



National Mission for Clean Ganga

Department of Water Resources,
River Development & Ganga Rejuvenation
Ministry of Jal Shakti, Government of India

PROTOCOL FOR RIVERINE MACROPLASTICS MONITORING



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Protocol for Riverine Macroplastics Monitoring

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Protocol for Riverine Macroplastics Monitoring

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FOREWORD

Rivers have sustained India's civilisation for millennia, and protecting them remains central to our vision of a Viksit Bharat @2047. Over the past decade, the Namami Gange Programme has built an extensive foundation for pollution abatement and ecological restoration along the Ganga. Yet one dimension of river pollution has, until now, gone largely unaddressed in any standardised way: plastic debris entering our rivers from cities, industries, fisheries and mass gatherings alike.

India generates close to 4.13 million tonnes of plastic waste every year, and a significant share of it finds its way into our river systems through drains, informal dumping and inadequate waste management. While the Central Pollution Control Board monitors water quality and the Central Water Commission tracks hydrology, no comparable national framework has existed for riverine macroplastics — resulting in fragmented, non-comparable data across states and agencies.

The Protocol for Riverine Macroplastics Monitoring closes this gap. It establishes a unified, scientifically grounded framework built around three complementary methods — community-based monitoring through fishing operations, fixed-point assessment at artificial barriers, and scientific net-towing surveys by boat — supported by a simplified five-category classification system designed for consistent use by field staff, fishers and community volunteers alike. The Protocol also responds to specific Indian realities such as event-based monitoring has been built in for the Kumbh Mela, Chhath Puja, Durga Puja, Kanwar Yatra and other mass gatherings that place exceptional, short-term loads on our rivers.

The Protocol is an outcome of the rigour and inter-agency collaboration, led by the Task Force under the leadership of the Director General, NMCG, with active participation from CPCB, CWC, NRCD, State Missions for Clean Ganga and leading technical institutions. The launch of this Protocol is especially opportune as Swachhata Hi Seva Campaign commences, reinforcing our collective commitment to preventing plastic pollution and safeguarding our rivers.

I congratulate the National Mission for Clean Ganga and every agency and expert who contributed to this Protocol. I am confident that its implementation will strengthen our evidence base for river basin management, support the objectives of the Swachh Bharat Mission and the Plastic Waste Management Rules, and mark a decisive step towards cleaner, healthier rivers for generations to come.



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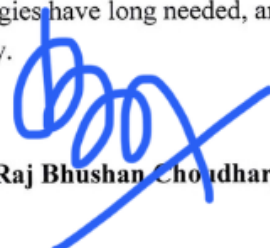
Forewords

Our rivers connect every part of the country's landscape — from Himalayan headwaters to coastal deltas — carrying with them not only water, but also the waste we generate along the way. Macroplastic pollution, though highly visible, has long escaped systematic measurement in India's river systems. The Protocol for Riverine Macroplastics Monitoring changes this, offering the country its first standardised, multi-tiered framework to assess macroplastic pollution across our rivers.

What makes this Protocol particularly meaningful is its grounding in community participation. The fishing-based method draws on the routine work of local fishing communities to generate continuous, long-term data at minimal cost, while building local ownership of river health. This is complemented by fixed-point monitoring at barrages and trash-interception structures, and by scientific net-towing surveys that estimate plastic flux with rigour. Together, these three methods capture the full picture — accumulation, interception, and transport — that no single method could provide alone.

The Protocol also responds to specific Indian realities: event-based monitoring has been built in for the religious mass gatherings that place exceptional, short-term loads on our rivers; and drain-outfall monitoring by Urban Local Bodies will help identify the upstream sources of plastic leakage. A clear institutional framework — with NMCG as the nodal agency, CPCB and SPCBs providing technical oversight, and State Missions for Clean Ganga coordinating implementation — ensures that this is not merely a document but an actionable system.

I am confident that its rollout, beginning with the Ganga main stem, will generate the reliable, comparable data our river basin management strategies have long needed, and will progressively extend to river systems across the country.


(Dr. Raj Bhushan Choudhary)

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GOVERNMENT OF INDIA
MINISTRY OF JAL SHAKTI
DEPARTMENT OF WATER RESOURCES,
RIVER DEVELOPMENT & GANGA REJUVENATION

FOREWORD

I am glad to introduce the Protocol for Riverine Macroplastics Monitoring at an important juncture for this Department's continuing efforts on river rejuvenation. Water quality, hydrology and sediment transport have long been subject to structured monitoring by the Central Pollution Control Board and the Central Water Commission; riverine macroplastic pollution has not had a comparable framework, despite rivers being recognised globally as major conduits carrying plastic waste from land-based sources into freshwater and marine environments.

