariyar bridge near Laxman Ghat, Bithoor

- The values of BOD (4.3 mg/l) and FC (7.8×10^3) at this location are found non-complying w.r.t. bathing water quality standard.
- Two drains Kalwari Ghat and laxman Ghat discharges into River Ganga upstream to Bithoor (1146 NWMP) location resulting into high BOD and FC values
- The DO (8.6 mg/l) and pH (8.47) values are found to be complying.

3.1 Kanpur Barrage (non-NWMP station)

- As mentioned above Downstream to Bithoor (1146 NWMP) location, 05 drains discharge into river Ganga.



Figure 9 Kanpur (Luv Kush) barrage

- The Kanpur Barrage location represents upstream location of Kanpur City and samples were collected from D/s of barrage. The analysis results indicate BOD (2.7 mg/l) and DO (8.3 mg/l) values within the limit prescribed for bathing purpose. The total coliform values were very high i.e. 240000 MPN/100 ml and faecal coliform was 49000 MPN/100 ml which is more than the prescribed limit for bathing water (more than 480 times for bathing).
- Higher values of coliform at this location is due to pooling of water at u/s of barrage and untreated sewage discharge from Bithoor and nearby areas as well as population agglomeration upstream to Luv Kush Barrage (Kanpur Barrage).
- The D.O. value continues to be complying and found to be 8.3 mg/l at this location.

Noon- River

- A tributary also exist in this stretch named as Noon River. As per the information provided by the U.P. State Pollution Control Board, Noon river is a seasonal river which receives industrial discharge from Shivrajpur and domestic sewage from Bithoor and its nearby areas. However, the river discharge doesn't reach river Ganga in dry season as the river water withdrew before meeting Ganga and found dry.



Figure 10 Noon River at Bithoor on Kalyanpur-Bithoor Road (before confluence with river Ganga)

U/s Bithoor (Murdahaghat) (Non-NWMP)

- U/s Bithoor (Murdahaghat) location taken as control station
- DO, Fecal Coliform and pH values are complying
- BOD value is non-complying due to three tributaries carrying high pollution viz. Ramganga, Garra and river Kali East which confluence into River Ganga (at Kannauj/Hardoi) at a distance of around 50-75 km upstream to Bithoor.

Bithoor (1146 NWMP)

- 02 drains Kaliwaighatt and laxmanghat discharges into River Ganga upstream to Bithoor (1146 NWMP) location resulting into higher BOD and FC values as compared to U/s Bithoor (Murdahaghat) location.
- DO and pH values are found to be complying.
- Downstream to Bithoor 1146 NWMP location, 05 drains discharge into river Ganga.

D/s Kanpur Barrage (Non NWMP)

- **River water quality has improved in terms of BOD & DO due to self-cleansing mechanism of river within 12 km** as no drain discharges into River Ganga within this 12 km stretch (luvkush drain – Kanpur barrage).
- BOD, DO and pH values are found to be complying at this location.
- Higher FC value observed due to pooling of water D/s to Barrage and also due to non-point sources.

** Algal growth was observed in whole stretch, which may be the cause of good quality of River water in terms of DO and pH.*

The alkanity found is due to algal growth present in whole stretch.

3.1.2 Stretch -2 D/S Kanpur Barrage to D/S Shuklaganj

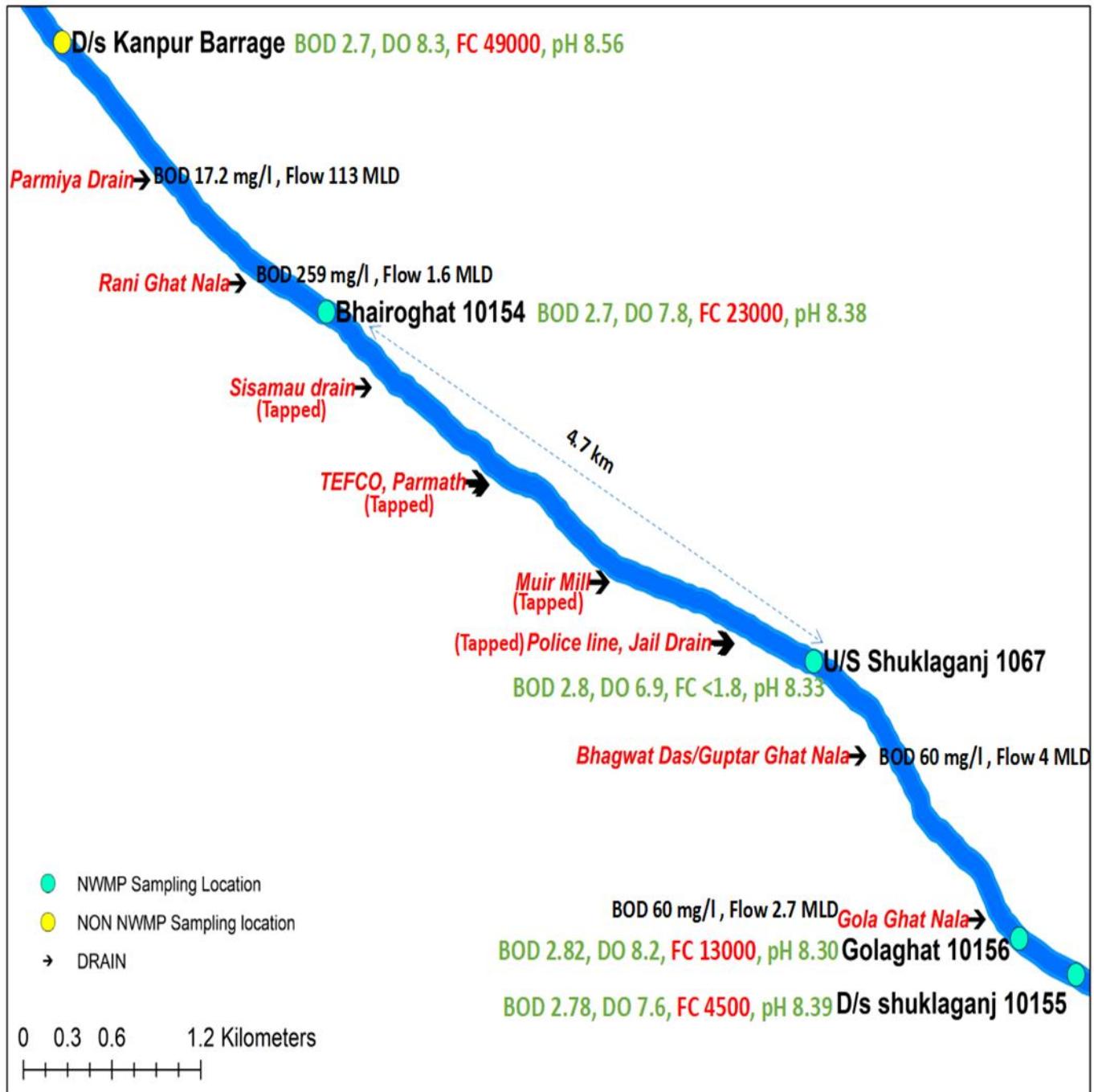


Figure 11 Stretch 2 of study area in river Ganga D/S Kanpur Barrage to D/S Shuklaganj

Bhairoghat Bathing Ghat (NWMP location – 10154)

- Rani ghat drain (partially treated with bioremediation) and Permiya drain discharge into Ganga at U/s location of Bhairo ghat.



Figure 12 Values of pH, FC, DO and BOD at Stretch 2

- The results of samples collected from this location indicates BOD as 2mg/l and DO as 7.8mg/l which is within the criteria prescribed for bathing water.
- The total coliform value (33000 MPN/100 ml) and faecal coliform (23000 MPN/100 ml) was found higher than the prescribed limit for bathing (66 times higher than permissible limit for bathing) water quality criteria hence not fit for designated use of bathing.

Upstream Shuklaganj (NWMP location - 1067): [Currently named as Kanpur U/s (Ranighat) in CPCB]

- As per information provided by UPPCB officers, NWMP location Kanpur U/s (Ranighat) -1067 is named as U/s Shuklaganj.



Figure 13 Sampling location at U/s Shuklaganj

- The location at upstream of Shuklaganj (NWMP- 1067) is situated at right bank of Ganga (opposite Kanpur city) The analysis results of samples collected from this location indicates BOD as 2.8 mg/l and DO as 6.9 mg/l which is within the prescribed permissible limit for bathing.
- The total coliform and faecal coliform values were found 2000 MPN/100 ml and <1.8 MPN/100 ml respectively which is also within the prescribed permissible limit for bathing.
- D/s to this location in Unnao district Five drains discharges into River Ganga without any treatment at Shuklaganj town. These drains are mentioned below:
 - i. Ganga Vishnu drain – 0.5 MLD
 - ii. Indira Nagar drain – 3.5 MLD
 - iii. Manohar Nagar drain – 3.0 MLD
 - iv. Ravidas Nagar – 3.5 MLD
 - v. Post Office Drain – dry at the time of monitoring.
- As per information provided, UP Jal Nigam proposed a 5 MLD STP under Namami Gange programme at Indira Nagar to treat the sewage of these drains after tapping.
- These drains are not listed in the priority drains list of CPCB and no regular monitoring/joint monitoring of these drains is undertaken by CPCB at present.

Golaghat - (NWMP location -10156)

- Most of the drains in this stretch are now tapped, however there are some reports of overflow at tapping points due to pumping failure from Sisamau Nala and Meur Mill Nala.



Figure 14 Sampling location at Gola Ghat Kanpur

- The analysis results indicate BOD of 2.82 mg/l and DO - 8.2 mg/l which are within the limit prescribed under bathing water quality criteria.
- However, faecal coliform (13000 MPN/100 ml) were not meeting criteria prescribed for bathing. The high values of coliform at this location indicates sewage contaminations at upstream to this location due to discharge of untreated sewage from the drains.

D/s Shukla Ganj (NWMP location- 10155) (26.468142, 80.386960).

- This sampling point is located downstream to discharge of drains of Shuklaganj.



Figure 15 Sampling location at Shukla Ganj D/s



Figure 16 Sampling location D/s Shukla Ganj

- The location at downstream of Shuklaganj (NWMP 10155) is situated near Ahmednagar Mohalla on left bank of River Ganga (opposite to Kanpur City) and D/s to discharge points of 5 drains from Shuklaganj town. The analysis results indicate BOD as 2.78 mg/l and DO as 7.6 mg/l which is within prescribed bathing water quality criteria. However, total coliform and faecal coliform values were found at 33000 MPN/100 ml and 4500 MPN/100 ml respectively. pH value at this location was found at 8.8 which is slightly higher than the limit. The higher values of coliform at this location indicates sewage contaminations upstream to this location from the drains at Shuklaganj town.

Bathing ghat Bhairoghat (10154 NWMP)

- BOD, DO and pH values are complying.
- River water quality has shown improvement in terms of FC due to:
 - a) Permiya drain is carrying high flow of water and low BOD level (No significant impact on River).
 - b) Ranighat drain is partially tapped.

Kanpur U/s (Ranighat) located as U/s Shuklaganj (1067 NWMP)

- All parameters (DO, BOD, FC & pH) are complying.
- Drains meeting River Ganga are tapped resulting into further improvement in terms of faecal coliform.
- **Again, self-cleansing of river Ganga within 4.7 km stretch can be observed.**

Bathing Ghat - Gola ghat (10156 NWMP)

- BOD, DO & pH values at this location are found to be complying.
- FC value becomes non-complying due to two drains Bhagwatdas drain & Golaghat drain upstream to this location having high BOD value discharge into river Ganga.

