Inception Report

Study on Yamuna Frothing in Delhi

Submitted to:

Director of Environment

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Department of Environment
Government of NCT of Delhi
सत्यमेव जयते

NMCG-TERI Centre of Excellence on Water Reuse
नमामि गंगे

The Energy and Resources Institute
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1 Introduction

1.1 Background

The Yamuna River is one of the most revered and iconic water bodies in India, having great socio-economic and cultural significance. It is the largest tributary of the Ganges that begins its journey from the pristine Yamunotri Glacier at Bandarpunch Peak in Uttarakhand. Renowned for its religious sanctity and historical importance, the Yamuna holds a special place in the hearts of millions across India. Spanning approximately 1,376 kilometres, it serves as a lifeline for countless communities, providing essential water for drinking, agriculture, and daily sustenance.

The Yamuna River in Delhi spans approximately 22 kilometres, a mere 1.5% of its total length, flowing from Wazirabad to Okhla. Despite this relatively short stretch, it plays a crucial role in the water supply of the national capital. More than 70% of Delhi's water needs are met by the Yamuna. Despite its vital role in the socio-economic fabric of the region, the Yamuna faces numerous challenges, including pollution and over-extraction of water. As per the Report submitted by the Delhi Pollution Control Committee (DPCC) on "Action points for Rejuvenation of River Yamuna" to the High Level Committee (HLC) constituted by National Green Tribunal (NGT) on January 2024[1], approximately 222 million gallons per day (MGD) of untreated sewage ends up Yamuna, either directly or indirectly, 79% of which comes from domestically generated sewage. In the last few years, this river has been grappling with a persistent and concerning issue of foaming, drawing a lot of attention from authorities, researchers, and concerned citizens. This issue has also been widely covered in media (Figure 1), especially during Chhath Puja, where devotees are seen worshipping in knee-deep foam laden Yamuna River.[2, 3]

In light of these findings and the pressing environmental concerns, a comprehensive study on foaming in the Yamuna River in Delhi was is essential. This study aims to identify the sources, nature, and extent of pollution contributing to foaming, develop strategies for mitigation, and explore alternatives to detergents and foaming agents that are responsible for this environmental challenge. The study seeks to protect the ecological integrity of the Yamuna River and safeguard the well-being of the communities that rely on it.

In response to the alarming degradation of the Yamuna River in Delhi, the Department of Environment, Government of NCT Delhi, has initiated a crucial proposal entitled "Study on Yamuna Frothing in Delhi."

[1] https://www.dpcc.delhigovt.nic.in/minutesofthemeetingofhlc#gsc.tab=0

[2] https://www.ndtv.com/delhi-news/delhi-pollution-devotees-stand-knee-deep-in-toxic-foam-in-delhis-yamuna-for-chhath-puja-2019-2126822

[3] https://zeenews.india.com/india/chhath-devotees-take-dip-in-toxic-foam-floating-on-yamuna-river-watch-2408729.html

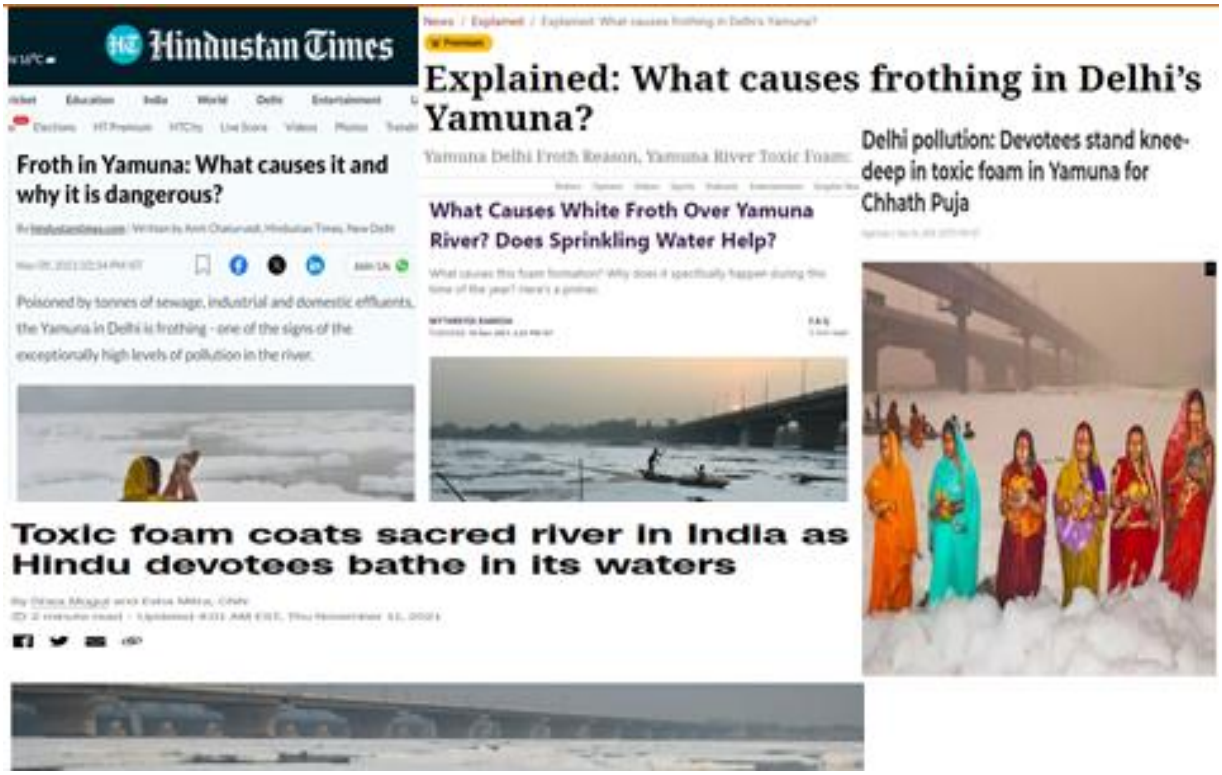


Figure 1: Persistent Problem of Froth in Yamuna reported widely on Print Media

Recognizing the urgency of addressing the persistent issue of foaming in the river, the department aims to delve deeper into the root causes and potential solutions. Through a competitive bidding process, The Energy and Resources Institute (TERI) secured the project, underscoring its expertise and commitment to environmental research and solutions. With the award letter issued on 14th February 2024, TERI promptly commenced the inception period activities. The contract was signed on 15th March 2024 between TERI and Department of Environment (DOE), GNCTD.

The inception report for the Yamuna frothing problem is crucial as it sets the groundwork for understanding and tackling this pressing issue. Timelines outlined in the inception report play a pivotal role in achieving the study's objectives and finding solutions to the Yamuna frothing problem. This will help in efficient resource allocation, facilitate progress monitoring, and ensure meeting deadlines, and foster collaboration among team members.

Hence this inception report clearly defines the problem, establishing objectives, and outlining the scope of the study, to ensure a focused and efficient research effort. It also addresses stakeholder engagement, resource planning, risk assessment, and ethical considerations, laying the foundation for a comprehensive and ethically sound investigation and work towards sustainable solutions to preserve the Yamuna River's socio-economic and cultural significance.