This Protocol addresses that gap through a multi-tiered methodological framework combining community-based monitoring, fixed-point assessment at artificial barriers, and scientific net-towing surveys by boat. Each method captures a distinct aspect of macroplastic dynamics — accumulation, interception and transport — and together they provide a far more complete understanding than any single approach could. A simplified five-category classification system, mapped to the CPCB's Extended Producer Responsibility framework, ensures the data generated remains consistent with national reporting requirements while staying practical for field-level implementation.

From an institutional standpoint, the Protocol is deliberately designed for scale: a centralised, integrated field-level reporting from across the monitoring network, enabling hotspot identification, seasonal trend analysis and periodic reporting in a policy-relevant format. The monitoring network along the Ganga main stem, developed jointly with CIPET, ICAR-CIFRI and CPCB, will provide the baseline on which this system will be built and, in time, expanded to other river basins.

This Protocol is the outcome of sustained work under the leadership of the Director General, NMCG, by the Task Force convened by Director, NMCG in consultation with CPCB, CWC, NRCD, Technical institutions and other Academic Institutions. I am confident that its launch by the Hon'ble Vice President of India at the India International Water Week will give it the visibility and institutional momentum it deserves.

I look forward to working closely with CPCB, State Missions for Clean Ganga and all implementing partners to advance NMCG's efforts in translating this Protocol into a robust and effective monitoring system, generating reliable evidence to strengthen river basin management across India.

(Archana Varma)

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GOVERNMENT OF INDIA
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FOREWORD

The Namami Gange Programme has, over the past decade, built a strong foundation for pollution abatement and ecological restoration along the Ganga. As this work has matured, it has become increasingly clear that macroplastic debris — visible, persistent, and traceable to identifiable sources — represents a significant and, until now, inadequately monitored dimension of river pollution. The Protocol for Riverine Macroplastics Monitoring was developed to close precisely this gap.

A Task Force convened under NMCG brought together the Central Pollution Control Board, the Central Water Commission, the National River Conservation Directorate, CIPET, ICAR-CIFRI, among other expert academic institutions, to design a framework grounded in scientific rigour and field practicality in equal measure. The result is a multi-tiered approach built around three complementary methods: community-based monitoring that draws on routine fishing operations for continuous, wide-coverage data; fixed-point monitoring at artificial barriers such as barrages and trash-interception structures; and scientific net-towing surveys by boat that estimate plastic concentration and flux with quantitative precision.

Each method captures a different aspect of macroplastic dynamics — accumulation, interception and in-river transport — and the Protocol is explicit that they are complementary rather than interchangeable, to be interpreted through common parameters of mass, composition and location rather than forced into a single indicator. A network of monitoring stations along the Ganga main stem has been identified jointly with CIPET's hotspot assessments and ICAR-CIFRI's fish-landing site data, alongside existing CPCB stations and major barrages, to provide representative baseline coverage.

Robust QA/QC protocols, standardised field formats, and a centralised, integrated system underpin the Protocol, ensuring that methods remain comparable, auditable and genuinely useful for identifying pollution hotspots and prioritising interventions.

I thank every member of the Task Force, led by Director, NMCG and all contributing agencies for their commitment to this effort, and I look forward to its implementation generating the robust evidence base that river basin management in India has long needed.


(Rajeev Kumar Mital)



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NMCG also acknowledges the valuable technical, field-level and institutional inputs received from CPCB, CWC, NRCD, CPHEEO, SPCBs and SMCGs of Uttarakhand, Uttar Pradesh, Bihar, Jharkhand and West Bengal, SLCR, IIT (BHU), CoE IIT Delhi, and other concerned scientific, technical and institutional stakeholders. Their inputs and field experience have contributed to strengthening the scientific basis, field applicability and institutional relevance of the Protocol.

The development of the Protocol was supported through a series of meetings and expert deliberations of the Plastic Pollution Task Force, along with consultations with relevant stakeholders. NMCG places on record its appreciation for the constructive discussions, technical observations, suggestions and reviews received during this process, which helped in shaping and refining the Protocol into a comprehensive and practical framework for riverine macroplastics monitoring.

Executive Summary

Riverine plastic pollution is an emerging environmental concern, with increasing quantities of plastics entering and accumulating in river systems, highlighting the need for a standardized and systematic monitoring approach. The Protocol for Riverine Macroplastics Monitoring establishes a standardized framework for monitoring macroplastics (>25 mm) in Indian river systems, covering sampling, segregation, quantification, data management and reporting. It aims to generate reliable and comparable data across locations and time to identify pollution hotspots, assess spatial and temporal patterns, and support evidence-based river-basin management.

The Protocol adopts three complementary monitoring methods the Community-Based Fishing Method, Artificial Barrier Method and Boat Net-Towing Method to capture different aspects of riverine macroplastic occurrence. The Fishing-Based Method represents local collection and accumulation, the Artificial Barrier Method captures plastic intercepted at fixed locations, while the Boat Net-Towing Method assesses floating macroplastics in the river. Together, these methods provide complementary information across different river settings and monitoring objectives.

