Inception Report

Study on Microplastics in Yamuna River and Groundwater in Delhi

Submitted to

Department of Environment

Govt. of NCT of Delhi

By

Dr. Nupur Bahadur
Associate Director
NMCG-TERI Centre of Excellence on Water Reuse (NTCOE)
Environment & Waste Management Division
The Energy and Resources Institute (TERI)
Lodhi Road, New Delhi-11003

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
Creating Innovative Solutions for a Sustainable Future

Principal Investigator (PI):

Dr. (Mrs.) Nupur Bahadur
Senior Fellow & Associate Director
NMCG-TERI Centre of Excellence on Water Reuse (NTCOE)
Environment & Waste Management Division
The Energy and Resources Institute (TERI), Lodhi Road, New Delhi-11003

Co-Principal Investigator (Co-PI):

Dr. P. Sarath Chandra
Associate Fellow
NMCG-TERI Centre of Excellence on Water Reuse (NTCOE)
Environment & Waste Management Division
The Energy and Resources Institute (TERI), Lodhi Road, New Delhi-11003

Contact Details

Dr. Nupur Bahadur
Associate Director
NMCG-TERI Centre of Excellence on Water Reuse (NTCOE)
Environment & Waste Management Division
The Energy and Resources Institute (TERI),
Lodhi Road, New Delhi-11003

Tel. 2468 2100 or 2468 2111
India +91 • Delhi (0)11
E-mail: nupur.bahadur@teri.res.in
Mob 9911023050
Web www.teriin.org

Table of Contents

1. Background

The global degradation of natural aquatic environments is a pressing issue linked to urbanization, industrialization, and mismanagement of water resources, resulting in heightened pollution levels. Around 2 billion people depend on contaminated drinking water sources, raising significant concerns. Various emerging contaminants like microplastics, pharmaceuticals, pesticides, heavy metals, and pathogens pose substantial threats to aquatic ecosystems. Of these, microplastics are particularly alarming due to their tiny size and associated environmental and health risks. Their widespread presence from diverse sources underscores the need for a comprehensive understanding of their prevalence and impacts.

Plastics tend to bind with environmental pollutants when they enter the environment. As they move through the food chain, these attached toxins can accumulate in animal fat and tissue, a process known as bioaccumulation. Microplastic contamination in freshwater sources such as rivers and groundwater is illustrated in Figure 1. The degradation of natural aquatic environments due to urbanization, industrialization, and water resource mismanagement exacerbates the risks associated with microplastic contamination.

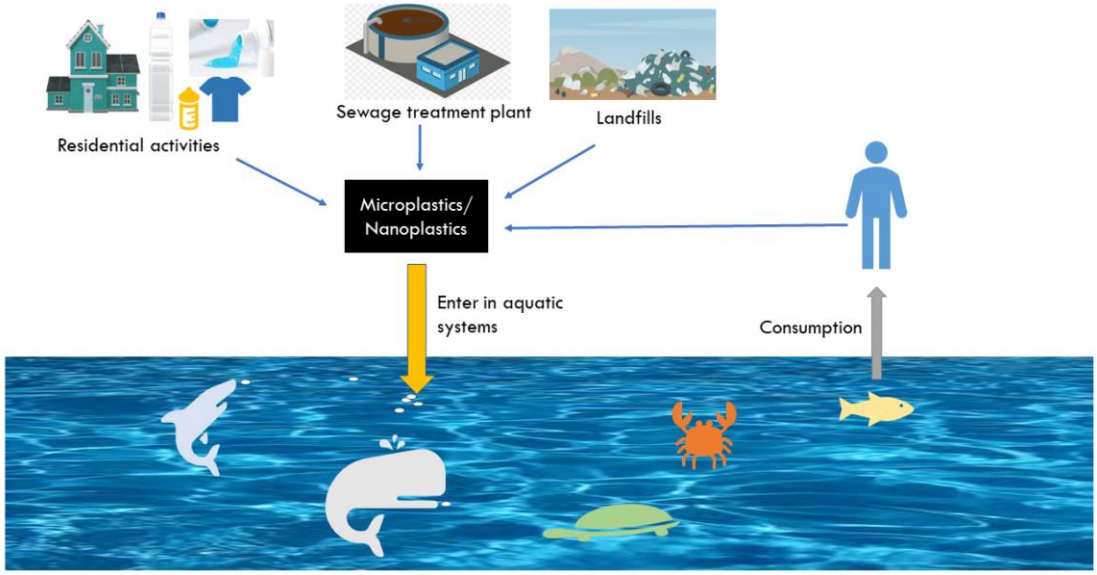

Figure 1: ***Microplastics contamination in fresh water sources*** ***(Source: Thakur, S, et al. 2022)***[1]

[1] Thakur, S., Mathur, S., Patel, S., & Paital, B. (2022). Microplastic accumulation and degradation in environment via biotechnological approaches. Water, 14(24), 4053.