1.2 Scope of Work as mentioned in RFP

The primary objectives of the project are:

1. To find out the reasons behind the foaming/frothing in Yamuna River and correlate it with the outflow of different drains.
2. To assess and identify froth sources in Najafgarh Drain (upstream Dhansa Regulator to Wazirabad) and supplementary drains.
3. To identify major drains accounting for maximum pollution, load responsible for froth and finding out parameters exceeding the standard/permissible limits.
4. To identify area sources such as colonies, industrial areas, etc., contributing to the pollution load responsible for frothing in Yamuna and finding out the relative quantification, nature, source and characteristic of the pollutants and identify hot spots as far as sources are concerned.
5. To develop short-term, medium-term and long-term action plan including clear enforcement strategies for minimizing frothing/foaming in the river Yamuna including possible alternatives to household products responsible for frothing.

2 Inception Period Activities

The letter of award was offered on 14th Feb 2024, following which several key activities were initiated to kick-start the project. Here is an overview of the activities undertaken:

1. **Baseline Data Collection and Analysis**: To understand the current state of the Yamuna River and its pollution levels, baseline data collection activities were commenced. This involved analysis of existing research and reports related to Yamuna pollution.

   The following reports were reviewed:

   a. Reports on "Action points for Rejuvenation of River Yamuna" submitted by DPCC to the High Level Committee (HLC) constituted by National Green Tribunal.[4]

   b. DPCC Annual Report 2019-20.[5]

   c. DJB Monthly STP monitoring Report[6]

   d. Report titled "Rejuvenation of River Yamuna, Department wise detailed action plans, 2019", submitted to NGT by DoE, GNCTD.

   e. CPCB Report titled, "Study Group Report on Increase of Pollution in River Yamuna, 2021".

   f. Report on "Water Quality Data of Rivers Monitored Under National Water Quality Monitoring Programme (NWMP), 2021".

   g. Research Paper titled "Perspective: The unexplored dimensions behind the foam formation in River Yamuna, India, 2023."[7]

2. **Project Planning and Strategy Development:** Immediately after receiving the award letter, the project team convened to develop a detailed plan and strategy for tackling the Yamuna pollution problem. This involved identifying specific objectives, outlining the scope of work, and defining the timeline for project implementation.

[4] https://environment.delhi.gov.in/

[5] https://www.dpcc.delhigovt.nic.in/home/annual_report

[6] https://delhijalboard.delhi.gov.in/doit/tab-content/daily-stp-reports?page=0

[7] Sejwal, G., & Singh, S. K. (2023). Perspective: The unexplored dimensions behind the foam formation in River Yamuna, India. Environmental Science and Pollution Research, 30(39), 90458-90470.(DTU)

2.1 Current Status of Pollution in Yamuna

The Yamuna River is continuously plagued by heavy pollution coming from various sources. One of the significant contributors being the untreated municipal sewage entering the river. The water quality of the Yamuna River deteriorated after it enters the national capital at Wazirabad Barrage and with the existing gaps in sewage management here needed and despite efforts to mitigate contamination, the current status remains alarming.

In addition to the pervasive pollution plaguing the Yamuna River, one particularly visible manifestation of its degraded state is the phenomenon of foaming. Foaming occurs due to high levels of organic and chemical pollutants in the water, which disrupt the river's natural balance and create conditions conducive to foam formation. The foam observed particularly on the outfall of Yamuna from Okhla barrage is thick and persistent, blankets stretches of the river. This foam is not a result of natural phenomena but rather the presence of excessive phosphates, detergents, oils, and other foam-causing agents.

Efforts to mitigate foaming in the Yamuna have been met with limited success, as addressing the underlying causes of pollution requires comprehensive strategies and long-term commitment. While temporary measures such as spraying of Silicon dioxide-based agent with poly-oxypropylene group as the de-foaming agent[8] (as done by DJB currently) can offer short-term relief, lasting solutions necessitate tackling the root causes of pollution through stringent regulations, effective enforcement, and sustainable development practices.

2.2 Key Reasons Identified for foaming in Yamuna River:

Although foaming is a natural phenomenon, often as a result of the natural decomposition of aquatic plants resulting in high organic content in the water in specific areas of river bed that are experiencing high agitation or turbulence. However, the aggravated situation of foaming in Yamuna, specifically near the Okhla Barrage has many underlying reasons that have been reported by Yamuna Monitoring Committee constituted by Hon`ble NGT on the basis of studies carried out by Delhi Pollution Control Committee (DPCC) and the Central Pollution Control Board (CPCB) .

The Key reasons identified by DPCC are as follows:

1. Excessive accumulation of Phosphates and Surfactants in form of chemicals like Sodium tri-poly-phosphate, Sodium dodecyl sulphate (SDS) etc. so often found in household detergents and industrial cleaning agents. The use of detergents and foaming agents has increased substantially due to heightened public awareness regarding hygiene as a precautionary measure to protect against COVID-19 infections leading to surge in detergent usage contributing to the foaming issue.
2. Excess nutrient flow in the Yamuna due to discharge of untreated or partially treated industrial, agricultural and domestic wastewater in river water.

[8]https://timesofindia.indiatimes.com/city/delhi/djb-starts-drive-cut-froth-kalindi-kunj-riverbank-chhath-puja/articleshow/105275337.cms

3. Enhanced agitation resulting in turbulence to the settled sludge on the riverbed due to sudden discharge and vertical fall especially at Okhla barrage. At this location, treated and untreated wastewater from Delhi is impounded, and only excess wastewater is released downstream. This release of wastewater agitates the surfactants present, leading to the formation of foam as depicted in Figure 1.
4. Ammoniacal Nitrogen and phosphates, which contribute to the formation of harmful algal growth, were reported at concentrations exceeding desired level near Okhla Barrage.
5. The presence of water Hyacinth in the upstream of Okhla Barrage leading to high biomass content in the river bed that gets agitated due to obstruction in flow near the barrage resulting in excessive foaming. This could also be seen in Figure 2.

Figure 2: Visible presence of water Hyacinth near Okhla Barrage[9]

2.3 Water demand and wastewater generation

Over the last few decades, Delhi has experienced phenomenal growth of population due to migration from adjacent states resulting intense pressure on the available resources. As per Delhi Jal Board (DJB), total water consumption in Delhi is 960 MGD from both surface and ground water sources and the estimated wastewater generated is 792 MGD and the present treatment capacity is 84.2% of the estimated sewage generation. As per Delhi Pollution Control Committee currently 565 MGD of sewage is treated and 222 MGD of untreated and ends up polluting the available fresh water sources*10*. Moreover, out of the 37 operational Sewage Treatment Plants (STPs) in Delhi region, only 27 STPs are conforming to the NGT norms of BOD<10mg/L, COD<30mg/L, suspended solids < 10mg/L, and nitrogen <10mg/L, as well as Fecal Coliform <230 most probable number

[9]https://www.imago-images.com/st/0101459449

[10] https://indianexpress.com/article/cities/delhi/delhi-sewage-untreated-pollution-control-board-report-8883518/#:~:text=The%20gap%20in%20sewage%20treatment,year%2C%20previous%20DPCC%20reports%20show.&text=control%20committee%20report

(MPN) for treated wastewater. Beside the lacking wastewater treatment infrastructure and distressing conditions of STPs, a key cause of concern are the 18 major drains responsible for collecting and transporting the sewage. Only 11 out of these 18 drains have been tapped and redirected to nearest wastewater treatment facility, whereas the rest 7 drains are either partially tapped or remains untapped leading to discharge of highly polluted and untreated wastewater in the river stream.

The alarming condition of the open drains and gap in infrastructure of STPs is seriously affecting the 22 km stretch of Yamuna River that flows through the western and southern parts of Delhi. As per reports, the dominant cause of pollution in the Yamuna River is the discharge of domestically generated sewage, which constitutes more than 79% of the total effluents being discharged into the river[11]. Figure 3 depicts the major STPs and drains in the Delhi region.