D/s Shuklaganj (10155 NWMP)

- BOD, DO & pH values are complying
- FC value shows improvement **due to self-cleansing process of river Ganga as no drain discharges into River Ganga between Golaghat and D/s Shuklaganj location.**

* *Most of the drains from Kanpur city are now in tapped condition, however there are some reports of overflow from tapping points due to pumping failure from Sisamau Nala and Meur Mill Nala.*

3.1.3 Stretch – 3 Downstream Shuklaganj to Deori Ghat

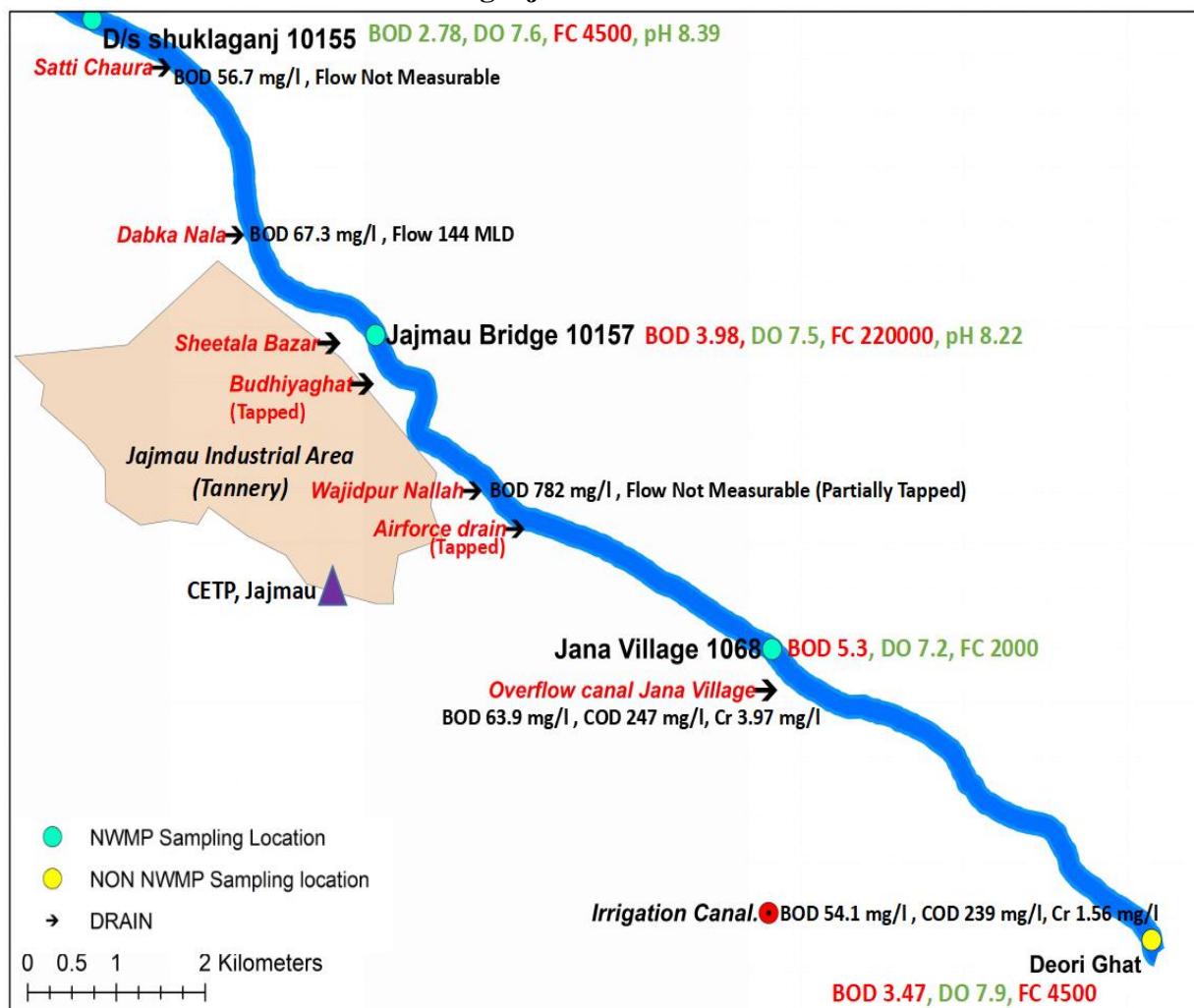


Figure 17 Stretch 3 of study area in river Ganga D/S Kanpur

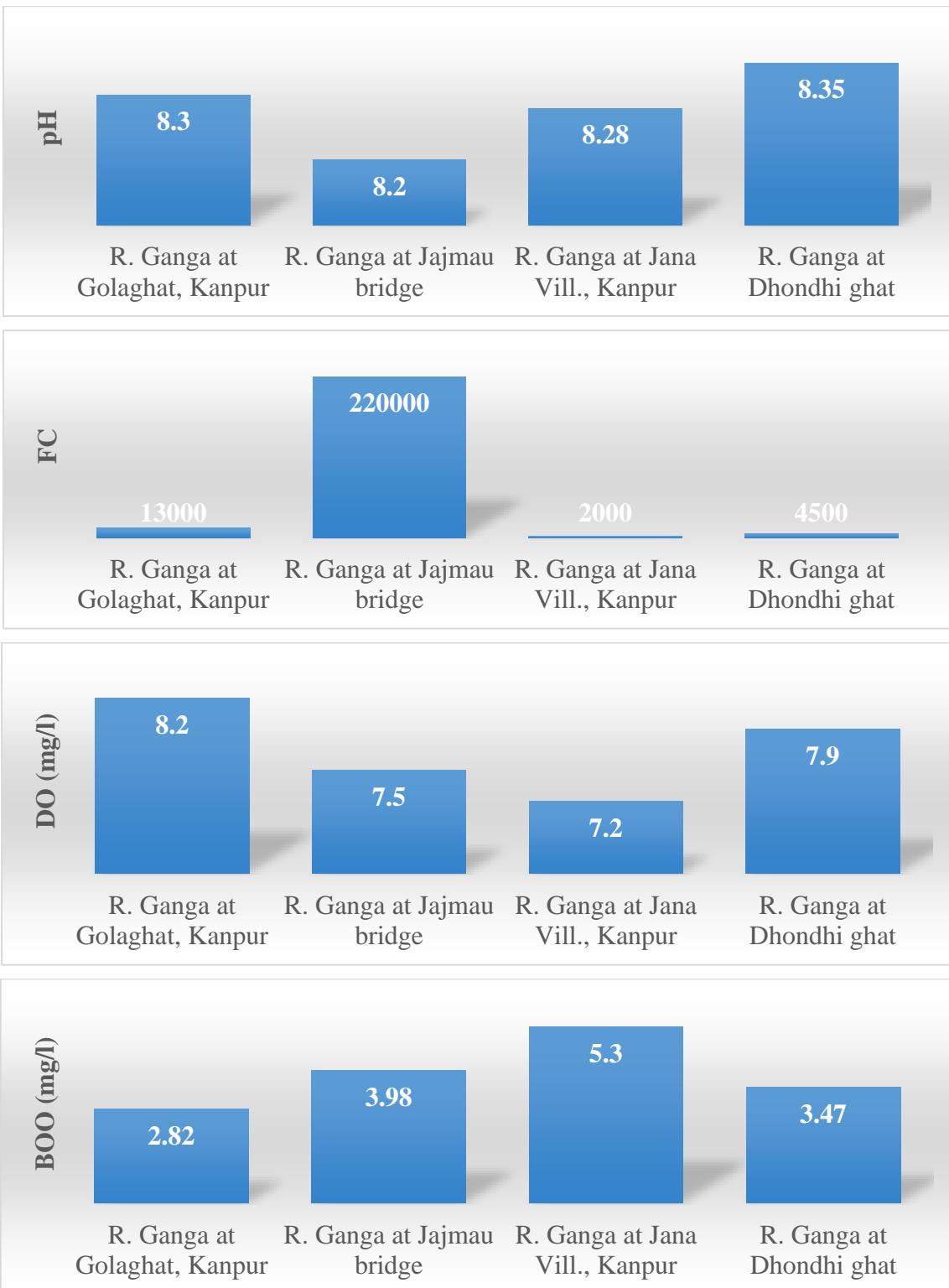


Figure 18 Values of pH, FC, DO and BOD at Stretch 3

Bathing Ghat (Jajmau bridge) (NWMP location – 10157)

- This location is situated in outskirt of Kanpur city and almost in the middle of tannery hub of Jajmau and nearby industrial pockets. The CETP and STP of Jajmau is situated downstream to this location. Large quantity of industrial effluent as well as sewage is generated upstream and downstream to this location.

Between Gola Ghat and Jajmau Bridge, five drains discharge into river Ganga.

1. Gola Ghat Drain – Discharges into river Ganga with bioremediation - untapped
2. Satti Chaura Drain – Discharges into river Ganga with bioremediation - untapped
3. Golf Club drain - Tapped
4. Dabka Nallah – Discharges into river Ganga with bioremediation – untapped
5. Shitla Bazar drain – Tapped with temporary pooling on river bed and is being pumped into CSPS of Jal Nigam .

	
Temporary pooling of Shitla Bazar Nallah	Under construction pumping station at Shitla Bazar Nallah

Figure 19 River Ganga and under construction pumping station near Shitla Bazar, Kanpur

- Several small drains from Jajmau directly discharge into river Ganga D/s of Jajmau bridge.
- Shitla Bazar drain is tapped with temporary pooling on river bed and is being pumped into CSPS of Jal Nigam.
- A permanent pumping station is under construction for direct pumping of drain after tapping.
- The Jajmau bridge bathing ghat is a manual monitoring location situated towards lower half of the Kanpur city on left bank of river Ganga in the tannery town of Jajmau. This location is situated downstream to previous location in Kanpur city at Gola Ghat after discharge points of 5 drains, out of which 2 drains are recently tapped and 3 drains still discharges into Ganga. The analysis results shows BOD as 3.98 mg/l and DO as 7.5 mg/l which indicates sudden increase in BOD and lowering of DO values at this location compared to previous upstream location at Gola Ghat.
- The higher BOD values may be attributed to discharges from industrial drains upstream to this location and non-points sources of discharge in the tannery area upstream to this location.
- The total coliform and faecal coliform values were found at 280000 MPN/100 ml and 220000 MPN/100 ml respectively indicating untreated effluent discharge into river Ganga upstream to this location.



Jajmau area from Ganga Bridge



River Ganga from Jajmau Bridge

Figure 20 River Ganga near Jajmau bridge at Kanpur city

Kanpur Downstream (Jajmau Pumping Station) (NWMP location – 1068) - Jana village

- This location is situated after discharge points of three drains situated downstream of Jajmau bridge.
- Three drains from the Jajmau area discharges into river Ganga D/s to Jajmau bridge:
 - i) Budhiyaghata Drain – Tapped at Pumping station (PS-4)
 - ii) Wajidpur Drain –Tapped at PS-3 – effluent seen in the post tapping stretch with little flow
 - iii) Airforce Nallah – Tapped – no flow at the time of visit, but intermittent overflow is reported
- As reported by UPPCB and observed all the three drains in Jajmau area carries industrial waste from tanneries located in the area.
- All three drains are reported to be tapped.
- The inspection team observed effluent filled in the Wajidpur drain with minuscule flow behind Wajidpur pumping station beyond tapping point.
- While all the three drains of this stretch were reported to be tapped, intermittent overflows from these drains were reported. However, no overflow was observed by the visiting team.