According to the Government of NCT of Delhi[2], the population of Delhi has surged from 13.85 million in 2001 to 16.78 million, with projections estimating it to reach 26.6 million by 2036 (Women & Men in Delhi-2023). This population growth, coupled with urbanization and industrialization, has led to a significant increase in plastic production. India, in particular, stands as a major global contributor to plastic waste, generating over 8 to 12 million tonnes annually, as reported in Overview of Plastic Waste Management, CPCB[3].

In the context of the Yamuna River in Delhi, a vital freshwater resource faces environmental hazard due to discharged pollutants, notably from the Najafgarh and Shahdara drains, leading to deteriorating water quality. Mismanagement of solid waste, including significant plastic waste generation, poses a severe risk of microplastic contamination. Our research endeavours to comprehensively investigate microplastic presence in the Yamuna River, assessing their co-occurrence with pollutants and potential implications. Emphasizing the importance of addressing this issue for ecosystems and human populations, our work aims to study microplastic abundance, highlighting the urgency of mitigating this growing problem.

The proposal was submitted in November 17, 2023, in response to the RFP for studying microplastics in the Yamuna River and groundwater in Delhi. TERI secured the project from the Department of Environment (DOE), Delhi Government. The letter of award was offered on Feb 14, 2024. The contract was signed on March 15, 2024, between TERI and the Department of Environment (DOE), GNCTD.

Preliminary Walk Through and Observations:

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:

a. Baseline Data Collection and Analysis: To understand the current state of the Yamuna River and Ground water pollution levels in Delhi, baseline data collection activities are commenced. These activities include sampling water quality, conducting ecological surveys, and analyzing relevant research. Additionally, reviewing listed reports concerning to the Yamuna River and groundwater in Delhi is aimed at comprehensively understanding their current state and pollution levels. a. National

[2] Government of NCT of Delhi Report on Women & Men in Delhi-2023

3 Overview of Plastic Waste Management by CPCB.

Water Quality Monitoring Program (NWMP) Report for Ground water monitoring stations by CPCB

b. Report on Economic Survey of Delhi 2022-23.

c. Report on Dynamic Ground Water Resources of NCT, Delhi March 2020.

d. Report on Aquifer mapping and Ground Water management Plan of NCT Delhi by (CGWB) 2016.

e. Delhi Pollution Control Committee (DPCC) Annual Report 2019-20.

f. Report on Detecting microplastics filed by Ministry of Environment, Forest and Climate Change (MOEFCC)

2. Project Planning and Strategy Development: Immediately after receiving the award letter, the project team met to make a detailed plan for dealing with the pollution in the Yamuna River. This involved identifying specific objectives, outlining the scope of work, and defining the timeline for project implementation.
3. Establishment of Monitoring and Evaluation Mechanisms:
   a. Tracking progress, measuring impact, and ensuring accountability throughout the project lifecycle.
   b. Identification of key performance indicators.
   c. Development of monitoring protocols to assess the effectiveness of interventions.

Based on the above a detailed methodology was designed for each scope mentioned in the RFP. The inception report for addressing microplastic contamination in the Yamuna River and groundwater in Delhi is essential. It sets objectives, timelines, and scopes, facilitating efficient resource allocation, progress monitoring, and collaboration among team members. It ensures a focused and ethical investigation, aiming for sustainable solutions to preserve the socio-economic and cultural significance of the Yamuna River and groundwater in Delhi.

2. Scope of work as mentioned in RFP

The Primary Objectives of work for the Study on Microplastic in Yamuna River and Ground Water in Delhi are mentioned below:

1. Assessment of water quality of the stretch of Yamuna River and groundwater in Delhi with special reference to the presence of microplastic.
2. Identification of potential source of microplastic contamination in groundwater in each district of Delhi and Yamuna River of Delhi.
3. Study on leaching impact of microplastic on both the banks of River Yamuna trail.
4. Mapping of major hotspots with respects to the variation of concentration of Microplastic in groundwater and River Yamuna.
5. To develop an Action plan including clear enforcement strategies to reduce the concentration of Microplastic in groundwater as well as River Yamuna in Delhi.

3. Brief Description of Project Methodology

The project site along the Yamuna River in Delhi covers regions affected by pollution from the Najafgarh and Shahdara drains. This pollution contributes to the observed deterioration in water quality, as documented in the Progress in Rejuvenation of River Yamuna report by the Department of Environment, Government of NCT of Delhi[4]. Additionally, the investigation extends to groundwater sources in the vicinity. The site serves as a critical focal point for studying microplastic contamination and its implications on aquatic ecosystems and human health. Understanding microplastic abundance in both surface water and groundwater is crucial for effective mitigation strategies in this section. Detailed geographic information is depicted in Fig. 2, showing the stretch of the Yamuna River across Delhi and the specific sampling points selected for this study.