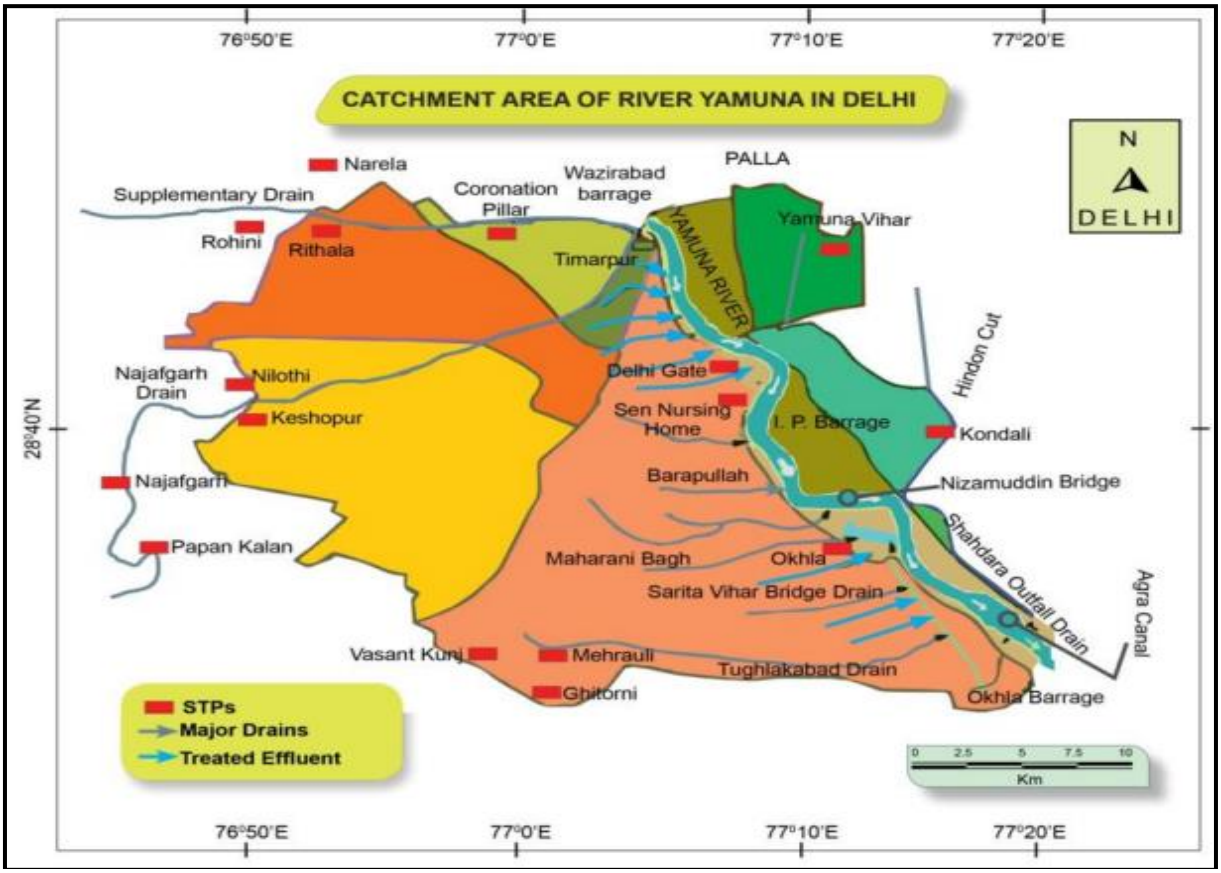


Figure 3: Flow Path of River Yamuna & major Drains and STPs in Delhi

2.4 Role of Major Drains in Polluting Yamuna

The pollution of the Yamuna River is exacerbated by the significant contributions from major drains that channel pollutants directly into its waters. These drains serve as conduits for untreated sewage, industrial effluents, and other pollutants, aggravating the already precarious state of the river. According to report submitted by GNCTD to High

[11] https://timesofindia.indiatimes.com/city/delhi/domestic-sewage-to-blame-for-80-of-river-pollution/articleshow/88960352.cms

Level Committee on Yamuna monitoring on January 2024[12], major drains contribute a staggering amount of untreated sewage and industrial waste into the Yamuna.

One of the primary sources of pollution is the Najafgarh Drain, which originates in Haryana and flows through the southwest part of Delhi before joining the Yamuna. This drain alone accounts for a substantial portion of the pollution load in the river. With a flow capacity of over 360 million litres per day (MLD), the Najafgarh Drain has been identified as a major contributor to the pollution crisis in the Yamuna. Similarly, the Shahdara Drain, originating in Uttar Pradesh and flowing through the densely populated areas of East Delhi, significantly adds to the pollution burden of the Yamuna. With a discharge capacity of approximately 196 MLD, this drain plays a pivotal role in the pollution dynamics of the river. The Barapullah Drain, which flows through the heart of Delhi, is another major contributor to Yamuna's pollution. Despite efforts to intercept and treat its flow, the Barapullah Drain continues to discharge a significant amount of untreated sewage and industrial waste into the river. With a discharge capacity of around 40 MLD, this drain adds to the cumulative pollution load in the Yamuna. Moreover, the supplementary drains across Delhi, collectively contribute to the pollution crisis in the Yamuna. Addressing the pollution from major drains is essential for restoring the ecological integrity and socio-economic significance of this iconic river.

2.5 Action Taken by the Government

1. Capacity augmentation of rehabilitation of existing STPs is being carried out.
2. Newer STPs are being set up to fill the gap in treatment of the wastewater generated.
3. The operational deficiencies of the existing STPs are being rectified
4. Interceptor Sewer Project (ISP) has been accelerated to ensure 100 % collection and treatment of domestic and industrial wastewaters generated in the regions around Yamuna River.
5. DPCC issued directions under section 33 (A) of the Water (Prevention and Control of Pollution) Act, 1974, to all the concerned agencies prohibiting sale, storage, transportation and marketing of soaps and detergents not confirming to BIS revised norms in NCT of Delhi to curb pollution in river Yamuna[13].
6. Spraying of silicon dioxide-based agent with poly-oxypropylene group as the de-foaming agent[14] by DJB.

These measures have been reported in various leeding papers and other media articles as shown in figure below

[12] MOM HLC Report (https://www.dpcc.delhigovt.nic.in/minutesofthemeetingofhlc#gsc.tab=0)
[13] Fifth Report of the Yamuna Monitoring Committee dated 07.12.2020
[14] https://www.hindustantimes.com/cities/delhi-news/opposition-alleges-govt-using-poisonous-spray-to-remove-yamuna-foam-101666982894621.html

Figure 4: Measures taken by authorities for mitigation of frothing in Yamuna

Based on the above, a detailed methodology was designed for each scope mentioned in the RFP and has been elaborated in the subsequent section.

3 Detailed Approach and Methodology

The details on the proposed approach and methodology for undertaking each task under this project depicting various assignments/activities, and the output at the end is presented as follow:

SCOPE 1

Scope 1 - To find out the reasons behind the foaming/frothing in Yamuna River and correlate it with the outflow of different drains.