	
Wajidpur pumping station (PS-3)	Wajidpur drain at tapping point with effluent post tapping

Figure 21 Wajidpur pumping station in Jajmau area, Kanpur

- The higher BOD (5.3 mg/l) values at Jana village may be attributed to discharges from industrial drains upstream to this location and non-point sources of discharge in the tannery area upstream to this location.
- The faecal coliform value was found to be 2000 MPN/100 ml which indicates less contamination from household sewage and high BOD level at the location can be due to higher quantity of untreated industrial effluent discharge into river Ganga upstream to this location.
- Airforce drain was found with no flow at the time of visit but reports of intermittent overflow is received in weekly monitoring by UPPCB.
- The treated effluent from CETP and STPs of Jajmau is pumped for irrigation purpose through a canal which carries the irrigation water through a network of channels in the Chakeri area and further areas nearby.
- Other small local drains from nearby population on river banks were observed at Janna village which were discharging directly into river Ganga with little flow due to natural gradient.

Irrigation Canal of CETP Jajmau and overflow from irrigation canal at Jana village

- The joint monitoring team has observed overflow from irrigation canal directly discharging into Ganga through the local drain network at Janna village having population of approximately 6000 persons.
- As informed by the local residents of Jana village the discharge from the irrigation canal continuously goes to river Ganga through the village drain including sewage from village.
- Samples were collected from the overflow flowing into river Ganga.

- The analysis of collected samples from the irrigation canal overflow shows colour – 75 hazen, BOD- 63.9 mg/l, COD - 247 mg/l and TSS – 153 mg/l which indicates partially treated/untreated industrial effluent and sewage flowing into the river Ganga through the irrigation canal overflow channel from Jajmau CETP at Jana village causing degradation in the water quality of River Ganga.
- The heavy metal analysis result shows high values of Chromium as 3.97 mg/l in samples collected from the irrigation canal.



Figure 22 Breach in irrigation channel near Jana village, Kanpur

- The Irrigation canal from Jajmau CETP complex receives treated effluent from following STPs/CETP in Jajmau
 - 36 MLD CETP
 - 130 MLD STP
 - 5 MLD STP
 - 43 MLD STP
- Samples collected from irrigation canal overflow was found non-complying with respect to notified standards for discharge from CETP and STP outlet. However, the water in the irrigation canal overflow was visually appeared black in colour.

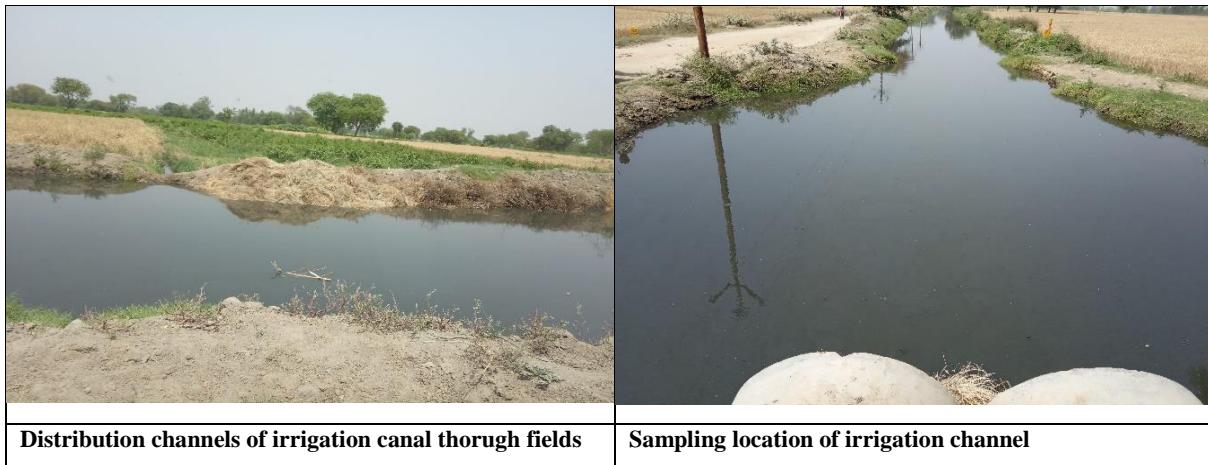


Figure 23 Irrigation channel views in Jajmau-Chakeri region carrying treated effluent from Jajamu CETP and STP

- The water from canal is used for irrigation in nearby fields upto Rooma area through the irrigation canal.
- The analysis of collected samples from the irrigation canal shows colour – 50 hazen, BOD- 54.1 mg/l, COD - 239 mg/l and TSS – 88.2 mg/l which indicates partially treated/untreated industrial effluent and sewage being used for irrigation purpose which can pose potential threat to the ground water in nearby area.
- The heavy metal analysis results indicate high values of Chromium at 1.56 mg/l in samples collected from the irrigation canal.

Deori Ghat (downstream of Kanpur)

Samples were collected from river Ganga near temple at Deori Ghat. This location represents the downstream location of Kanpur city at Deori Ghat which is the last manual water quality monitoring location.



Figure 24 Deori Ghat sampling location with RTWQMS in view

- City Jail drain meets River Ganga on left bank near the Deori Ghat. A drain from Rooma industrial area joins river Ganga just downstream to this location.

- Samples collected from this location at Jana village and analysis result indicates BOD as 3.47 mg/l, DO as 7.9 mg/l which indicates high level of pollution due to cumulative effect of all the discharges from drains and non-points sources of discharge in the Kanpur city.
- The total coliform and faecal coliform values were found at 14000 MPN/100 ml and 4500 MPN/100 ml respectively indicating contamination from household sewage from Kanpur city. The higher values of BOD, COD and coliform makes the water unfit for bathing.