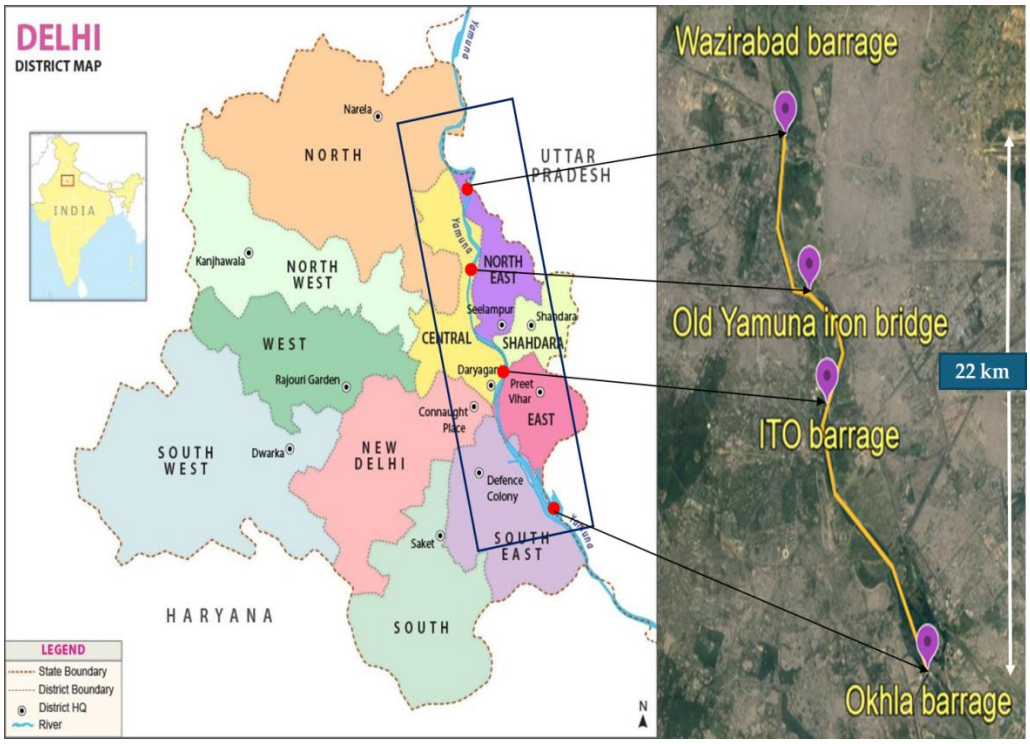

Figure 2: Map of Delhi along with Yamuna River

(Source: https://delhimap360.com/new-delhi-neighborhood-map)

[4] A Report on Progress in Rejuvenation of River Yamuna, Department of Environment, Govt. of NCT of Delhi.

3.1 Comprehensive Laboratory Analysis for Yamuna River and Groundwater

The laboratory analysis table for the Yamuna River and Groundwater in Delhi encompasses a comprehensive list of 27 parameters, which will be performed for all samples across all locations. These parameters include various water quality indicators and microplastic characteristics. Such thorough analysis is vital for accurately assessing the river's condition and identifying potential pollutants for effective remediation strategies. Table 1 summarizes probable parameters to be tested from NABL Accredited Laboratory

Table 1: List of Parameter to be tested to identify Microplastics in Yamuna River and Ground water in Delhi

S.No	Parameters	Compounds	Instrument
1	Standard Parameters (P1)	• pH • Electric Conductivity • Dissolved Oxygen • Temperature • BOD • COD • TSS • Ammonia • Nitrates • Phosphates • E. Coliforms, F. Coliforms and Total Coliforms	**NABL accredited Environmental laboratory (Standard APHA method)**
No. of Standard Parameters (P1) = 11			
2	Microscopic Analysis for microplastics Identification and Quantification (P2)	• Shape • Colour • Size • Count (No./kg or No./m^3)	• **Optical Microscope** • **Florescence Microscope**
No. of Parameters for Microscopic Analysis (P2) = 4			
3	Microplastic Characterization	• polyvinyl chloride (PVC) • Poly ethylene (PE) • Polystyrene (PS) • Polypropylene (PP) • Poly ethylene terephthalate (PET)	• **FTIR/Raman Spectroscopy** • **FESEM-EDX**
No. of Parameters for Microplastics Characterization (P3) = 5			
4	Heavy Metals	• Cr, Cd, Cu, Fe, Mn, Pb and Zn	• **Atomic Absorption spectroscopy (AAS)**
No. of Parameters for Heavy metals (P4)= 7			
Total Number of Parameters (P1+P2+P3+P4) = 27			

The following methodology flowcharts outline the comprehensive extraction processes for surface water, groundwater, and sediments.

3.2 Microplastics (MPs) Extraction Procedure for Surface and Groundwater

- Collection of surface water (Sampling Volume 10- 50 L)
- Collection of ground water (Sampling Volume ≥ 500 L). If MPs are detectible in ≤ 100 L volume, then Sample should be filtered by vacuum filtration setup. If MPs are not detectible in ≤ 100 L volume, then Sample should be sieved by stainless sieve of 0.3 mm size. And further the filtered or sieved contaminants will be carried out by listed step by step procedures as shown in Fig. 3.