Approach	Methodology	Expected Deliverables
Collect and review available data	Coordinate with various Departments (DJB, DPCC etc.) and collect reports, literature and data available on Yamuna and frothing issues.	Comprehensive Report on Scientific reasons & factors contributing to foaming/frothing in the most visible and high frothing areas in the Yamuna River.
Visit locations specific to excessive foaming	Conduct site visits to key locations like Okhla Barrage/Kalindi Kunj and ITO to visually inspect and find reasons for frothing.	
Identify outflow of different drains into the river around these areas.	Quantify avg. flow volumes, seasonal variation, pollutant concentration at the outflow of major drains around these areas like Najafgarh, Delhi Gate, Sen Nursing Home, Maharani Bagh, Shahadra/ Ghazipur drains etc.	This assessment will help in the identification of the pollutants responsible for frothing and correlate with the outflow of major drains falling in Yamuna River.
Sample Collection & Analysis from selected locations	Collect grab samples from Identified locations (Figure 5 & 6) for testing and analysis which include selected 30 Parameters (Table 1) specifically responsible for froth formation.	
	Study effect of factor like Temperature, flow etc. on the stability, volume and height of foam	

Selection of Testing Parameter to Identify Key Reason for Foaming:

The selection of parameters for testing in the Yamuna River and associated drains has been listed in Table 1. A total of 30 parameters were selected through extensive literature review. In addition to monitoring the 10 standard parameters, which are essential indicators of water quality and pollution levels of any water source, we have also included 8 anthropogenic compounds, 3 Filamentous bacteria, 9 Bio-genic Origins Compounds and 4 parameters to detect foam activators. All these parameters will be tested in all the locations identified in Yamuna River and associated drains. However, some of the parameters can be eliminated in the second sampling process based on the concentration obtained from the first Sampling Process.

Table 1: Parameters to be tested for identified sampling points

	Source/ presence of	Parameters / Compounds		Testing Methods
1.	**Standard Parameters**	1. pH 2. BOD 3. COD 4. DO 5. TSS 6. TDS	7. Ammonia 8. Ammonium 9. Nitrates 10. Phosphates 11. E. Coliforms, F. Coliforms and Total Coliforms	As per APHA Standards
2.	**Anthropogenic compounds / industrial effluent / pharma products / Heavy metals**	1. Surfactants 2. Pesticides 3. Herbicides	4. Oil and grease 5. Chromium, lead, Manganese, iron etc.	Analytical equipment including chromatography (HPLC, GC, GC/MS) and atomic absorption spectroscopy (AAS, GFA, FIAS) as per BIS standards
3.	**Effluent from STP**	Filamentous bacteria 1. Nocardia amarae, 2. Gordonia amarae		Kirby-Bauer agar diffusion method/ Bio-assay as per APHA standards
4.	**Bio-genic Origins/Compounds such as food products, aquatic plants.**	1. Saponin 2. lipids 3. proteins, 4. Carbohydrates 5. Fatty acids 6. Monosaccharides	AQUATIC PLANTS 7. Eichhornia crassipes, commonly known as water hyacinth 8. Ranunculus fluitans	Protein assay as per APHA standards
5.	**Foam activators**	1. Compounds of Mg and Ca 2. Sodium Lauryl Sulphate 3. Ammonium ion 4. Sodium tri-poly-phosphate, etc.		Atomic Absorption spectrometry (AA), Inductively Coupled Plasma Optical Emission Spectrometry (ICP-OES) as per International Standards.
		Total Parameters = 30		

Selection of Sampling Locations:

A total of 10 sampling locations were identified for Scope 1 and have been listed in Table 2. A total of 7 specific sampling locations were selected to better understand the correlation between foaming and the outflow from drains like Najafgarh Drain, Sen Nursing Home Drain, Barrapulla Drain, Maharani Bagh Drain, Tuglakabad Drain, and Shahdara Drain will shed light on the potential link between specific pollutants and foam formation. The identified locations on Google Earth image has been presented in Figure 5.

Also, 3 locations have been identified on the Okhla Barrage where foaming is visually observed. These 10 locations will help in identifying the spatial distribution of pollutants entering the Yamuna and to this approach facilitates targeted interventions to mitigate pollution and address the root causes of foaming in the Yamuna River. The identified locations on Okhla Barrage have been presented in Figure 6 respectively.

Table 2: List of selected sampling points

S.No	Sampling Location	Location Details	Sampling Design
1	SL_Y_1	Yamuna entering at Wazirabad Barrage	7 sampling points to quantify the outflow from drains in Yamuna River
2	SL_Y_2	Outfall of Najafgarh Drain	
3	SL_Y_3	Outfall of Sen Nursing Home Drain	
4	SL_Y_4	Outfall of Barrapulla Drain	
5	SL_Y_5	Outfall of Maharani Bagh	
6	SL_Y_6	Outfall of Tuglakabad Drain,	
7	SL_Y_7	Outfall of Shahdara Drain	
8	SL_Y_8	Entry to Okhla Barrage	3 sampling points on the Okhla Barrage where foaming is visually observed
9	SL_Y_9	Exit from Okhla Barrage	
10	SL_Y_10	500 feet from the Barrage	
	Total Locations: 10		

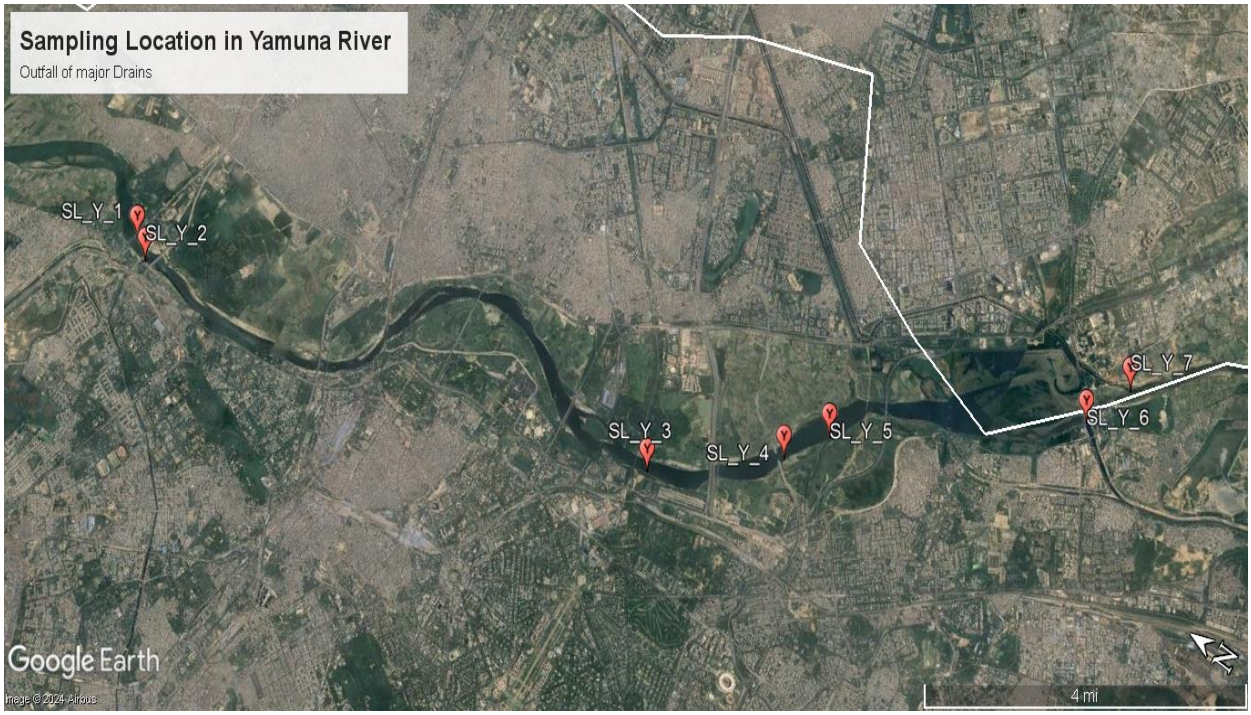


Figure 5: Google Earth image of 7 sampling locations in Yamuna River as per Table 2.