Graphical representation of samples collected for pH, DO, BOD and FC

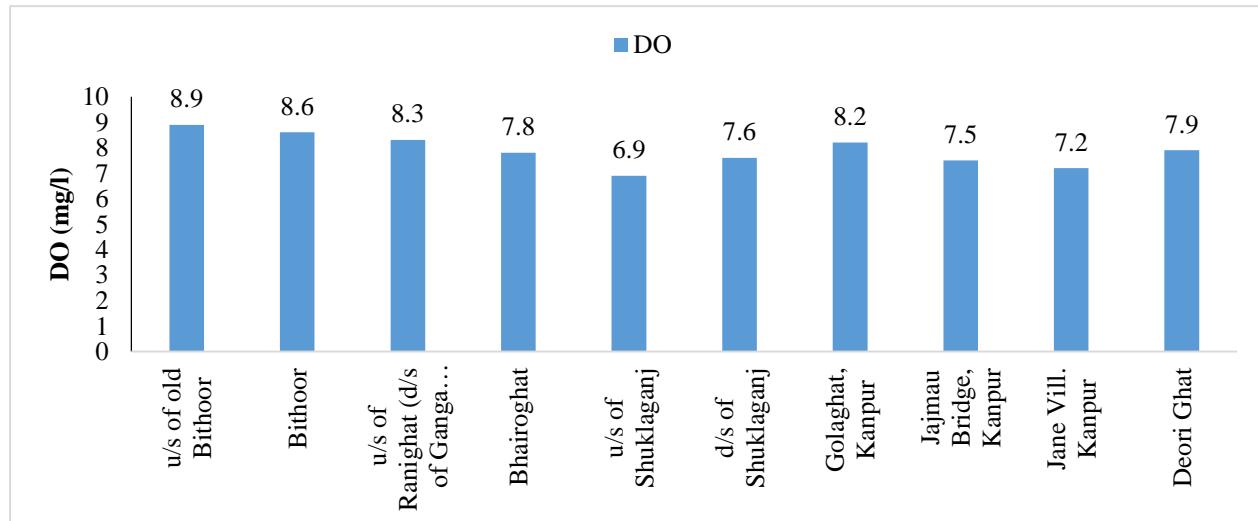


Figure 25 DO value at different locations of river ganga at Kanpur

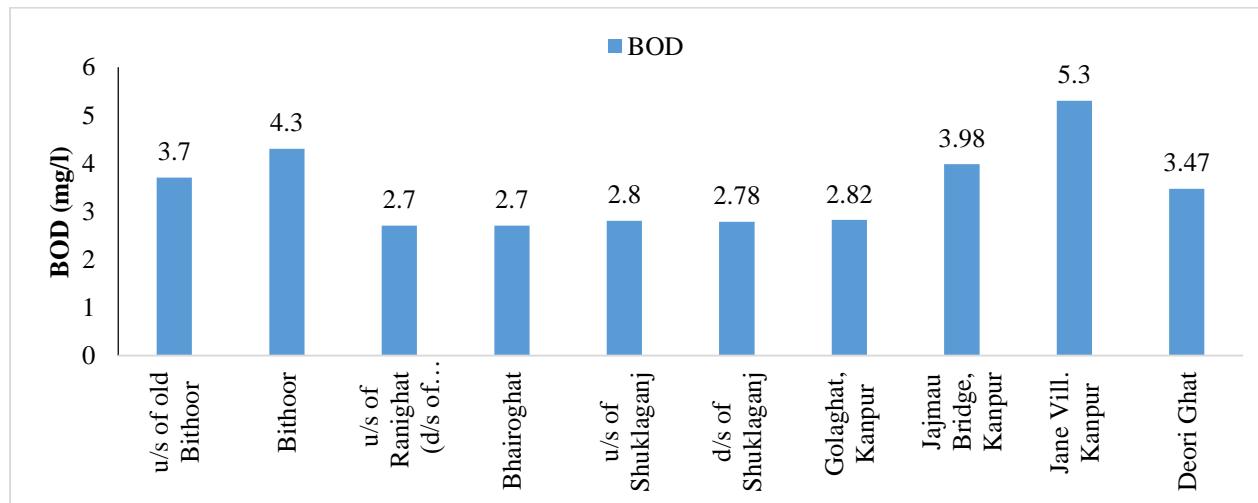


Figure 26 BOD value at different locations of river Ganga at Kanpur

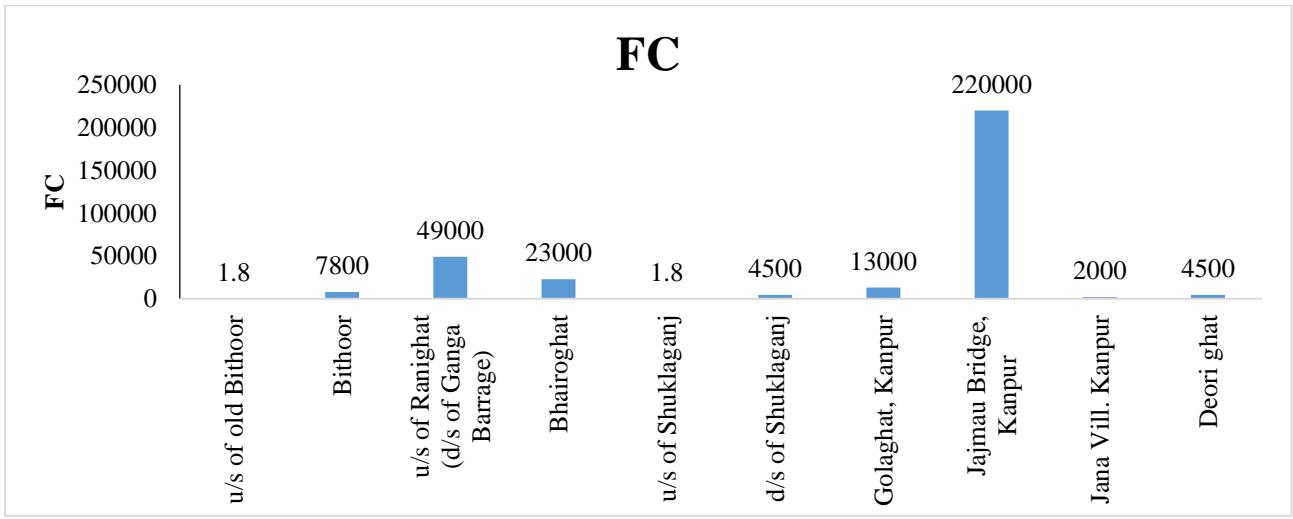


Figure 27 FC value at different locations of river Ganga at Kanpur

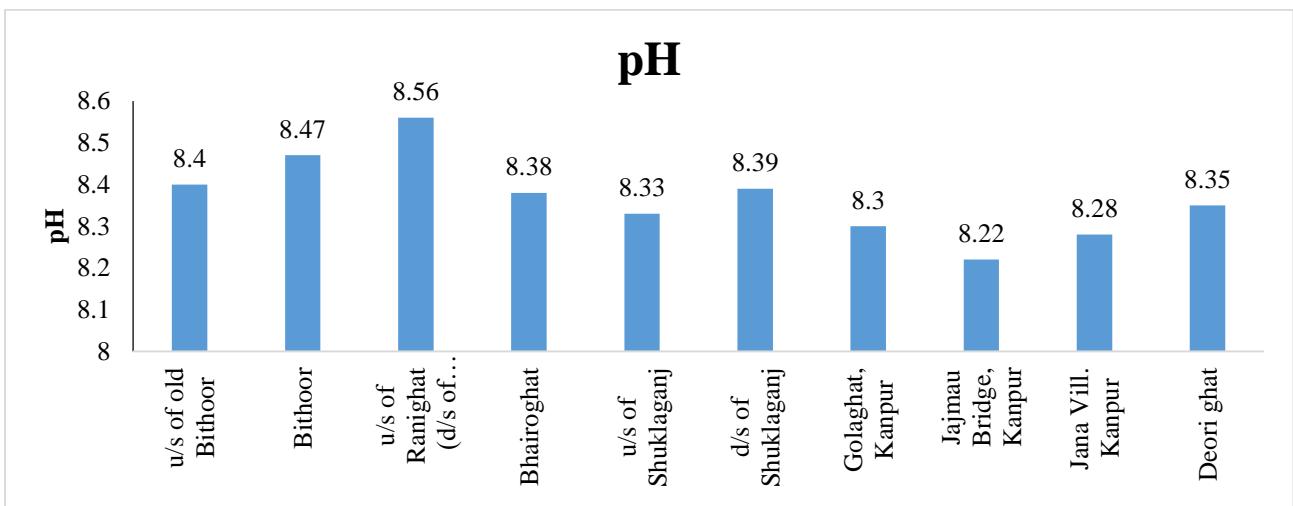


Figure 28 pH value at different locations of river Ganga at Kanpur

Bathing Ghat - Jajmau Bridge (10157 NWMP)

- BOD and FC parameters becomes non-complying due to Satti Chaura and Dabka Nullah discharging into river Ganga

Kanpur d/s Jajmau pumping (Jana Village 1068 NWMP)

- BOD concentration reached 5.30 mg/l level which is **highest BOD value observed in the entire Kanpur stretch.**
- Faecal coliform value was found to be significantly low because of higher proportion of industrial effluent through Jajmau Industrial Area.
- The Chromium level at Jana village was also found in the river.

Deori Ghat (Non-NWMP)

- The irrigation canal was found severely polluted carrying untreated/partially treated effluent with colour – 75 hazen, BOD- 63.9 mg/l, COD - 247 mg/l and TSS – 153 mg/l causing potential serious threat to the water quality of River Ganga.
- The water quality of river Ganga at Deori ghat improved. The BOD value improved to 3.47 mg/l compared with 5.30 mg/l at Jana village which **may be attributed to the self-cleansing mechanism of river.**

Analysis Results of Heavy Metal

Samples were collected for heavy metal from all the locations along with samples for general parameters. Analysis report is enclosed as Annexure-II. The following was inferred:

- i) The analysis report shows below detection limit values for Arsenic (As), Cadmium (Cd), Nickel (Ni), Lead (Pb), Cobalt (Co), Antimony (Sb), Selenium (Se) and Vanadium (V) in all the samples including irrigation channel.
- ii) The analysis results indicated presence of iron (Fe) and Manganese (Mn) at all the locations of river Ganga and also in irrigation canal with iron quantity ranging from highest quantity 2.91 mg/l in irrigation canal overflow at Jana village and lowest value at 0.069 mg/l at d/s location of Kanpur Barrage.
- iii) Total Chromium was analysed in all the samples and was detected only at two locations of river viz. River Ganga at Jajmau village – 0.01 mg/l; River Ganga at Jana Village – 0.03 mg/l; and two samples of irrigation canal collected from overflow of irrigation canal at Jana village – 3.97 mg/l and Irrigation canal at Karibgawan village, Kulgaon area – 1.56 mg/l. The sample collected from the overflow of irrigation canal at Jana village was found having highest quantity of total chromium which is higher than the prescribed limit for discharge into water body. The high value of Chromium in irrigation canal samples clearly indicates improper chrome recovery at CETP-CRP which causes higher concentrations of Chromium discharged into environment poses threat to environment.

- iv) Copper (Cu) metal was detected at three locations viz. River Ganga, Bithoor; irrigation canal and overflow of irrigation canal at Jana Village. Analysed value of Cu at River Ganga, Bithoor – 0.01 mg/l; Irrigation canal overflow at Jana village – 0.01 mg/l and Irrigation canal at Karibgawan d/s of Jana village – 0.01 mg/l.
- v) Zinc (Zn) metal was detected at four locations two locations on river Ganga and two samples from irrigation canal. Analysed value of Zn at River Ganga, Bithoor – 0.02 mg/l; River Ganga at Jajmau bridge – 0.02 mg/l; Irrigation canal overflow at Jana village – 0.02 mg/l and Irrigation canal at Karibgawan d/s of Jana village – 0.01 mg/l.

Drains monitored in Bithoor, Shuklaganj and Kanpur during 09th -11th April, 2019

Drains in Bithoor

- A total of 7 drains were found discharging into river Ganga from Bithoor town and all are under bioremediation treatment system at present. A sewage treatment plants based on wetland system is under construction for all the 07 drains in Bithoor.

S.No.	Drains Bithoor (d/s to u/s)	Estimated Flow
1	Luv-Kush Nala	220 KLD
2	Bhannu Nala	600 KLD
3	Peshwa Nala	100 KLD
4	Gudhara ghat drain	30 KLD
5	Brahmawat ghat drain	50 KLD
6	Laxman ghat drain	30 KLD
7	Kalwari ghat drain	270 KLD

Drains in Unnao/Shuklaganj

- Loni drain and City Jail drain from Unnao city discharges into river Ganga and monitored by CPCB half yearly (currently monitored on weekly basis under PMO reference).
- Loni river (monitored as drain) receives discharge from CETP, Unnao and City Jail drain receives discharge from CETP, Banthar.
- Five number of drains from Shuklaganj town in Unnao district were found discharging into river Ganga and a STP is proposed in Indira Nagar area of Shuklaganj to treat the sewage after tapping these drains.

S. No.	Drains Shuklaganj (d/s to u/s)	Estimated Flow
1	Ganga Vishnu drain	0.5 MLD
2	Indira Nagar drain	3.5 MLD
3	Manohar Nagar drain	3.0 MLD
4	Ravidas Nagar	3.5 MLD
5	Post Office Drain	dry at present

Drains in Kanpur

- A total of 22 drains from Kanpur city (16 towards Ganga and 06 towards Pandu) are presently monitored by CPCB under regular monitoring and presently monitored on weekly basis.
- Out of 16 drains having their natural gradient towards river Ganga, 10 drains are having tapping provision but overflow from 2 drains were observed (samples were collected by the drain monitoring team) and one drain (Parmath drain) was found dry.
- A total of 06 drains discharging into Pandu river, 01 is reported to be tapped.

Status of Weekly Monitoring of Drains Carried Out On 09.04.2019

1. A parallel team of UPPCB and CPCB carried out the monitoring of drains in Kanpur region during the period of visit.
2. The weekly monitoring status of drains and river Ganga at different locations in Kanpur was carried out by another joint team from CPCB and UPPCB on 09.04.2019. The monitoring report of drains and river Ganga are annexed at **Annexure- III & III-A** and **Annexure- IV**.
3. The drain monitoring report clearly indicates that out of 22 drains from Kanpur city 16 have discharges into river Ganga directly and 06 drains discharges into river Pandu which ultimately discharge into River Ganga.
4. Out of 16 drains, 10 drains were having tapping provision but overflow from 2 drains were observed and samples were collected by the drain monitoring team and one drain (Parmath drain) was found dry. Therefore, out of the 16 drains, samples were collected from 07 drains.
5. Monitoring team visited Wajidpur drain in Jajmau area where partial tapping provision was observed and effluent was found overflowing towards river Ganga. The samples collected from the overflow from tapping of Wajidpur drain has very high BOD – 782 mg/l and COD – 1606 mg/l followed by Ranighat drain with BOD concentration measured as 259 mg/l and COD as 552 mg/l.
6. Lowest BOD – 17.2 mg/l and COD – 32.2 mg/l concentrations was reported from Permiya drain.
7. The total coliform (TC) and faecal coliform (FC) numbers were found very high in almost all the samples collected from 07 drains ranging from TC - 5.4×10^{10} MPN/100 ml and FC – 2.4×10^{10} MPN/100ml in Dabka drain followed by TC – 5.4×10^{10} MPN/100 ml and FC – 3.5×10^{10} MPN/100 ml in Bhagwatdas ghat drain with the lowest TC/FC measured in overflow of Wazidpur drain at TC – 7.9×10^6 MPN/100 ml and FC – 4.9×10^6 MPN/100 ml.
8. River Pandu receives discharge from 06 number of drains from Kanpur city, out of which COD drain was reported to be tapped and dry during the monitoring.
9. Highest BOD and COD in drain discharging in River Pandu was found in Panki drain at 104 mg/l and 229 mg/l respectively, followed by Ganda drain with BOD- 100 mg/l and COD - 264 mg/l.
10. Two drains from Unnao city discharges into river Ganga namely City Jail drain and Loni drain.

11. Loni drain receives discharge from CETP, Site-II, Unnao and was reported to be dry before confluence with river Ganga and no sample was collected.
12. City jail drain receives discharge from Banthar CETP and meets the river Ganga downstream to Shuklaganj, samples collected from City jail drain had BOD – 122 mg/l and COD – 280 mg/l and TC/FC was calculated as $4.5 \times 10^5 / 2.0 \times 10^5$ MPN/100 ml.