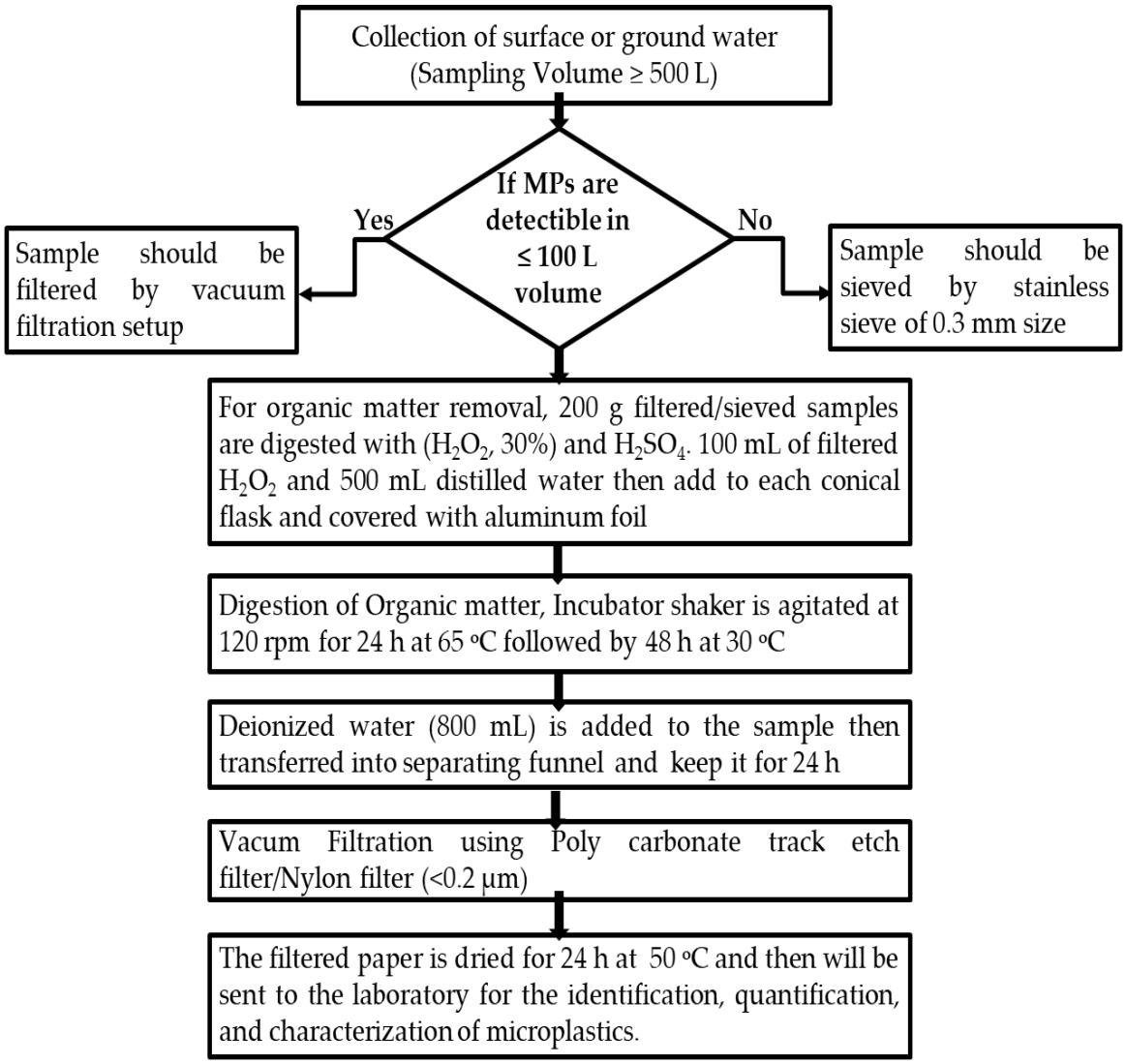

Fig. 3: Microplastics Extraction Procedure for Surface and Groundwater

3.3 Microplastics (MPs) Extraction Procedure for Sediments

- Collection of sediment samples (Approximately three kilograms of sand). The detailed procedure is listed in the Fig. 4.