Figure 6: Google Earth image of 3 sampling locations near Okhla Barrage on Yamuna River as per Table 2.

<u>Methodology for Flow Measurement:</u>

To calculate the flow of outfall for various drains in the Yamuna, we may use using the V-notch plate method, as guided in the CPHEEO manual. The calculation will be made using the formula: $Q = 1.42\ X\ (H^{2.5})$

Where, Q is the discharge in cubic meters per second (cum/sec) and H is the depth of flow in meters.

SCOPE 2

Scope 2 - To assess and identify froth sources in Najafgarh Drain (upstream Dhansa Regulator to Wazirabad) and supplementary drains.

Approach	Methodology	Expected Deliverables
Collect and review historical data.	Collect reports, literature and conduct field surveys along Najafgarh Drain and supplementary drains and associated frothing issues.	Comprehensive Report on pollutants and pollution hotspots contributing to foaming/frothing in Najafgarh Drain and its Supplementary drains.
Conduct site visits to key locations to visually inspect frothing.	Selected locations (marked on Figure 7) are based on the outflow of supplementary drains in Najafgarh drain and supplementary drains and their intersection points.	
Collect grab samples from key locations for testing and analysis	GIS mapping to schematically analyse geographical referenced information	

Selection of Sampling Locations:

The 6 sampling location selected are listed based on pollutant source incoming into Najafgarh Drain. These points will be monitored pre and post monsoon to also study the seasonal effect. The 6 locations are listed in Table 3 and depicted in Figure 7.

Table 3: Identified location for monitoring of Najagfarh Drain

S.No	Sampling Location	Location Details	Sampling Design
1	SL_N_1	Intersection with Supplementary Drain	6 sampling points to quantify the pollution load entering the Najafgarh Drain
2	SL_N_2	Intersection with Mungeshpur drain	
3	SL_N_3	Outlet of Najafgarh STP	
4	SL_N_4	Outlet 2 of Sector 16 Dwarka STP	
5	SL_N_5	Intersection with Najafgarh Lake	
6	SL_N_6	Intersection at Delhi Border	
	Total Location: 6		

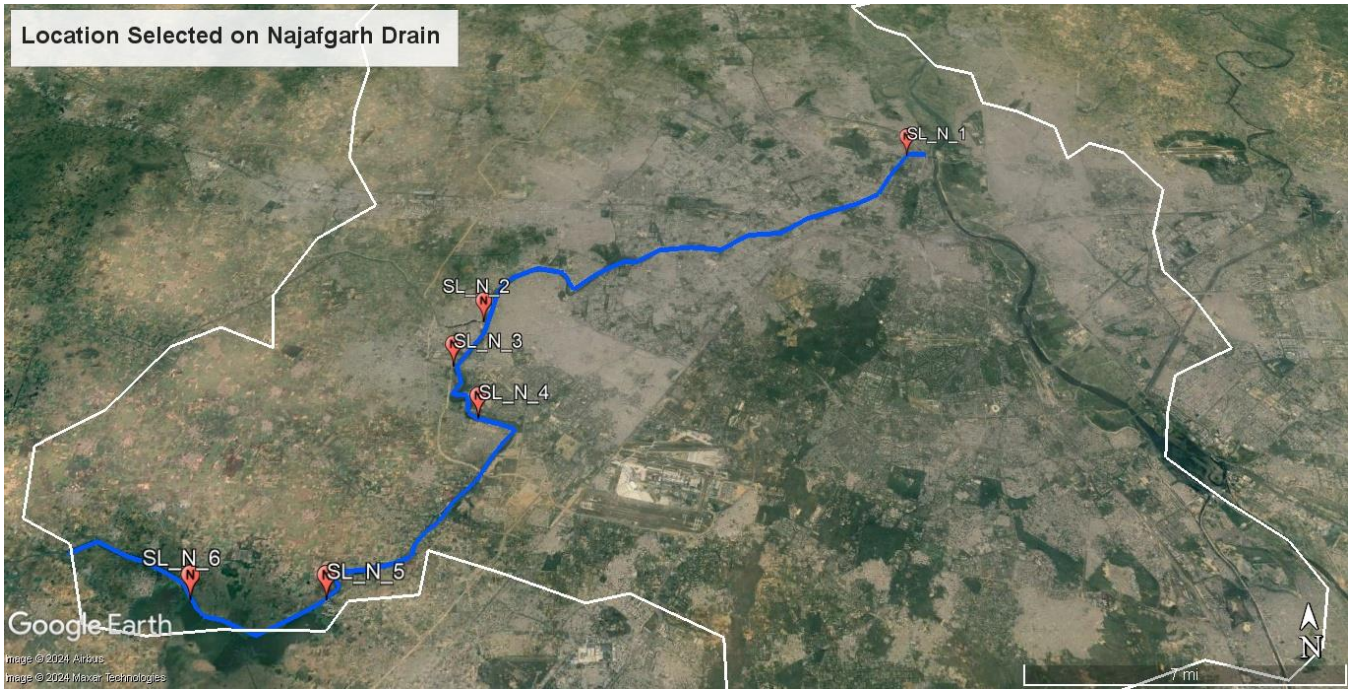


Figure 7: Google Earth image of 6 sampling locations in Najafgarh Drain (Dhansa Regulator to outfall at Wazirabad.

SCOPE 3

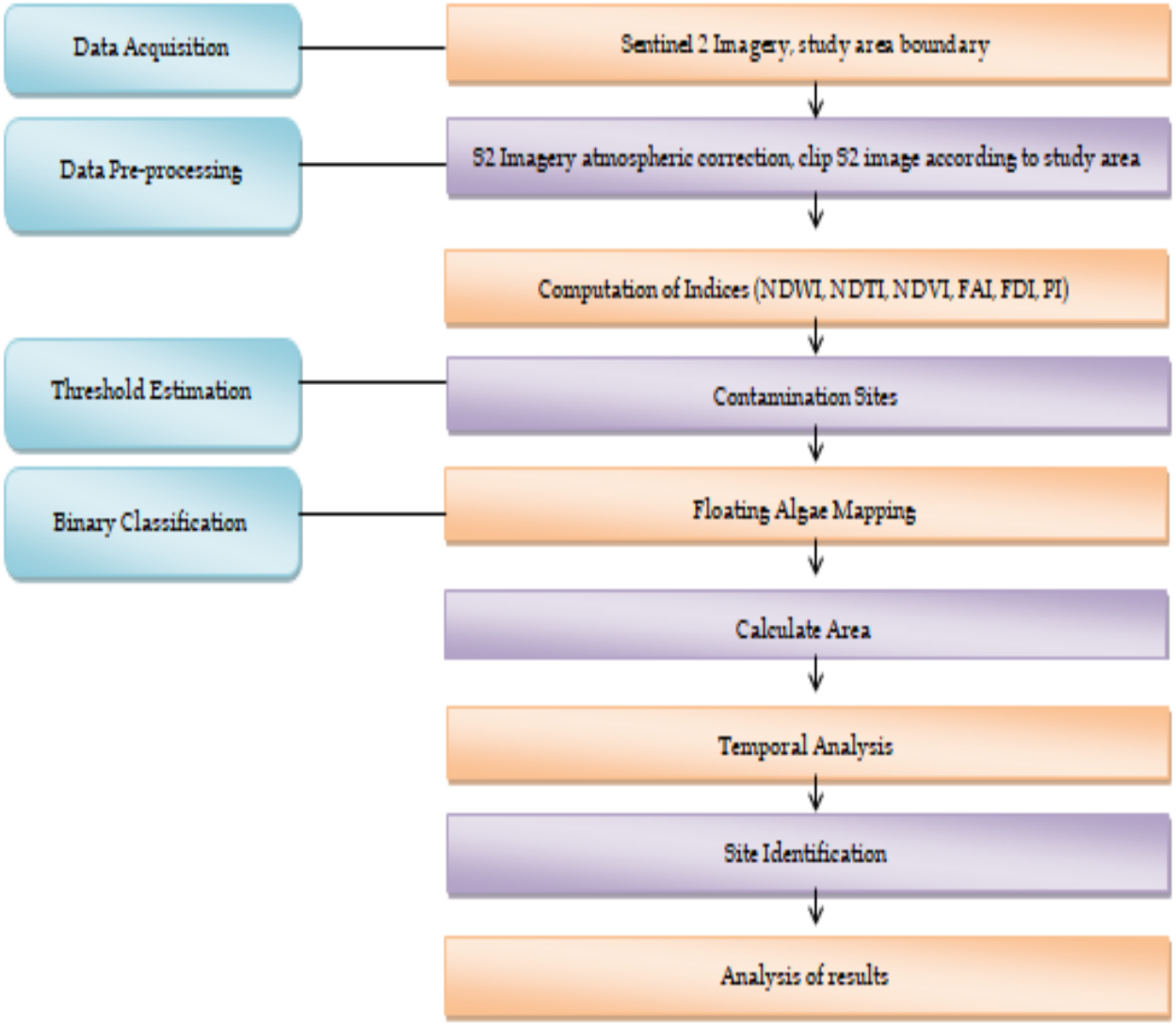
Scope 3 - To identify major drains accounting for maximum pollution load responsible for froth and finding out parameters exceeding the standard/permissible limits.