A common classification and recording system are applied across all methods. Collected macroplastics are segregated into five categories: Category I – Bottles and Containers; Category II – Bags, Wrappers and Packaging; Category III – Fishing and Utility Plastics; Category IV – Thermocol Products; and Category V – Other Plastics and Composite Items. Category-wise weight and the number of filled fixed-volume bags are recorded to ensure consistency in data generation and reporting.

The Protocol prescribes site selection, sampling and processing procedures, classification, weighing, supervisory cross-checks, data validation, geo-referenced recording and safe disposal. It thus provides a standardized, scalable and Implementable framework for generating quality-assured macroplastic data, strengthening the scientific basis for identifying priority areas, understanding pollution patterns and supporting targeted interventions and long-term river-basin management.

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List of Abbreviations

S.No.	Abbreviation	Full Form
1	BOD	Biochemical Oxygen Demand
2	CETP	Common Effluent Treatment Plant
3	CIFRI	Central Inland Fisheries Research Institute
4	CIPET	Central Institute of Petrochemicals Engineering & Technology
5	CoE	Centre of Excellence
6	CPCB	Central Pollution Control Board
7	CPHEEO	Central Public Health and Environmental Engineering Organisation
8	CWC	Central Water Commission
9	DO	Dissolved Oxygen
10	DGC	District Ganga Committees
11	EC	Electrical Conductivity
12	EPR	Extended Producer Responsibility
13	g	Gram
14	GIS	Geographic Information System
15	GPS	Global Positioning System
16	HDPE	High-Density Polyethylene
17	ICAR	Indian Council of Agricultural Research
18	kg	Kilogram
19	km	Kilometre
20	L	Litre
21	LDPE	Low-Density Polyethylene
22	m	Metre
23	MIS	Management Information System
24	MLD	Million Litres per Day
25	MLP	Multi Layered Plastic
26	mm	Millimetre
27	µm	Micrometre
28	NMCG	National Mission for Clean Ganga
29	NRCD	National River Conservation Directorate
30	NWMP	National Water Quality Monitoring Programme

31	PA	Polyamide
32	PE	Polyethylene
33	PET	Polyethylene Terephthalate
34	PP	Polypropylene
35	PPE	Personal Protective Equipment
36	PS	Polystyrene
37	PVC	Polyvinyl Chloride
38	PWM	Plastic Waste Management
39	QA/QC	Quality Assurance/Quality Control
40	SLCR	Smart Laboratory on Clean Rivers
41	SMCG	State Mission for Clean Ganga
42	SOP	Standard Operating Procedure
43	SPCB	State Pollution Control Board
44	STP	Sewage Treatment Plant
45	ULB	Urban Local Bodies
46	UNEP	United Nations Environment Programme

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1. Background and Rationale

1.1 Background

Rivers are the lifelines of the country, sustaining ecosystems, communities and economies while connecting the landscape from upstream catchments to downstream freshwater and coastal environments. They provide essential services such as water supply, agriculture, fisheries, groundwater recharge, biodiversity support, sediment and nutrient transport, navigation and cultural values. At the same time, rivers act as natural pathways through which materials, wastes and pollutants generated across a river basin are transported and redistributed downstream. Maintaining the health of river systems is therefore fundamental to ecological security, water security, livelihoods and the overall well-being of society.

The dynamic and interconnected nature of river systems also makes them highly vulnerable to pollution and challenging to monitor. River flow, rainfall, floods, seasonal variations, sediment characteristics, river morphology and human interventions continuously influence the movement, distribution and accumulation of pollutants. Consequently, the nature and extent of pollution can vary significantly across locations and over time, making isolated or non-uniform monitoring inadequate to represent the overall condition of a river system. A systematic, representative and standardized approach is therefore essential for understanding pollution patterns and supporting effective management of India's rivers.

Plastic pollution has emerged as a global environmental challenge, with rivers recognized as important pathways for the transport of plastic waste from terrestrial sources to downstream freshwater and marine environments. The movement, accumulation, and leakage of riverine plastics are influenced by hydrological conditions, population density, waste management practices, and river morphology, necessitating systematic monitoring to understand their sources, transport pathways, and environmental impacts (UNEP, 2021).

The Government of India, through the National Mission for Clean Ganga (NMCG) under the Ministry of Jal Shakti, is implementing a comprehensive river rejuvenation programme focusing on pollution abatement, ecological restoration, and sustainable basin management. Although there exist several river monitoring frameworks include surface water quality monitoring by the Central Pollution Control Board (CPCB) and State Pollution Control Boards (SPCBs), hydrological and sediment monitoring by the Central Water Commission (CWC),

and fisheries and biodiversity assessments by State departments, no prominent framework for the assessment of riverine plastic pollution exists.