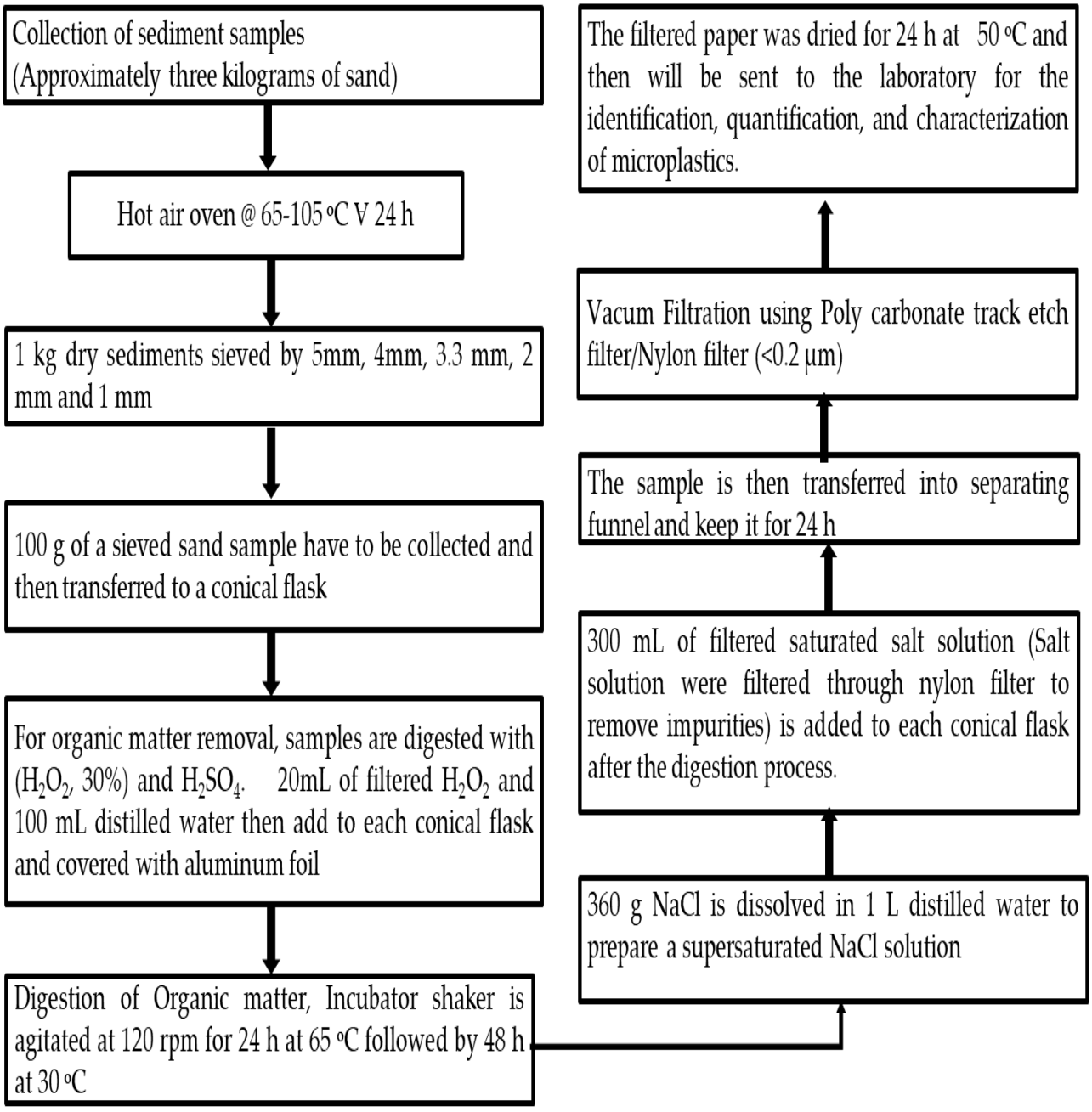

Fig. 4: Microplastics Extraction Procedure for Sediments

3.4 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:

3.4.1 SCOPE 1

Scope 1- Assessment of water quality of the stretch of Yamuna River and groundwater in Delhi with special reference to the presence of microplastics.

Task	Approach	Methodology	Deliverables
1. Sample Collection	- Using grab sampling method from designated boreholes, and conduct multilevel sampling for depth understanding. - Sampling from identified surface water bodies near Yamuna River and groundwater from 11 Districts of Delhi.	- Conduct comprehensive physicochemical analysis. - Employ microplastic identification & extraction techniques. - Utilize Fourier Transform Infrared (FTIR) for polymer identification.	- Physicochemical analysis report - Microplastic identification report

3.4.2 SCOPE 1

Scope 2- Identification of potential source of microplastic contamination in groundwater in each district of Delhi and Yamuna River of Delhi.

Task	Approach	Methodology	Deliverables
2. Identification of Potential Sources	- Employ robust sampling techniques with protective measures. - Use standardized methods for microplastic extraction and analysis.	- Analyze water quality parameters alongside microplastic assessments. - Utilize GIS for spatial mapping.	- Potential source identification report - GIS-based microplastic concentration maps

Sampling Locations of Surface Water in Yamuna River

For the current study, a total of six sampling points have been identified as shown in Fig. 5, Four sampling locations are chosen along this segment, spanning from Wazirabad to

the Okhla barrage downstream, while, remaining two sampling locations involve Najafgarh drain and Shahdara drain. The geographic details of these chosen locations are outlined in Table 2.