Approach	Methodology	Expected Deliverables
Identify major drains transporting wastewater in the Yamuna River.	Identification of major drains like Ghazipur Drain, Shahadra Drain/ Hindon Cut Canal etc. (from Scope 1) based on their contribution to pollution using historical data, water quality parameters, and pollutant levels.	**Comprehensive Report on major drains contributing directly and indirectly to foaming/frothing in the Yamuna River.**
Quantify the pollution load generated by these drains	Estimate pollution load for each drain, considering factors such as flow rate, pollutant concentration, and discharge volume.	
Assessment of water quality parameters exceeding standard or permissible limits.	GIS mapping of Identified Drains	

Selection of Sampling Locations:

Based on the sampling done in Scope 1 major polluting drains will be identified and will be mapped with GIS the detailed methodology has been described below:

Flowchart of GIS Methodology:



SCOPE 4

Scope 4 - To identify area sources such as colonies, industrial areas, etc., contributing to the pollution load responsible for frothing in Yamuna and finding out the relative quantification, nature, source and characteristic of the pollutants and identify hot spots as far as sources are concerned.

Approach	Methodology	Expected Deliverables
Identification of point-source areas like: **1. Unsewered residential colonies** **2. Open drains** **3. Non-performing CETPs, ETPs** **4. Underutilized and Non-performing STPs**	Collaborating with local authorities to identify residential colonies (authorized and/or unauthorized), industrial areas, and other locations contributing to source of pollution.	Comprehensive Report on Pollution Hotspots responsible for maximum pollution load and contributing to foaming.
	Questionnaire survey and field visits in these areas to collect data on types of industries, residential/occupation/ practices, and wastewater disposal methods and collect water samples from outlets in these areas. (Refer Section 4.1, 4.2 and 4.3)	
Characterization of the nature and quantity of pollutants.	Technology Assessment of STPs/ CETPs operating in identified locations.	Strategies to mitigate and address these pollution sources can be formed.
	Analysing water samples for pollutants to determine the characteristics and sources of pollution.	

Selection of Sampling Locations:

The identification of various key locations near the Okhla Barrage, including sewage treatment plants (STPs), a common effluent treatment plant (CETP), an industrial area, and residential colonies like Jamia Nagar and Shaheen Bagh, plays a pivotal role in discerning and addressing the foaming problem in the Yamuna River. Details of the identified locations are listed in Table 4 and located in Figure 8.

Moreover, 6 additional locations that include 3 popular Pooja Ghats and 3 Major Dhobi Ghats and were selected specifically within 2 km radius of the Yamuna River bank that can be releasing excess surfactant in the River. These locations will also be explored for their current practices of cleaning agents' selection and will explore eco-friendly alternatives to minimize the surfactant release. Identified locations have been given in Figure 9.

All 12 locations have been summarized in Table 4.

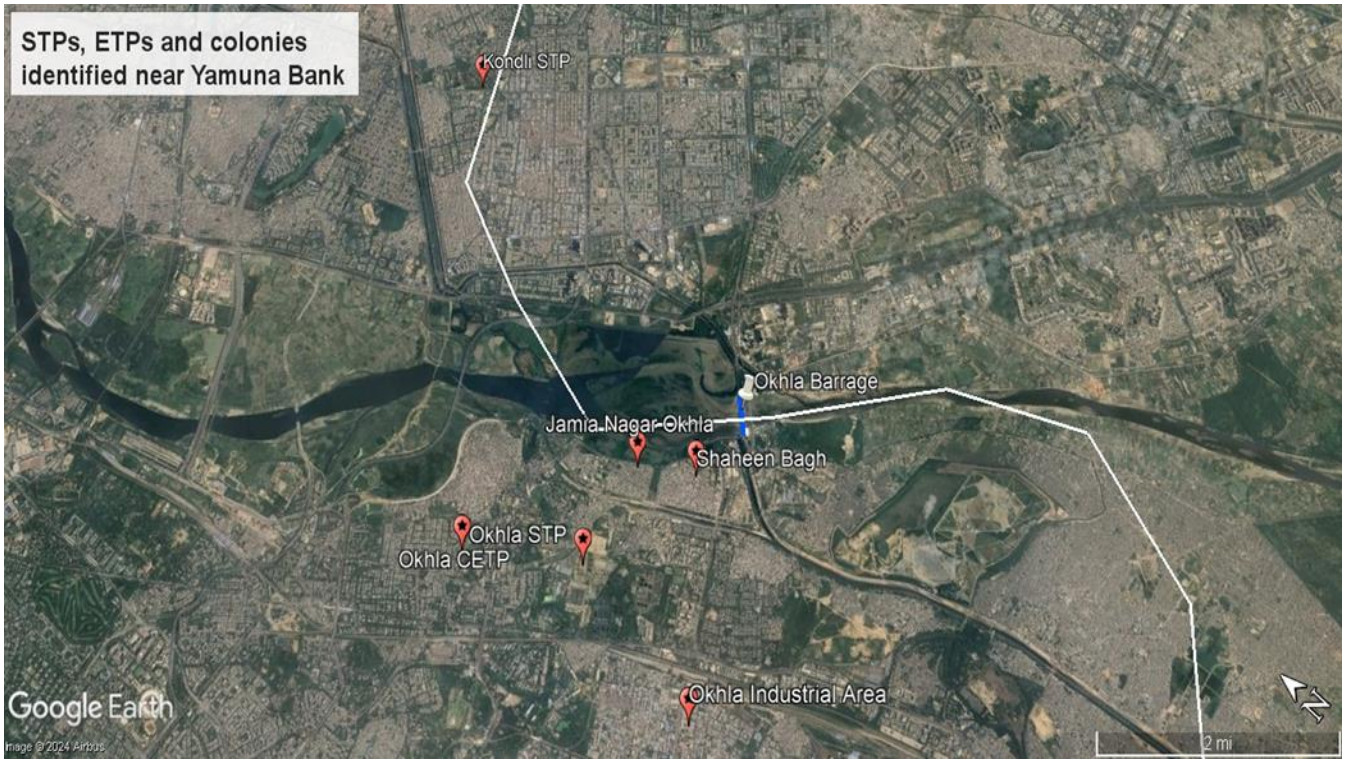


Figure 8: 2 STPs, 1 Industrial Areas and 1 CETP and 2 colonies identified that directly contributing to the pollution Load in Yamuna River