4.0 Study Area -II- Farukhabad To Dalmau (Rae Bareilly)

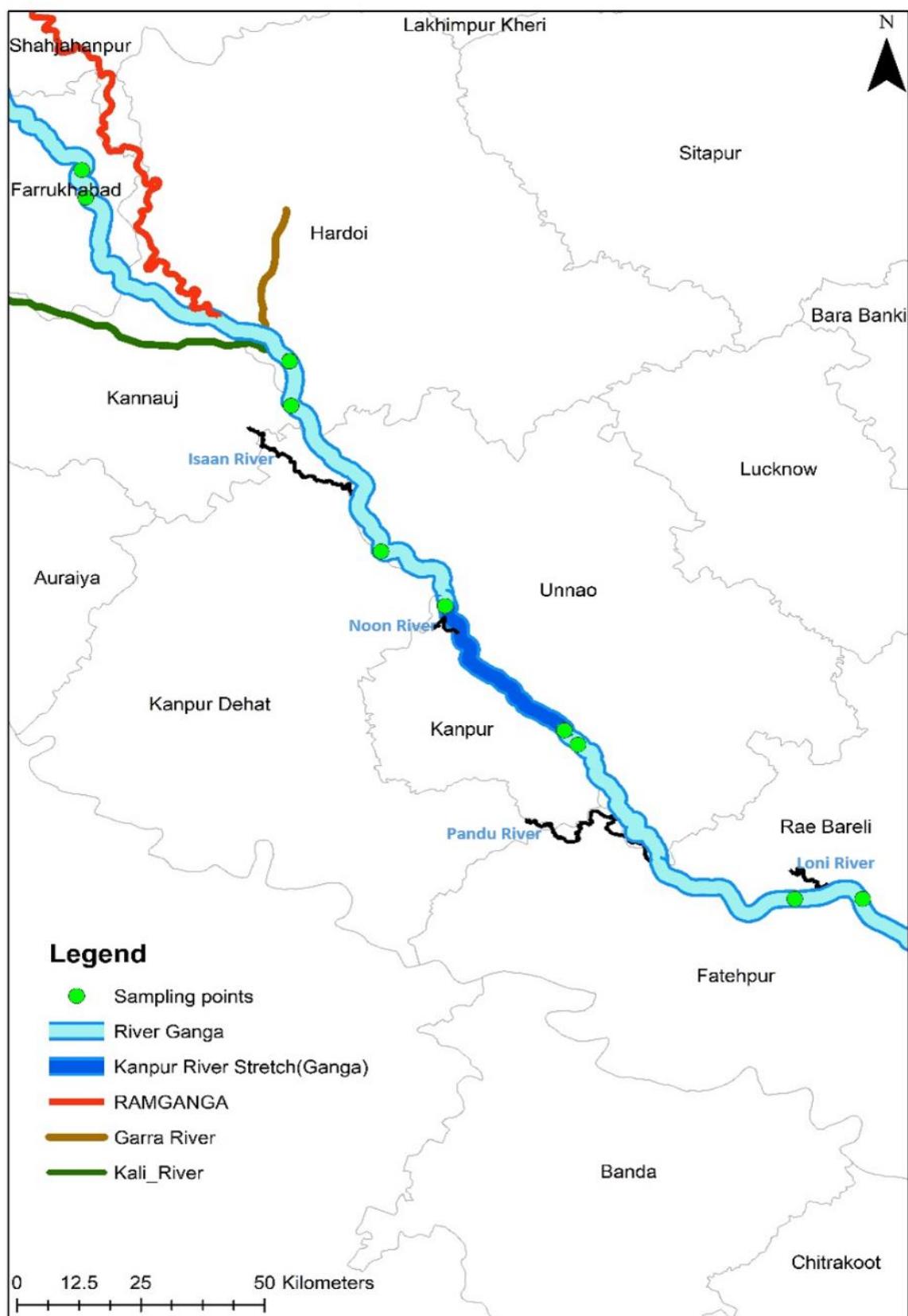


Figure 29 Overall study stretch view from Farrukhabad to Dalmau and position of tributaries in stretch

4.1 Major Sources of Pollution in the stretch

The details of tributaries & monitoring of drains by CPCB falling in the catchment of the River Ganga stretch from Farrukhabad to Dalmau are as follows:

- CPCB monitors a total of 32 priority drains in the stretch
- Out of the 32 priority drains monitored by CPCB, 23 drains discharge directly into River Ganga
- 16 drains from Kanpur; 05 drains from Farrukhabad & 02 drains from Unnao, 06 drains from Kanpur city confluence into river Pandu and 03 drains in Kannauj confluence into river Kali East.
- River Pandu passes through Kanpur city, which receives discharge from five major drains of Kanpur city (Panki and its nearby areas) and Bingawa STP in Kanpur. River Pandu confluence with river Ganga at Guneer village in Fatehpur district which is at around 45 km D/s from Deori ghat in Kanpur.
- Five tributaries that confluence into River Ganga are: Ramganga, Garra, Kali East, Pandu, Loni and two seasonal tributaries— Isan and Noon.

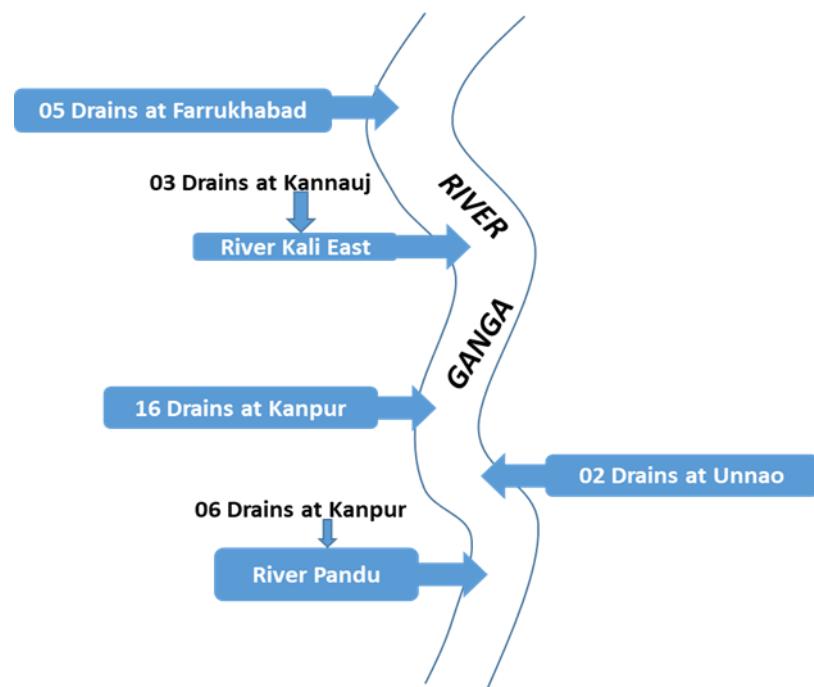


Figure 30 Position and number of drains in Kanpur stretch discharging into river Ganga

Table 3 Details of sampling locations on R. Ganga and its tributaries from Farrukhabad to Raebareli

S. No.	River Name and Location	Sample Code	Parameters Analysed
1.	R. Ganga u/s of Farrukhabad (b/c of Bhairoghat drain)	River 0	pH, DO, Temperature, BOD, COD, TSS, TDS, Colour, Turbidity, NO ₃ -N, PO ₄ -P, NH ₃ -N, Chloride, Fluoride, Potassium, Total Coliform and Faecal Coliform
2.	R. Ganga at Ghatiaghata, Farrukhabad	River 1	
3.	R. Ramganga at Farrukhabad –Allaganj road	River 2	
4.	R. Garra at Sandi, Hardoi	River 3	
5.	R. Ganga u/s of Kannauj	River 4	
6.	R. Ganga d/s of Kannauj	River 5	
7.	R. Kali East b/c to R. Ganga at Kannauj	River 6	
8.	R. Isan b/c to R. Ganga at Mohiuddinpur, Bilhaur	River 7	
9.	R. Ganga a/c to R. Isan near Shivrajpur, Kanpur	River 8	
10.	R. Ganga at Bithoor, Kanpur	River 9	
11.	R. Noon b/c to R. Ganga at Kanpur – Bithoor road	River 10	
12.	R. Ganga at Dhodhighat, Kanpur	River 11	
13.	R. Ganga a/c to irrigation canal at Rajapur village, Kanpur	River 12	
14.	R. Pandu b/c to R. Ganga at Baksar – Muradipur road	River 13	
15.	R. Ganga at Asni, Fatehpur	River 14	
16.	R. Loni b/c to R. Ganga at Chak Malik Bhti, Raebareli	River 15	
17.	R. Ganga at Dalmau, Raebareli	River 16	

4.2 Water Quality of River Ganga

Dissolved Oxygen

- The dissolved oxygen values were found complying at all the sampling locations except at Dhondhi ghat with value of 4 mg/l (d/s Kanpur). The highest value was found at Dalmau (Rai Bareilly) having DO 6.8 mg/l.

Biochemical Oxygen Demand

- In the stretch from Farrukhabad to Kanpur city, the BOD value remains below the standard limit of 3.0 mg/l w.r.t. bathing standard at all locations.
- BOD values varies D/s Kanpur city (Dhondhighat) (2.97 mg/l) to Dalmau (4.37 mg/l), with highest value of 4.62 mg/l at Asni (Fatehpur).
- The BOD value was found higher than the criteria at three locations viz. Rajapur village (d/s Kanpur) - 4.14 mg/l; Asni (Fatehpur) – 4.62 mg/l and Dalmau (Rae Bareilly) – 4.37 mg/l. All the three locations are at downstream to Kanpur city.
- The BOD value of river Ganga from Ghatiaghata (Farrukhabad) to Rajghat (U/s Kannauj) was found to be below 2.0 mg/l.
- The BOD value at Durjanapur village (d/s of Kannauj) was found to be 2.37 mg/l which may be because of the impact of pollution load from river Kali East, Ramganga and Garra at upstream to this location.
- Durjanapur village (D/s Kannauj) sampling point is located at around 25 Km after meeting point of river Ramganga and has impact from all the three tributaries discharging into river Ganga between Farrukhabad and Kannauj.
- BOD reaches 2.97 mg/l at Dhondhighat (D/s Kanpur city location) before meeting of irrigation canal and goes above the desired limit to **4.14 mg/l at Rajapur village** at D/s of Kanpur (D/s Dhondhi Ghat) after meeting of Irrigation Canal near Jamada village.

BOD value higher than 3.0 mg/l found in the stretch between D/s Kanpur to Dalmau may be attributed to the combined effect of three major tributaries (Kali east, Ramganga & Garra) meeting river Ganga and discharge from drains of Kanpur city including breach in irrigation canal from Jajmau tannery area.

Suspended solids

- In general, the Suspended Solid (SS) values were found high at all sampling locations of River Ganga including seven tributaries due the rainy season and observed rainfall in the catchment areas of the rivers.
- In River Ganga, the highest SS values was observed at U/s Kannauj – 1325 mg/l which gradually decreased towards the downstream locations with the lowest value observed value at Dalmau – 227 mg/l.
- The high values of SS may be because of ongoing rain during the early two days of study period. Rain can directly increase the level of total suspended solids through runoff. As water flows over a surface, it can pick up particles and deposit them in water body. Runoff can also wash away topsoil, and contribute to riverbank erosion. If the flow rate increases enough due to rain, it can resuspend bottom sediments, further raising TSS concentrations.

pH

- The pH of river Ganga was found to be within the desired limit in the whole study stretch and varied between 6.91 to 7.88 respectively at Rajapur village (d/s of Kanpur) and Ghatiaghata (Farrukhabad).

Faecal Coliform

- Faecal coliform values were found above the permissible limit of 500 MPN/100 ml in the whole stretch with the minimum value at Farrukhabad (2×10^3 MPN/100 ml) and highest value observed at Dhondhi Ghat - D/s Kanpur (4.9×10^4 MPN/100 ml).