Figure 5: Sampling Site Locations for Surface Water

Table 2: List of selected sampling points for surface water in Yamuna River

S.No	Sampling Points	Type of Sample	Sampling Design
1	Wazirabad Barrage (SW1)	Surface Water	• There are 06 sampling points (SW1-SW6) for surface water out of which four locations (SW1-SW4) from Wazirabad Barrage to Okhla Barrage are identified through river stretch as shown in Fig 4. • ***Sampling Design for Surface water:*** a) 10-50 L of surface water sample (0–60 cm depth) will be collected from each site using a stainless steel bucket. • The samples shall be filtered Vacuum Filtration using Poly carbonate track etch filter/Nylon filter (<0.2 μm) and the
2	Old Yamuna Iron Bridge (SW2)	Surface Water	
3	ITO Barrage (SW3)	Surface Water	
4	Okhla Barrage (SW4)	Surface Water	
5	Najafgarh Drain (SW5)	Surface Water	
6	Shahdara Drain (SW6)	Surface Water	

			residue collected on the media will be rinsed into a glass bottle using double distilled water. • Finally, the filter paper will be sent to the laboratory for identifying, quantifying, and characterizing microplastics.
Total Number of Sampling points for Surface Water (A) = 6			

Sampling Locations for Groundwater across Delhi

For Groundwater samples, eleven numbers of sampling points have been selected in each district of Delhi. As per the ground water monitoring network listed by CPCB, the geographical locations have been highlighted as depicted in Fig. 6. The entire list of groundwater stations are listed out in Table 3.

Table 3: List of selected sampling points for Groundwater in Each district of Delhi

S.No	Sampling Points	District of Delhi	Type of Sample	Sampling Design
1	Well at Rohini	North west	Groundwater	• There are 11 sampling points for Ground water from all 11 Districts of Delhi based on environment concerns: o Drain/Canal/Lake/Yamuna Stretch o Landfill o Plastic Fabrication Companies o Manufacturing, Automobiles, Pharmaceutical, Packaging and Chemical based industries. • Water sample will be filtered by vacuum filtration setup. • Eventually, the filter paper will be sent to the laboratory for identifying, quantifying, and characterizing microplastics.
2	Well at Shahdara	Shahdara	Groundwater	
3	Well at ISBT	New Delhi	Groundwater	
4	Well at Gajipur	East	Groundwater	
5	Well at Naraina Industrial area	South west	Groundwater	
6	Well at Tilak Nagar	West	Groundwater	
7	Well at Okhla	South east	Groundwater	
8	Well at Karol bagh	Central	Groundwater	
9	Well at Saket	South	Groundwater	
10	Well at Kamla nagar	North	Groundwater	
11	Well at Rajpura road	North east	Groundwater	
Total Number of Sampling points for Ground Water (C) = 11				