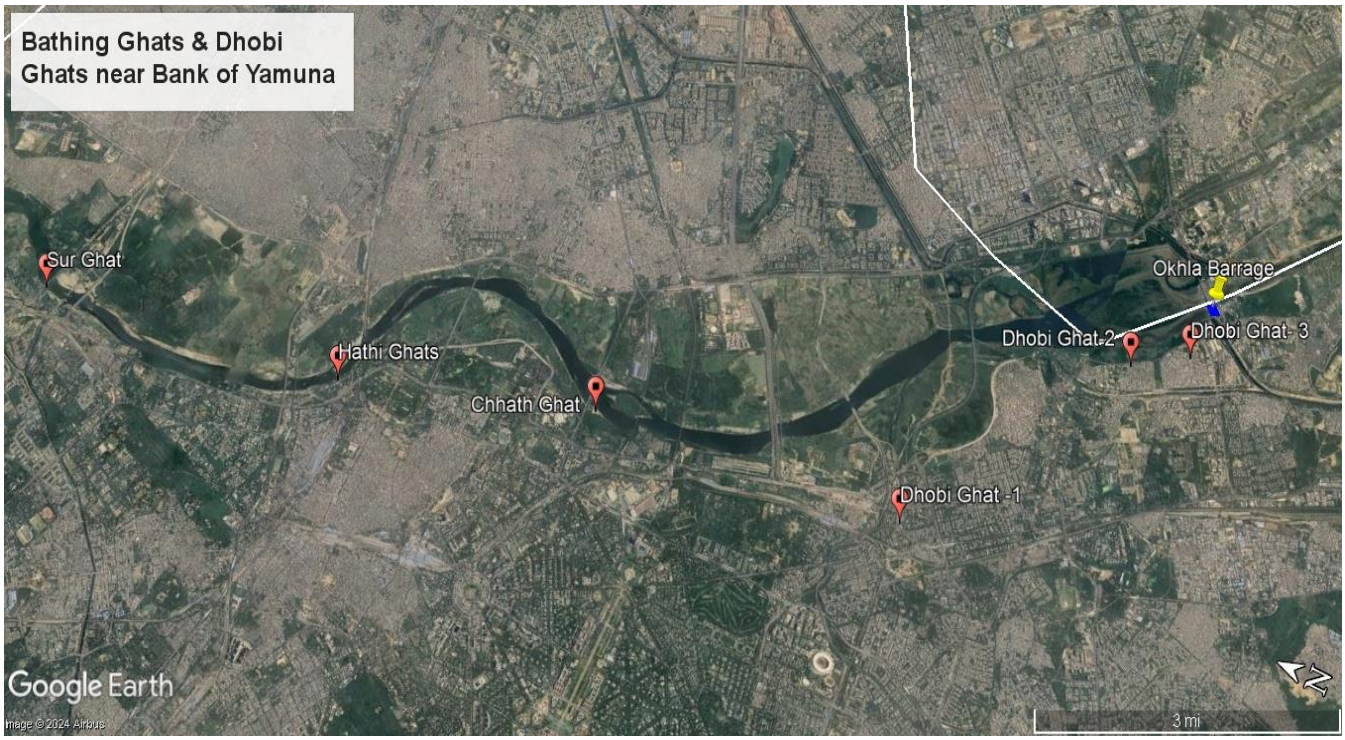


Figure 9: Identified Major 3 Pooja Ghats and 3 Dhobi Ghats within 2 km of Yamuna River responsible for releasing excess of surfactant

Table 4: STPs, CETPs, Industrial Area and Colonies Identified

S.No	Sampling Location	Location Details	Sampling Design
1	Okhla STP	STP identified near Okhla Barrage	Total 6 sampling points identified near Okhla barrage: 2 STPs, 1 CETP, 1 Industrial Area and 2 Residential colonies
2	Kondli STP		
3	Okhla CETP	CETP identified near Okhla Barrage	
4	Okhla Industrial Area	Industrial Area identified near Okhla Barrage	
5	Jamia Nagar	Residential Colonies identified near Okhla Barrage	
6	Shaheen Bagh		
7	Haathi Ghat, near Kashmere Gate	Chhath Pooja Ghats on Yamuna River	Total 6 Ghats that includes 3 Chhath Pooja Ghats and 3 dhobi Ghats responsible for excessive surfactant release in the river.
8	Sur Ghat, near Wazirabad Bridge		
9	Chhath Ghat, Near IP estate		
10	Dhobi Ghat-1, near Sarai Kale khan	Dhobi Ghats within 2 kilometres of the banks of Yamuna River	
11	Dhobi Ghat-2, Near Jamia Nagar		
12	Dhobi Ghat-3, near Shaheen bagh		
	Total Location: 12		

SCOPE 5

Scope 5 - To develop short-term, medium-term and long-term action plan including clear enforcement strategies for minimizing frothing/foaming in the river Yamuna including possible alternatives to household products responsible for frothing.

Based on the results obtained from Scope 1 -4 and GIS maps, final analysis will be made based on which short, medium and long term strategies will be suggested to mitigate the problem of frothing in the Yamuna River.

Approach	Methodology	Expected Deliverables
Analyze existing environmental regulations and enforcement mechanisms	**Regulatory Analysis:** Review existing environmental regulations and policies related to foaming.	Comprehensive Report on: ▪ Regulatory Gap Analysis Document ▪ Action Plan & Enforcement Guidelines ▪ Alternatives to household products responsible for frothing ▪ Policy Recommendations
Identify gaps in addressing frothing.	**Best Practices Review:** Conduct National and International case study analysis.	Based on above short-medium-long term strategy will be provided
Formulate a targeted action plan	Explore and recommend eco-friendly alternatives to household products, industrial and commercial processes	
	Conduct Stakeholder Engagement workshop	

Comprehensive list of sampling locations identified for each Scope:

1. Pre-monsoon (May and June)
2. Post-monsoon (October and November)

Scope	Number of Sample each season	Total number of Samples
Scope 1	**10**	**20**
Scope 3		
Scope 2	**6**	**12**
Scope 4	**12**	**24**
Total Samples =28		**56**

4 Assistance needed from various Authorities in Delhi

S. No.	Authority	Assistance Needed
1.	Dept. of Environment, GNCTD	Coordination between TERI and all other authorities.
2.	Delhi Pollution Control Committee (DPCC)	Sample collection from CETPs, STPs, industries, residential colonies etc. under their jurisdiction.
3.	Delhi Jal Board	Sample Collection from CETPs and STPs.
4.	All Municipal Corporation of Delhi (MCD)	Sample collection from open drains, residential, commercial colonies under their jurisdiction.
5.	Delhi Development Authority (DDA)	Sample collection from authorised/ unauthorised residential, commercial colonies under their jurisdiction.
6.	Irrigation and Flood Control Department, Delhi	Sample collection from open drains, surface water
7.	Delhi State Industrial and Infrastructure Development Corporation (DSIIDC)	List of authorised/ unauthorised Industrial Clusters, effluent sample collection.