4.3 Water Quality of Tributaries of River Ganga in Farrukhabad – Dalmau Stretch

There are six tributaries in the Farrukhabad – Dalmau stretch: Data of the samples collected during July 2019 is presented in Table 5 to Table - 8

- 1. River Ramganga** – This tributary carry waste water/industrial effluent from Uttarakhand (Kashipur), Moradabad and Rampur; ultimately meet river Ganga at downstream of Farrukhabad on the left bank near Tera Ghat in district Hardoi. Sample collected from river Ramganga at Hullapur -Allahganj bridge.
- 2. River Garra** – This river carries waste water from Shajahanpur and Hardoi areas and ultimately meets river Ganga at u/s to Rajghat in Hardoi district from the left bank. Samples collected from river Garra from bridge at Sandi (dist – Hardoi).
- 3. River Kali East** – River Kali East is a major tributary of river Ganga originating from Western Uttar Pradesh and carrying sewage/industrial effluent from major industrial cities as Muzaffarnagar, Meerut, Bulandshahr, Aligarh and Kannauj. Kali East has its confluence with river Ganga near Mehndipur village in Kannauj district from the right bank. Samples collected from river Kali east u/s to Manimau bridge near Mehndipur Ghat (b/f c/f with river Ganga in dist – Kannauj..)
- 4. River Isaan** – This river is a tributary of river Ganga from Uttar Pradesh which meets river Ganga d/s of Bilhaur in Kanpur city. Samples collected from river Isan from Sri Ram Ghat, Mohiuddinpur, Bilhaur in Kanpur city.
- 5. River Noon** – Noon river is a tributary of river Ganga carrying waste water and industrial effluent from Shivrajpur area of Kanpur. Two major drains namely

Namastey India drain and drain near Tikkanpurwa on Mandhana-Bithoor Road, meets river Noon before it reaches river Ganga at d/s of Bithoor in Kanpur. Samples were collected from Noon river from Kalyanpur-Bithoor Road near Mohammadpur.

- 6. River Pandu** – This river is reportedly having polluted status due to industrial and sewage discharge from the Western and southern part of Kanpur city. The treated effluent from Bingawan STP is also received by this river. River Pandu is having its confluence with river Ganga near Katri Buxar in Fatehpur district. Samples were collected from the river Pandu from just before confluence with river Ganga from bridge on Buxar Road – Muradipur Road.
- 7. River Loni** – This river has its confluence point with River Ganga from the left bank. This river receives discharge from Unnao city and CETP, Unnao. It travels over 100 kms upto Rai Bareilly before meeting river Ganga.

Table-3 shows the analysis results of samples from the above tributaries before confluence with river Ganga.

4.4 Water Quality of Tributaries

- The observed values of DO was found above the desired limit of 4.0 mg/l in six tributaries, and below the limit in river Noon at 2.1 mg/l. The DO concentration except Noon river was found varying between 4.4 mg/l to 6.2 mg/l.
- The concentration of BOD in the tributaries varies between 2.38 mg/l (Ramganga at Allahganj) to 5.86 mg/l (river Pandu at Katri Baksar).
- The BOD value in River Ramganga (2.38 mg/l) and River Garra (2.47 mg/l) was found to be within the limit for bathing water quality.
- The other five tributaries were not within the prescribed limit w.r.t. bathing water quality criteria in terms of BOD. The values observed were as follows: River Kali East – 4.4 mg/l; river Isan – 3.19 mg/l; river Noon – 3.86 mg/l; river Pandu – 5.86 mg/l and river Loni – 4.90 mg/l.

Suspended Solid (SS)

- The highest SS value was observed in river Ramganga at Allahganj – 903 mg/l and the lowest value in River Loni at 74 mg/l just before confluence with river Ganga.

pH

- The pH value observed in the seven tributaries was found to be within the desired limit (between 6.5 to 8.5) with the lowest value in river Noon - 7.33 and highest in river Kali East - 7.90.

Faecal Coliform (FC)

Faecal coliform values were found above the permissible limit of 500 MPN/100 ml in the seven tributaries with value higher than the permissible limit, with the lowest value in river Kali East and River Loni at 4.5×10^3 MPN/100 ml and highest value in river Isan at 4.9×10^5 MPN/100 ml.

4.5 Drains Monitored in Farrukhabad – Kannauj

Monitoring of five drains in Farrukhabad and three drains in Kannauj city was carried out by joint team, all these 08 drains are listed as priority drains.

Table 4 Details of drains and flow in Farrukhabad

S. No.	Drain Name and Location	Sample Code	Flow (MLD)	Parameters Analysed	Remarks
1.	Dhinapur drain, Farrukhabad	FD-01	2.18	pH, Colour, TSS, TDS, Chloride, Sulphate, Oil & Grease, COD, BOD, NO ₃ -N, PO ₄ - P, NH ₃ -N, Total Coliforms, Faecal Coliforms, Heavy metals	• Total 05 drains were monitored at Farrukhabad, which meet R. Ganga on its right bank.
2.	Bhairoghat drain, Farrukhabad	FD-02	24.73		• Total 03 drains were monitored at Kannauj, which meet R. Kali on its right bank.
3.	Cantt drain, Farrukhabad	FD-03	13.82		• Being rainy season, the concentration of pollution sensitive parameters, i.e., BOD and COD were found on lower side, except colour in Dhinapur drain. High colour concentration in Dhinapur drain may be due to discharge from textile industries.
4.	Bargadiaghant drain, Farrukhabad	FD-04	1.44		
5.	Hathikhana drain, Farrukhabad	FD-05	12.17		
6.	Patta drain, Kannauj	K-01	17.28		
7.	Adanga drain, Kannauj	K-02	3.54		
8.	Tammi drain, Kannauj	K-03	3.67		

The analysis report of the samples collected from the above 08 priority drains in Table- 8.

4.5.1 Drains in Farrukhabad

- Major five priority drains having discharge to River Ganga in Farrukhabad town are monitored by CPCB in pre- and post-monsoon season.
- Dark red coloured effluent was observed in Dhinapur drain (priority drain) directly reaching river Ganga in Farrukhabad during the monitoring on 16.07.2019 possibly originating from textile units located in Farrukhabad.
- The analysis results of samples from Dhinapur drain shows BOD value of 40 mg/l and COD as 122 mg/l. Value of colour analysed in the sample collected from Dhinapur drain was analysed as 625 Hazen units caused by coloured effluent discharge into the drain.

- The BOD value of Hathikhana drain, was found highest at 54.2 mg/l amongst the 05 priority drains in Farrukhabad. BOD of Bhairoghat drain was found to be lowest at 16.8 mg/l.
- The Faecal coliform values were found very high in the priority drains of Farrukhabad. The observed values are as follows: Dhinapur drain - 3.3×10^6 MPN/100 ml; Bhairoghat drain - 2.3×10^5 MPN/100 ml; Cantt Drain – 7.9×10^5 MPN/100 ml; Bargadiaghata drain - 3.3×10^6 MPN/100 ml and Hathikhana drain – 3.3×10^6 MPN/100ml indicating discharge of untreated sewage in all the drains.
- As informed by the SPCB officials, 02 CETPs are proposed in Farrukhabad to tackle the discharge from textile units currently discharging into the drains.



Figure 31 View of Dhinapur drain in Farrukhabad carrying coloured effluent

- Low intensity pink-red colour was also observed in the effluent of Tokaghat Nala (priority drain) in Farrukhabad.

4.5.2 Drains in Kannauj

- CPCB undertakes monitoring of 03 drains in Kannauj city which have their discharge into river Kali East.
- The BOD value of the drains in Kannauj is as follows – Patta Nalla – 20.7 mg/l; Adanga Nallah – 14.6 mg/l and Tammi Nallah – 35.4 mg/l.
- The Faecal coliform values were found very high in the priority drains of Kannauj. The observed values are as follows: Patta nallah - 1.3×10^6 MPN/100 ml; Adanga Nallah - 2.2×10^6 MPN/100 ml; and Tammi Nallah – 1.3×10^7 MPN/100ml indicating discharge of untreated sewage in all the drains in Kannauj.
- As per the analysis results, Tammi nallah carries the highest pollution in Kannauj district.
- One STP in Kannauj is installed and functional on Patta Nala.
- As reported, two drains namely Adanga Nalla and Tammi Nala do not reach River Kali East in dry season and sewage water from drain accumulates in a kutcha pond. Possibility of these ponds overflowing and sewage reaching Kali East river is possible in rainy season.

4.5.3 Drains in Shivrajpur Area, Kanpur discharging into river Noon

- As informed by the SPCB, two drains from Shivrajpur area in Kanpur discharges into river Noon-
 - i) Drain carrying effluent from Namastey India dairy in Shivrajpur meets river Noon near Ajauli village in Shivrajpur area, Kanpur.
 - ii) A drain from Shivrajpur area carrying industrial effluent with dark brown coloured effluent reported from Kattha factory was found discharging into Noon river at Tikkapurwa (Baideni) on Mandhana - Bithoor Road samples were collected from Tikkapurwa (Baidani) drain and Noon river d/s of drain meeting point, analysis results of the samples is awaited.
- The samples were collected from the Tikkapurwa drain and the analysis report shows very high value of colour at 500 Hazen units; BOD as 37.7 mg/l and COD as 139 mg/l indicating discharge of coloured industrial effluent in the drain ultimately reaching River Ganga through Noon river in Bithoor area.



Figure 32 Industrial effluent from Shivrajpur drain meeting Noon river near Tikkapurwa

- Noon river reaches river Ganga D/s of Bithoor carrying effluent from Shivrajpur area of Kanpur and sewage from nearby areas of Bithoor.

Cause of Concern: Irrigation Canal from Jajmau CETP and discharge from CETP, Rooma

- The irrigation canal originating near CETP, Jajmau carrying treated effluent of 36 MLD from CETP, Jajmau and STPs. It carries treated effluent to Chakeri -Kulgaon area of Kanpur where the water is utilized for irrigation in vast farm area including Government agriculture farms.
- The irrigation canal bifurcates into two major arms d/s of Jajamu CETP and later the left arm moves parallel to river Ganga and distributes irrigation water in the northern side of the canal (towards Ganga).

- Breach was observed in the irrigation channel at 2-3 locations near Jana village in Kanpur which directly discharges the polluted effluent to river Ganga with high concentrations of BOD (63.9 mg/l), COD (247 mg/l) and Chromium (3.97 mg/l).
- Samples from the irrigation canal were collected during the monitoring carried out during April 2019 and found to have high BOD (54mg/l), COD (239 mg/l) and chromium as 1.56 mg/l.
- The irrigation canal distributes the treated effluent into farms in the area through multiple channels.
- A drain from UPSIDC, Rooma was found meeting one of the channels of irrigation canal in Chakeri area near Allenhouse School with no flow observed at the time of visit.
- Samples were collected from the channel from Rooma UPSIDC, and analysis results shows Colour- 500 Hazen; BOD value as 38 mg/l and COD as 154 mg/l. The High value of colour indicates discharge of industrial effluent into this channel/drain.
- The left channel of irrigation canal was almost dried up till it reaches Salempur village near Deori ghat.
- The other channel (Left side), reaches Chakeri farm area upto NH-2 & Kulgaon area and was found carrying high volume of effluent (irrigation water) near Chakeri Ward which ultimately meet river Ganga at Jamda village (d/s of Deori Ghat).
- Maharajpur village (located downstream to the meeting point of irrigation canal at Jamda village), on Ganga River Bank has informed about foul smell and coloured water in river Ganga during lean season.