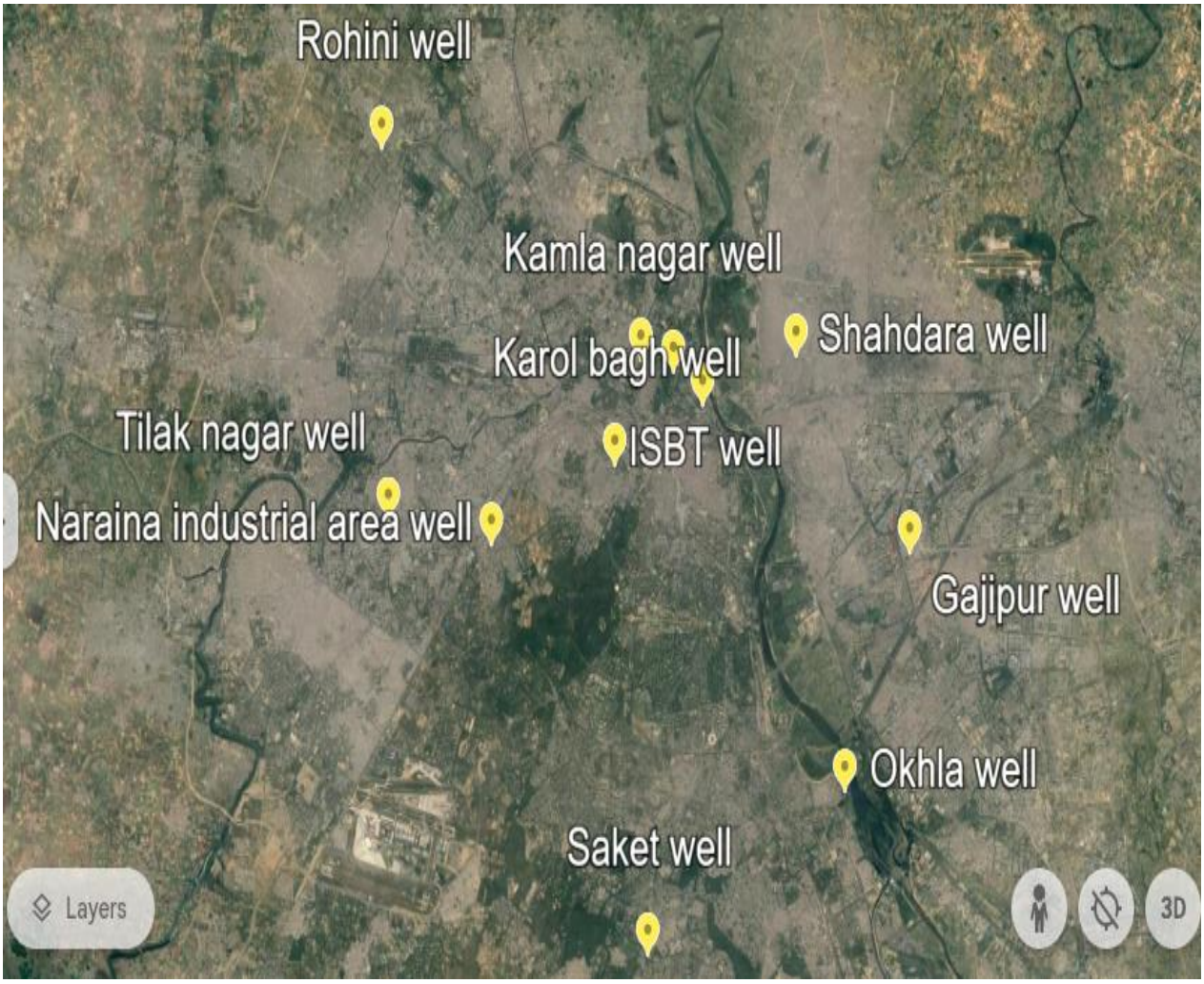

Fig. 6: Sampling Site Location for Groundwater

3.4.3 SCOPE 3

Scope 3- Study on leaching impact of microplastic on both the banks of River Yamuna trail.

Task	Approach	Methodology	Deliverables
3. Study on Leaching Impact	- To collect soil samples from the same location across both banks of the river.	- Utilize microscopy and FeSEM along with EDX for leaching impact.	- Leaching dynamics report - Leachate composition document - Ecological impact assessment report

Sampling Locations of Sediments on both banks of the River Yamuna trail

For sediment samples, four sampling locations on both banks of the River Yamuna trail will be selected, resulting in a total of eight samples, as depicted in Figure 7. The detailed locations are listed out in Table 4.

Fig. 7: Sampling Site Locations for Sediments

Table 4: List of selected sampling points sediments through both the banks of River Yamuna trail

S.No	Sampling Points	Type of Sample	Sampling Design
1	Wazirabad Barrage (S1)	Sediment	• Sediment Sampling will be carried out through both sides of river bank (S1-S4). • ***Sampling Design for Sediments:*** a) 1 kg dry sediments should be sieved in situ by stainless steel sieves by 0.25 mm-5mm.
2	Old Yamuna Iron Bridge (S2)	Sediment	
3	ITO Barrage (S3)	Sediment	
4	Okhla Barrage (S4)	Sediment	

			b) The residue collected on the 0.25 mm sieve has to be rinsed into a conical flask using double distilled water. • After the digestion process, the filtered or sieved sediments will be sent to the laboratory for the identification, quantification, and characterization of microplastics.
Total Number of Sampling points for Sediments on both banks of the River Yamuna trail (B) = 8			

Complete List of total number of samples for all the locations

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

Type	No. of Seasons	No. of samples at each season	Total No. of samples
Surface water (A)	**2 (Pre and Post monsoon)**	**6**	**12**
Sediments (B)	**2 (Pre and Post monsoon)**	**4+4 (both banks at each location) = 8**	**16**
Ground water (C)	**2 (Pre and Post monsoon)**	**11**	**22**
Total No. of samples at all locations (A+B+C)			**50**

3.4.4 SCOPE 4

Scope-4 Mapping of major hotspots with respects to the variation of concentration of Microplastic in groundwater and River Yamuna.

Task	Approach	Methodology	Deliverables
4. Mapping of Major Hotspots	- Use GIS to create spatial maps of microplastic concentrations.	- Develop and Analysis of major hotspots with respects to the variation of concentration of Microplastics by using GIS-based maps and comprehensive hotspot locations.	- GIS-based microplastic concentration maps - Hotspot mapping report

---

3.4.5 SCOPE 5

Scope-5 To develop an Action plan including clear enforcement strategies to reduce the concentration of Microplastic in groundwater as well as River Yamuna in Delhi.

sk	Approach	Methodology	Deliverables
5. Action Plan Developmen	- Compile and analyze microplastic data qualitatively and quantitatively and also through GIS imagery through our reports from 50 samples. - Correlate findings with surroundings. - Provide suitable mitigation measures .	-Organize stakeholder workshops	- Short, medium and long term action plan & policy recommendations - Enforcement guidelines.