4.1 STP Evaluation Questionnaire

Details of the person to contact if additional information is required:		
Name & Designation:		
Email:		
Phone No.		
Date of completing questionnaire:		
Provide the following details about the STP		
1	Population catered by STP	
2	Total Wastewater Treatment Capacity (MLD)	
3	Total Wastewater Treated (MLD)	
4	Total Treated water Reused (MLD)	
5	End use of treated water.	
6	Revenue generated from selling treated wastewater (if any)	
7	Wastewater technologies (Secondary+ Tertiary) installed in the STPs	

8	Capital Cost (INR lakh/MLD)		
9	Annual Operation & Maintenance Cost (INR Lakh/MLD)		
10	**Kindly provide the following details about the treatment parameters**		
		Inlet wastewater parameters	**Final effluent parameters at outlet**
10.1	Volume (MLD)		
	Parameter Value*		
10.2	pH		
10.3	BOD5 (mg/L)		
10.3	COD (mg/L)		
10.4	TSS (mg/L)		
10.4	TKN (mg/L)		
10.5	Ammonical Nitrogen (mg/L)		
10.5	Total Phosphorus (mg/L)		
10.6	Total Coliform (MPN/100ml)		
	Signature of Staff		
	Date		
NOTE: 1. The relevant data available in any format can be attached with the form (Repots, surveys etc.),			
***The parameters specified are as per NGT order dated December 21, 2018**			

4.2 CETP Evaluation Questionnaire

Details of the person to contact if additional information is required:		
Name & Designation:		
Email:		
Phone No.		
Date of completing questionnaire:		
Provide the following details about the CETP		
1	Number of Industries catered by CETP	
2	Type o Industrial Waste Received	
3	Mention all industries included in the CETP	
4	Total Wastewater Treatment Capacity (MLD)	
5	Total Wastewater Treated (MLD)	
6	Total Treated water Reused (MLD)	
7	End use of treated water.	
8	Revenue generated from selling treated water (if any)	
9	Wastewater technologies (Secondary+ Tertiary) installed in the STPs	
10	**Kindly provide the following details about the treatment parameters**	

		Inlet wastewater parameters	Final effluent parameters at outlet
10.1	Volume (MLD)		
	Parameter Value*		
10.2	pH		
10.3	BOD5 (mg/L)		
10.3	COD (mg/L)		
10.4	TSS (mg/L)		
10.4	TKN (mg/L)		
10.5	Ammonical Nitrogen (mg/L)		
10.5	Total Phosphorus (mg/L)		
10.6	Total Coliform (MPN/100ml)		
10.7	Specify if any other parameter is monitored		
11	Capital Cost (INR lakh/MLD)		
12	Annual Operation & Maintenance Cost (INR Lakh/MLD)		
	Signature of Staff		
	Date		
NOTE: 1. The relevant data available in any format can be attached with the form (Repots, surveys etc.),			
***The parameters specified are as per NGT order dated December 21, 2018**			

4.3 Survey form to find Eco-Friendly Alternatives of high phosphate cleaning agents

Survey for Alternative eco-friendly alternatives to household products, industrial and commercial processes		
Basic Information	Name & Designation:	
Location:		
Type of Establishment (Laundry /Industry/ household/ Other):		
Which household cleaning products do you regularly use, kindly specify the quantity used per day?		
Laundry Detergent:	Name:	Quantity/day:
Laundry Conditioner		
All-Purpose Cleaner		
Floor and Bathroom Cleaner		
Dishwasher		

Would you consider switching to eco-friendly products to reduce pollution in the Yamuna River?	Yes	No
What factors would influence your decision to switch to eco-friendly alternatives:	Environmental impact/ Cost-effectiveness/Availability in local stores/ Ease of use/ Brand reputation Other (please specify)	
How aware are you of the frothing issue in the Yamuna River?	Very aware Somewhat aware Not aware at all	
Do you have any suggestions or recommendations for eco-friendly alternatives that could help mitigate frothing in the Yamuna River?		

5 Deliverables & Payment Schedule

Deliverables

The following Deliverables shall be submitted in the following order:

1. Comprehensive Report on:

I. **Scientific reasons & factors contributing to foaming/frothing** in the most visible and high frothing areas in the Yamuna River
II. **Pollutants and pollution hotspots contributing to foaming/frothing** in Najafgarh Drain and its Supplementary drains.
III. Major drains contributing directly and indirectly to foaming/frothing in the Yamuna River.
IV. **Pollution Hotspots** responsible for maximum pollution load and contributing to foaming from other sources like STPs, CETPs and Residential colonies.
V. Regulatory Gap Analysis, Action Plan & Enforcement Guidelines, alternatives to household products responsible for frothing and policy recommendation and short-medium-long term strategy for mitigation of Foam on Yamuna River.

Payment Schedule

The Payment is linked to the following deliverables:

Installment	Activity/ report completed	Timeline	Percentage of total project cost
First	Submission of inception report and its due acceptance by the competent authority	One Month from acceptance of award letter.	**25%**
Second	Submission of interim report – I and its due acceptance by the competent authority	4 months from acceptance of award letter	**25 %**
Third	Submission of interim report - II and its due acceptance by the competent authority.	8 months from acceptance of award letter	**25 %**
Fourth	Submission of Final report with the satisfactory completion of project and its due acceptance by the competent authority.	1 month after completion of the project	25%

6 Project Schedule

Scope of Work	Month 1	Month 2	Month 3	Month 4	Month 5	Month 6	Month 7	Month 8	Month 9	Month 10	Month 11	Month 12
Inception Meeting												
Objective 1: To identify and analyse the various factors contributing to foaming/frothing in the Yamuna River and establish a correlation between the presence of foaming and the outflow of various open drains and other polluting sources into the river.												
Submission of interim report-I and its due acceptance by the competent authority												
Objective 2: Assess and identify specific sources for froth formation in Najafgarh Drain (upstream Dhansa Regulator to Wazirabad) and identify supplementary drains that are significant contributors to the froth in the Yamuna River.												
Objective 3: Identify Major Drains responsible for transporting the maximum pollution in the Yamuna River and quantify the pollution load attributed to these major drains.												
Objective 4: Identify the pollution hotspots, such as residential colonies and industrial areas, open drains, non performing STPs etc. contributing to the pollution load responsible for foaming in the Yamuna River and characterize and quantify the nature of pollutants emanating from these sources												
Submission of interim report-II and its due acceptance by the competent authority												
Objective 5: To create a short-term, medium-term, and long-term action plan to mitigate and prevent foaming in the Yamuna River by exploring alternatives to major foam causing agents with a focus on sustainable and eco-friendly options.												
Compilation of Work & Draft Report Preparation and Stakeholder Review Meeting												
Submission of Final report with the satisfactory completion of project and its due acceptance												

Project Start Date: 15th March 2024

Project End Date: 14th March 2025

7 Project Staff

The following staff will work on the assignment are mentioned below:

Name of Staff	Organisation	Designation for the Assignment
Dr Nupur Bahadur	TERI	Principal Investigator (PI)
Dr Metali Sarkar	TERI	Co-Principal Investigator (Co-PI)
To be Recruited	TERI	Project Associate
To be Recruited	TERI	Project Associate
To be Recruited	TERI	Field Staff

Note: New staff recruitment is expected to be complete by 15st April 2024. Hence a designated Research Staff to be seated in DOE office will be provided from May 2024.

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