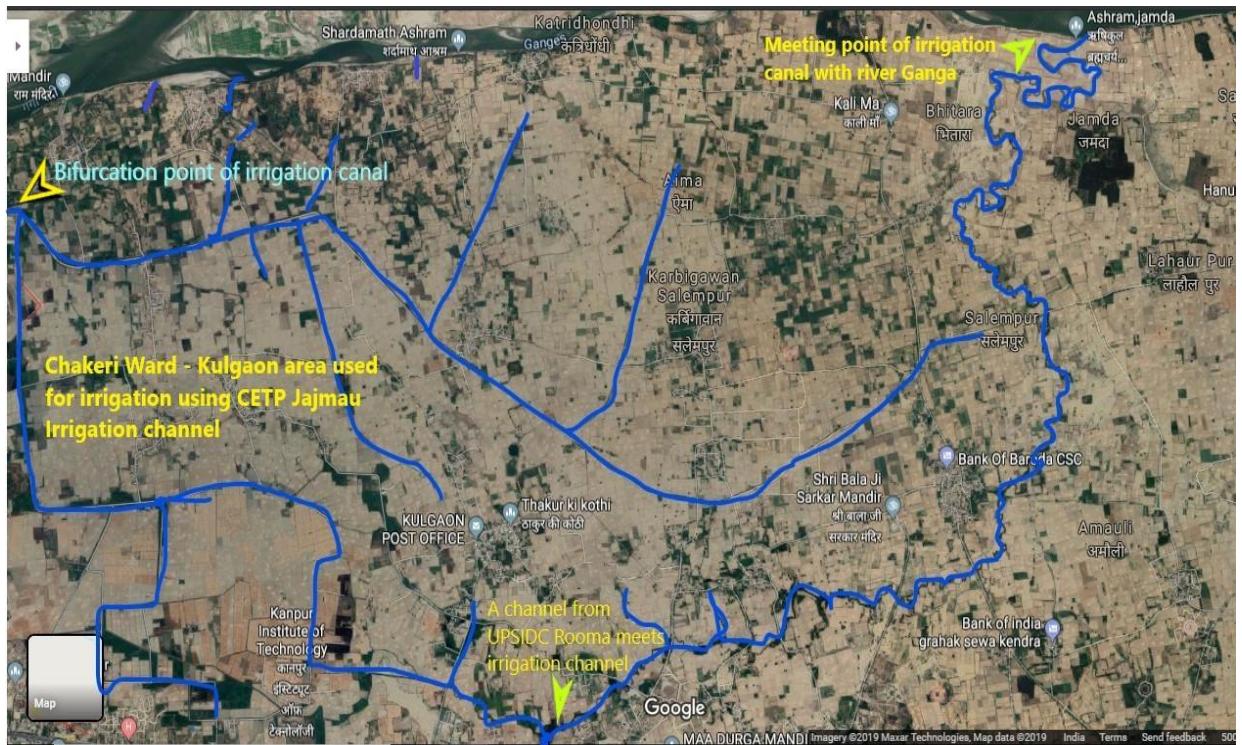


Figure 33 Network of irrigation channel in Chakeri region of Kanpur

Analysis report of the samples collected from drains in Kanpur district as Tikkapurwa drain (Shivrajpur), drain from Rooma UPSIDC, and irrigation canal breach reaching river Ganga are provided in the following table.

Table 5 Analysis report of samples from drain in Kanpur (non-priority drains)

S. No.	Parameters	Unit	Sample code		
			Drain-1 (Drain meeting to R. Noon at Mandhana- Bithoor road, Near Tikkapurwa, Kanpur)	Drain-2 Drain from Rooma UPSIDC, Kanpur	Drain-3 Irrigation canal b/c to R. Ganga, at Katri Jamda village, Kanpur
1.	pH	-	8.07 (31.1°C)	7.71 (31.1°C)	8.14 (30.8°C)
2.	Colour	Hazen	500	500	125
3.	TSS	mg/L	58.5	24.8	55.2
4.	COD	mg/L	139	154	73.1

5.	BOD	mg/L	37.7	38.0	27.7
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5.0 Conclusion

Study Area I:

- Stretch-1 i.e. from U/s Bithoor (Murdahaghat) to D/s Kanpur Barrage shows high pollution due to the pollution contribution from three major tributaries, Ramganga, Garra and Kali East.
- The middle stretch (Stretch-2) i.e. from D/s Kanpur barrage to D/s Shuklaganj shows better quality of River water as compared to stretch-1 and stretch-3.
- In the lower stretch (stretch-3) discharge from Kanpur city and Shuklaganj city contribute to pollution load and further deterioration in river water quality is observed due to discharges from drains and industries located at Jajmau.

Study Area II:

- From Farrukhabad upto Kanpur City, the River water quality in terms of BOD was found within the limit laid down in the Bathing Water Quality Criteria. Downstream to Kanpur City the BOD value was found above the limit of 3mg/l throughout the stretch.
- Higher the dissolved oxygen, the better is the health of the River. The DO values were found more than the criteria of Bathing Standard throughout the stretch except at only one location Deori Ghat (Kanpur City). Downstream to this location, the DO again regenerates and increase above Bathing Standard (5 mg/l) throughout the stretch.
- The high BOD values ($> 3.0 \text{ mg/l}$) of the five tributaries (Kali East, Isan, Noon, Pandu and Loni) indicates the pollution load in these rivers. The cumulative effects of the pollution load of these rivers and other non-point/point sources discharge from Kanpur city results into higher BOD values observed in River Ganga at three locations D/s to Kanpur city.
- 06 tributaries confluence with river Ganga in the Farrukhabad-Dalmau stretch, out of which 04 tributaries (Ramganga, Kali East, Garra and Pandu) carry high pollution.
- Breaches were observed in irrigation canal from Jajmau CETP at Jana village and nearby areas. A channel containing treated effluent from CETP Jajmau after meeting a channel from UPSIDC Rooma was found reaching river Ganga at Jamda village. These discharges are one of the causes of pollution in River Ganga at Kanpur City

WATER QUALITY OF RIVER GANGA IN FARRUKHABAD – DALMAU STRETCH

The following table (Table-6) shows the laboratory data of water quality analysis for 10 sampling locations of river Ganga in Farrukhabad to Dalmau stretch.

Table 6 Analysis results of samples from River Ganga

S. No.	Parameters	Unit	Sample code									
			River 0	River 1	River 4	River 5	River 8	River 9	River 11	River 12	River 14	River 16
1.	pH	-	7.54	7.88	7.77	7.80	7.22	7.75	7.66	6.91	7.73	7.82
2.	Temperature	°C	30.0	29.0	29.0	29.0	30.0	29.5	31.0	30.0	31.0	31.0
3.	Turbidity	NTU	260	250	400	220	350	310	160	150	160	140
4.	Colour	Hazen	10	10	25	20	20	20	25	20	25	20
5.	TSS	mg/L	845.0	769.0	1325.0	674.0	915.0	1114.0	257.0	324	301	227
6.	TDS	mg/L	98.8	111.0	148.0	146.0	136.0	146.0	198.0	198	205	225
7.	Potassium K ⁺	mg/L	2.74	2.80	4.01	5.10	4.14	4.23	4.58	4.09	4.87	4.91
8.	Chloride as Cl ⁻	mg/L	BDL	6.03	6.04	10.4	7.89	8.18	26.6	13.0	14.9	15.5
9.	Fluoride as F ⁻	mg/L	BDL	BDL	BDL	BDL	BDL	BDL	BDL	0.516	BDL	BDL
10.	Phosphate as P (PO ₄ -P)	mg/L	BDL	BDL	BDL	BDL	BDL	BDL	0.02	0.062	0.110	0.089
11.	Nitrate as N (NO ₃ -N)	mg/L	0.96	1.04	1.84	1.26	1.58	1.83	2.28	1.28	1.44	1.42

12.	Ammonical Nitrogen as (NH ₃ -N)	mg/L	BDL	BDL	BDL	BDL	BDL	BDL	BDL	0.515	0.436	0.208
13.	Dissolved oxygen	mg/L	6.5	5.8	5.6	5.9	6.6	5.8	4.0	5.8	5.9	6.8
14.	BOD	mg/L	1.1	1.63	1.49	2.37	1.33	2.1	2.97	4.14	4.62	4.37
15.	COD	mg/L	10.6	12.4	8.35	12.6	9.56	12.8	18.1	14.8	18.9	17.2
16.	Total Coliforms	MPN/ 100ml	2.3x10 ⁴	7.8x10 ³	3.3x10 ⁴	3.3x10 ⁴	1.3x10 ⁵	2.3x10 ⁴	1.3x10 ⁵	2.2x10 ⁵	2.3x10 ⁴	2.3x10 ⁴
17.	Faecal Coliforms	MPN/ 100ml	2x10³	2x10³	1.3x10⁴	1.1x10⁴	3.3x10⁴	1.3x10⁴	4.9x10⁴	1.3x10⁵	1.3x10⁴	1.3x10⁴

Table 7 Analysis results of samples from tributaries in Farrukhabad-Dalmau

S. No.	Parameters	Unit	Sample code						
			River 2	River 3	River 6	River 7	River 10	River 13	River 15
1.	pH	-	7.71	7.58	7.90	7.64	7.33	7.58	7.56
2.	Temperature	°C	30.0	29.0	30.0	29.0	31.0	32.0	32.0
3.	Turbidity	NTU	400	310	340	320	150	120	130
4.	Colour	Hazen	30	30	25	25	60	20	50
5.	TSS	mg/L	903.0	630.0	238.0	242.0	123.0	175	74
6.	TDS	mg/L	153.0	155.0	164.0	115.0	209.0	308	218
7.	Potassium K ⁺	mg/L	3.01	3.97	8.03	4.59	5.37	5.30	5.61
8.	Chloride as Cl ⁻	mg/L	10.7	3.25	21.4	8.36	11.5	21.8	20.9
9.	Fluoride as F ⁻	mg/L	BDL						
10.	Phosphate as P (PO ₄ -P)	mg/L	BDL	BDL	0.07	0.07	0.37	0.565	0.386
11.	Nitrate as N (NO ₃ -N)	mg/L	1.97	2.66	1.63	1.55	2.09	2.55	1.41
12.	Ammonical Nitrogen as (NH ₃ -N)	mg/L	BDL	BDL	BDL	BDL	BDL	0.656	0.240
13.	Dissolved oxygen	mg/L	5.5	4.8	6.1	6.0	2.1	4.4	6.2
14.	BOD	mg/L	2.38	2.47	4.4	3.19	3.86	5.86	4.90
15.	COD	mg/L	16.5	11.3	16.6	13.8	19.2	18.6	19.8
16.	Total Coliforms	MPN/ 100ml	1.3x10 ⁵	7.9x10 ⁵	7.9x10 ⁴	3.5x10 ⁶	4.9x10 ⁵	1.1x10 ⁴	7.8x10 ³
17.	Faecal Coliforms	MPN/ 100ml	2.3x10 ⁴	3.3x10 ⁵	4.5x10 ³	4.9x10 ⁵	1.7x10 ⁵	7.8x10 ³	4.5x10 ³