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	Ground Water 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.
8	Central Ground Water Board (CGWB)	Ground water monitoring stations in different districts in Delhi

We seek assistance from authorities during sampling collections across various locations in Delhi. Tentative questionnaires have been prepared to gather information for the Sampling Site Details and Microplastics Monitoring Protocol Trail (MMPT) Data Sheet for the Yamuna River and groundwater in Delhi, enclosed below.

ANNEXURE I: Questionnaire to Gather Information for Sampling Site Details in Yamuna River and Ground Water in Delhi

***Sampling Site Data Sheet**		
Name of the Location:		
Address: (Including Latitude & Longitude)		
		Latitude:
		Longitude:
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 Sampling Site		
1	What is the water body's elevation (m)?	
2	What is the Water body name?	
3	What is the Water Body Type?	□ Surface Water □ Ground Water □ Unknown
4	What is the water body's elevation (m)?	
5	What is the Water Body Source?	□ Pond □ Lake □ Reservoir □ Ditch □ Ocean □ Estuary □ River □ Stream/Canal □ Agriculture □ Others
5	What is the Area of Standing water (sq.km)?	
6	What is the Average Depth of Standing water (m)?	
7	Population using the water bodies (in Thousand)	
8	What is the type of Bed rock at the sampling site?	□ Granite □ Limestone □ Volcanic □ Mixed Sediments □ Unknown
10	What is the type of freshwater habitat at the sampling site?	□ Rocky Substrate □ Vegetated Bank □ Mud Substrate

		□ Sand Substrate □ Submerged Vegetation □ Logs)
11	Type and Nature of Soil for sediments sampling for selected River Banks	
	Signature of Staff	
	Date	

ANNEXURE II: Microplastics Monitoring Protocol Trail (MMPT) Data Sheet

Name of Our Organization	
Team Name	
Research Staff Name/s:	
PI/Co-PI Name/s:	
Sampling Date (DD/MM/YYYY):	
Time (hh:mm:ss, 24 h format):	
Study site:	
Study site Lattitude:	
Study site Longitude:	
Sample Code:	
Temperature (Celsius):	
Total Volume of Water Filtered (L):	
Total Mass of Sediments Sieved (kg):	
Sample Code #	

Menu		
Geometry-CHOOSE	**Colur-CHOOSE**	**Structural Appearance-CHOOSE**
Fibre Fillament Sheet Round Particle Flat Particle	Black White Grey Blue Red Yellow Orange Brown	Shiny Rough Porous

5. Deliverables & Payment Schedule

5.1 Deliverables

i. **Water Quality Report:** Generate a comprehensive report detailing the overall water quality of the Yamuna River and groundwater in Delhi, highlighting key parameters and their compliance with regulatory standards.

ii. **Microplastics Assessment Report:** Present a detailed report on the presence, types, and concentrations of microplastics in the water samples, along with spatial and temporal trends.

iii. **Hotspot Mapping Report** will generate a comprehensive report detailing the major hotspots of microplastics contamination in groundwater and the River Yamuna, presenting spatial distribution patterns and key characteristics.

iv. **Action Plan:** Develop a detailed action plan that includes specific strategies, interventions, and enforcement measures to reduce microplastics concentrations in both groundwater and the River Yamuna.

v. **Policy Recommendations:** Provide recommendations for potential policy changes or amendments to support the effective implementation of the action plan, addressing systemic challenges in regulating microplastics contamination.

5.2 Payment schedule

The release of payment for the study will be in three installments as below mentioned:

Installments	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 accepting the award letter	25%
Second	Submission of interim report and its due acceptance by the competent authority.	4 months from acceptance of award letter	25 %
Third	Submission of interim report 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	Milestone	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** • ***Submission of inception report and its due acceptance by the competent authority***												
1. Assessment of water quality of the stretch of Yamuna River and groundwater in Delhi with special reference to the presence of microplastic.	• **Comprehensive Water Quality Assessment** • **Microplastic Presence Analysis** • ***Submission of interim report-I and its due acceptance by the competent authority*.**												
2. Identification of potential source of microplastic contamination in groundwater in each district of Delhi and Yamuna River of Delhi	• **Spatial Source Identification** • **Quantification of Microplastics**												
3. Study on leaching impact of microplastic on both the banks of River Yamuna trail.	• **Leachate Composition Analysis:** • **Soil and Water Interaction Study**												
4.Mapping of major hotspots with respects to the variation of concentration of Microplastic in groundwater and River Yamuna	• **Hotspot Identification** • **Spatial Distribution Analysis** • ***Submission of interim report-II and its due acceptance by the competent authority.***												
5. To develop an Action plan including clear enforcement strategies to reduce the concentration of Microplastic in groundwater as well as River Yamuna in Delhi.	• **Identification of Enforcement Gaps** • **Development of Action Plan** • **Stakeholder Engagement**												
Compilation of Work & Draft Report Preparation													
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	PI
Dr Pragada Sarath Chandra	TERI	Co-PI
Ms. Yuganshi	TERI	Research Staff
To be Recruited	TERI	Research Staff
To be Recruited	TERI	Field Staff

The Energy and Resources Institute

www. teriin.org