Table 8 Wastewater quality of drains monitored at Farrukhabad and Kannauj

S. No . .	Paramet ers	Unit	Sample code							
			FD- 01	FD- 02	FD- 03	FD- 04	FD- 05	K-01	K-02	K-03
1.	pH	-	7.34	7.39	7.99	7.53	7.61	7.73	8.05	7.53
2.	Colour	Hazen	625	75	60	50	70	70	75	60
3.	TSS	mg/L	19.7	112	44.3	19.4	29.5	33.4	22.1	102
4.	TDS	mg/L	796	456	603	591	786	739	670	571
5.	Chloride as Cl ⁻	mg/L	12	71.9	66.4	71.9	105	93.4	76.2	45.1
6.	Sulphate as SO ₄ ²⁻	mg/L	100	62.9	61.6	51.3	77.5	80.5	89.7	77.5
7.	Oil & Grease	mg/L	BDL							
8.	COD	mg/L	122	51.8	58.6	70.9	90.7	58.3	49.5	83.8
9.	BOD	mg/L	40.1	16.8	25.7	40.0	54.2	20.7	14.6	35.4
10.	Phosphate (as PO ₄ ³⁻ - P)	mg/L	3.62	1.50	2.43	1.58	2.42	BDL	BDL	1.29
11.	Nitrate (as NO ₃ ⁻ - N)	mg/L	6.62	11.0	2.67	2.64	7.25	21.6	10.3	2.37
12.	NH ₃ -N	mg/L	31.1	BDL	BDL	10.3	21.7	12.9	BDL	6.37
13.	Total Coliform s	MPN/ 100ml	7.9x1 ^{0⁶}	4.9x1 ^{0⁵}	1.3x1 ^{0⁶}	4.9x1 ^{0⁶}	3.3x1 ^{0⁵}	2.4x1 ^{0⁶}	4.9x1 ^{0⁶}	3.5x1 ^{0⁷}
14.	Fecal Coliform s	MPN/ 100m l	3.3x1 ^{0⁶}	2.3x1 ^{0⁵}	7.9x1 ^{0⁵}	3.3x1 ^{0⁶}	2.3x1 ^{0⁵}	1.3x1 ^{0⁶}	2.2x1 ^{0⁶}	1.3x1 ^{0⁷}

Annexure-I

Mapping of NWMP Locations in Kanpur (duration - 9th to 11th April, 2019)

S. No.	Location	pH	DO	Temp.	Colour	BOD	COD	TC	FC	TDS	TSS	Turbidity	NO ₃ -N	NH ₃ -N	PO ₄ -P	K ⁺	Cl ⁻	F ⁻
1.	R. Ganga u/s of old Bithoor	8.40	8.9	30	10	3.7	15.1	2.0×10^3	<1.8	173	78.6	38	1.78	0.594	0.050	4.73	10.6	BDL
2.	R. Ganga Bithoor (1146)	8.47	8.6	30	10	4.3	15.2	4.9×10^4	7.8×10^3	175	70.5	34	2.45	0.838	0.046	4.62	10.6	BDL
3.	R. Ganga u/s of Ranighat (d/s of Ganga Barrage)	8.56	8.3	30	10	2.7	12.7	2.4×10^5	4.9×10^4	184	26.2	18	3.16	0.279	0.057	4.78	8.65	BDL
4.	R. Ganga Bhairoghat (10154)	8.38	7.8	29	10	2.7	14.3	3.3×10^4	2.3×10^4	185	34.6	19	2.38	0.264	0.100	5.07	10.6	BDL
5.	R. Ganga u/s of Shuklaganj (1067)	8.33	6.9	30	5	2.8	12.8	2.0×10^3	<1.8	166	40.6	16	2.40	0.181	0.045	4.85	10.6	BDL
6.	R. Ganga d/s of Shuklaganj (10155)	8.39	7.6	32	5	2.78	11.2	3.3×10^4	4.5×10^3	171	31.3	17	1.72	0.109	0.052	4.73	9.61	BDL
7.	R. Ganga at Golaghat, Kanpur (10156)	8.30	8.2	31	5	2.82	14.1	1.7×10^4	1.3×10^4	175	24.5	18	1.84	BDL	0.099	5.03	10.6	BDL
8.	R. Ganga at Jajmau Bridge, Kanpur (10157)	8.22	7.5	31	10	3.98	13.7	2.8×10^5	2.2×10^5	179	37	17	1.66	BDL	0.089	4.99	12.5	BDL
9.	R. Ganga at Jane Vill. Kanpur (1068)	8.28	7.2	31	10	5.30	16.5	4.9×10^4	2.0×10^3	179	53.4	20	1.24	BDL	0.062	4.73	11	BDL
10.	R. Ganga at Dhondhi ghat	8.35	7.9	31	5	3.47	16.0	1.4×10^4	4.5×10^3	175	67	27	1.34	BDL	0.055	4.52	9.86	BDL
11.	Channel of Irrigation canal meeting to R. Ganga at Jane Vill., Kanpur	8.00	-	-	75	63.9	247	-	-	-	153	-	-	-	-	-	-	
12.	Irrigation canal near Karbigaon Vill., Kanpur	7.63	-	-	50	54.1	239	-	-	-	88.2	-	-	-	-	-	-	

Colour in Hazen; TC and FC in MPN/100ml; all others except pH & temp are in mg/l;

Annexure – II

Heavy metal analysis report of samples collected from river Ganga and irrigation canal in Kanpur region of UP during 9-11 April 2019.

As – Arsenic; Cd – Cadmium; Cr – Chromium; Cu – Copper; Fe- Iron; Mn – Mangnese; Ni- Nickel; Pb – Lead; Zn – Zinc; Co- Cobalt; Sb- Antimony; Se – Selenium; V - Vanadium

Sample code	As (mg/l)	Cd (mg/l)	Cr (mg/l)	Cu (mg/l)	Fe (mg/l)	Mn (mg/l)	Ni (mg/l)	Pb (mg/l)	Zn (mg/l)	Co (mg/l)	Sb (mg/l)	Se (mg/l)	V (mg/l)
River Ganga at Bithoor	BDL	BDL	BDL	0.01	1.48	0.08	BDL	BDL	0.02	BDL	BDL	BDL	BDL
Ganga at U/s Bithoor, Murdhaghat	BDL	BDL	BDL	BDL	2.65	0.08	BDL	BDL	BDL	BDL	BDL	BDL	BDL
River Ganga d/s Kanpur barrage	BDL	BDL	BDL	BDL	0.069	0.06	BDL	BDL	BDL	BDL	BDL	BDL	BDL
River Ganga at Bhairoghat, Kanpur	BDL	BDL	BDL	BDL	0.77	0.06	BDL	BDL	BDL	BDL	BDL	BDL	BDL
River Ganga at U/s shuklaganj	BDL	BDL	BDL	BDL	0.91	0.07	BDL	BDL	BDL	BDL	BDL	BDL	BDL
River Ganga at D/s shuklaganj	BDL	BDL	BDL	BDL	0.82	0.06	BDL	BDL	BDL	BDL	BDL	BDL	BDL
River Ganga at D/s Golaghat	BDL	BDL	BDL	BDL	0.62	0.06	BDL	BDL	BDL	BDL	BDL	BDL	BDL
River Ganga at Jajmau bridge	BDL	BDL	0.01	BDL	0.89	0.09	BDL	BDL	0.02	BDL	BDL	BDL	BDL
River Ganga at Jana village	BDL	BDL	0.03	BDL	1.53	0.08	BDL	BDL	BDL	BDL	BDL	BDL	BDL
River Ganga at Deori ghat (d/s jana village), Kanpur	BDL	BDL	BDL	BDL	1.94	0.08	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Irrigation canal overflow going to Ganga at Jana village	BDL	BDL	3.97	0.01	2.91	0.14	BDL	BDL	0.02	BDL	BDL	BDL	BDL
Irrigation channel at Karibgaon	BDL	BDL	1.56	0.01	0.65	0.10	BDL	BDL	0.01	BDL	BDL	BDL	BDL

Annexure-III

Weekly Monitoring of Drains at Kanpur (Date of Monitoring: 09.04.2019)

s. No.	Name of Drain	Characteristics								
		Flow	pH	DO	Colour	BOD	COD	TC	FC	T. Cr.*
Drains having their gradient towards river Ganga at Kanpur										
1	Permiya Drain	113	7.56	3.1	30	17.2	32.2	1.3×10^8	4.9×10^7	-
2	Ranighat Drain	1.6	7.31	NT	100	259	552	9.2×10^9	2.2×10^9	-
3	Bhagwattas Ghat Drain	4	7.36	NT	50	60	161	5.4×10^{10}	3.5×10^{10}	-
4	Sattichaura Drain	Not Measurable	7.47	1.1	60	56.7	142	3.5×10^{10}	1.1×10^{10}	-
5	Golaghat Drain	2.7	7.53	NT	50	60	205	9.2×10^9	1.7×10^9	-
6	Muir Mill Drain	Tapped	-	-	-	-	-	-	-	-
7	TEFCO Drain	Tapped	-	-	-	-	-	-	-	-
8	Parmat Drain	Dry	-	-	-	-	-	-	-	-
9	Jail Drain	Tapped	-	-	-	-	-	-	-	-
10	Dabka Drain	(Tapping provision exist) 144	7.38	NT	50	67.3	278	5.4×10^{10}	2.4×10^{10}	-
11	Sisamau Drain	Tapped	-	-	-	-	-	-	-	-
12	Sheetala bazar Drain	Tapped	-	-	-	-	-	-	-	-
13	BudhiyaGhat Drain	Tapped	-	-	-	-	-	-	-	-
14	Wazidpur Drain	(Partially Tapped) Flow was not measurable	8.26	NT	80	782	1606	7.9×10^6	4.9×10^6	-
15	Police Line Drain	Tapped	-	-	-	-	-	-	-	-
16	Airforce Drain	Tapped	-	-	-	-	-	-	-	-
Drains having their gradient towards river Pandu at Kanpur										

1	ICICI Drain	17.77	7.58	2.5	40	35.7	77.6	9.2×10^8	2.2×10^8	-
2	Panki Drain	22.68	7.54	NT	80	104	229	1.3×10^8	7.9×10^7	-
3	COD Drain	Tapped & Dry	-	-	-	-	-	-	-	-
4	HalwaKhanda Drain	34.74	7.41	NT	80	85.7	205	5.4×10^8	1.4×10^8	-
5	Ratanpur Drain	7.15	7.92	NT	125	36.8	74.7	3.3×10^7	2.4×10^7	-
6	Ganda Drain	78.18	7.35	NT	60	100	264	3.5×10^8	1.3×10^8	-

Drains having their gradient towards river Ganga at Unnao, Fatehpur

1	City Jail Drain	9.23	8.37	3.5	200	122	280	4.5×10^5	2.0×10^5	
2	Loni River	Not meeting to R. Ganga (Dry at confluence)	-	-	-	-	-	-	-	-

Note : Flow in MLD; Colour in Hazen; TC and FC in MPN/100ml; all others except pH are in mg/l;

NT- Not traceable

*Result awaited

Weekly Monitoring of River Quality at Kanpur (Date of Monitoring: 9.04.2019)

S. No.	Location	DO	Temp	pH	Colour	BOD	COD	TC	FC
1	R. Ganga at Bithoor	9.3	30	8.67	10	4.1	15.5	2.0×10^3	<1.8
2	R. Ganga at u/s of Barrage, Kanpur	10.0	30	8.81	10	3.0	12.7	4.5×10^3	2.0×10^3
3	R. Ganga at d/s of Barrage, Kanpur	8.3	30	8.59	10	3.1	13.6	2.0×10^3	<1.8
4	R. Ganga u/s of Shuklaganj, Kanpur	8.4	30	8.55	10	2.2	10.4	3.3×10^4	1.3×10^4
5	R. Ganga d/s of Shuklaganj	8.8	30	8.54	10	2.9	9.65	7.9×10^4	4.9×10^4
6	R. Ganga b/c R. Pandu, Fatehpur	6.3	29	8.23	10	11.3	28.7	2.3×10^4	1.3×10^4
7	R. Pandu, Fatehpur	1.8	29	7.72	15	3.6	16	2.3×10^4	7.8×10^3
8	R. Ganga a/c R. Pandu	5.0	29	8.51	10	5.6	19.9	4.5×10^3	2.0×10^3

Note: Colour in Hazen, TC and FC in MPN/100 ml; all others except pH are in mg/l