Plastic waste in riverine environments occurs in a wide range of sizes, forms, and polymer compositions. To ensure consistency in monitoring and reporting, size-based classification as tabulated below is adopted (Walker et al. 2026):

Category	Size Range
Nanoplastics	< 1 µm
Microplastics	1 µm – 1 mm
Large Microplastics	1 mm – 5 mm
Mesoplastics	5 mm – 25 mm
Macroplastics	> 25 mm

However, riverine plastic pollution particularly macroplastic debris remains inadequately monitored, partly due to an absence of a unified national protocol and/or standardized methodology for monitoring, sampling, analysis, and reporting. This results in fragmented and non-comparable datasets across agencies.

Plastic waste entering the river system originates from multiple sources, including gap in municipal solid waste management in urban and peri-urban areas, religious offerings and mass gatherings, industrial and commercial packaging waste, and fishing and river-based activities. Major tributaries and urban drains further act as pathways for plastic transport into the main river system.

In alignment with national initiatives such as the Swachh Bharat Mission, Plastic Waste Management Rules, and the Namami Gange Programme, there is a critical need to establish a standardized and scientifically robust monitoring protocol to assess and manage riverine macroplastic pollution across river systems in India.

1.2 Pollution Status and Plastic Waste Context

- As per monitoring by the Central Pollution Control Board (CPCB), rivers across India are assessed at various locations under the National Water Quality Monitoring Programme (NWMP). Key water quality indicators include pH, Electrical Conductivity (EC), Biochemical Oxygen Demand (BOD), Dissolved Oxygen (DO), and faecal coliform levels etc.

- High pollution loads are typically observed in stretches influenced by urban centres, industrial clusters, and densely populated regions. These areas also exhibit a high prevalence of plastic waste, primarily due to inadequate solid waste management systems and illegal dumping into river channels.
- India generates approximately 4.13 million tonnes of plastic waste annually, as reported by CPCB in the Annual Report on Implementation of Plastic Waste Management Rules, 2016 for F.Y. 2020–21. Moreover, a significant proportion of this plastic waste remains uncollected or improperly managed, contributing to leakage into river systems.
 - Major pathways for plastic waste entering the river system include storm water drains and urban outfalls
 - Open dumping along riverbanks and floodplains
 - Informal and unregulated waste disposal practices

1.3 Rationale

- Rivers are recognized as major conduits for transporting plastic waste from land-based sources to marine environments.
- Macroplastics (>25 mm) constitute the most visible and manageable category of plastic pollution and are primarily associated with identifiable sources such as packaging, carry bags, and fishing gear.
- The absence of standardized monitoring leads to:
 - Inconsistent data across states and agencies.
 - Limited ability to identify pollution hotspots.
 - Weak evidence base for policy interventions.
 - Non-uniform sampling, analysis, and reporting protocols across institutions highlighting a strong need for a single harmonized framework.
- In addition, long-term monitoring of macroplastic is also necessary to:
 - Capture seasonal variations (monsoon vs non-monsoon).
 - Assess spatial variability across upstream, midstream, and downstream stretches

- Correlate pollution trends with human activities and waste management practices.
- A harmonized protocol will enable standardized data generation, inter-site comparability, and informed decision-making, thereby strengthening river basin management strategies.

2. Goal and Scope

2.1 Goal

The primary goal is to assess the status, trends, and spatial distribution of macroplastic pollution in Indian river systems, and to establish a unified protocol for sampling, characterization and assessment. In addition, this will also facilitate the generation of reliable and comparable data across spatial and temporal scales, thereby supporting evidence-based decision-making, targeted interventions, and an effective river basin management.

2.2 Definition and Classification

- As per Plastic Waste Management (PWM) Rules, 2016, as amended, 'plastic' means material which contains as an essential ingredient a high polymer such as polyethylene terephthalate (PET), high density polyethylene, Vinyl, low density polyethylene (PE), polypropylene (PP), polystyrene (PS) resins, multi-materials like acrylonitrile butadiene styrene, polyphenylene oxide, polycarbonate, Polybutylene terephthalate. This protocol primarily focuses on macroplastic debris (size > 25 mm), which is visible to the naked eye and can be reliably monitored through field-based methods.
- Plastic waste occurs in diverse product forms and is composed of different polymer types (e.g., PE, PP, PET, PS, etc.), which are often difficult to distinguish through visual inspection alone. Therefore, identification based on product type is recommended for field-level monitoring, aligned with the Extended Producer Responsibility (EPR) framework of the Central Pollution Control Board (CPCB, 2024).

Under the EPR framework, plastic packaging is categorized as follows:

- Category I: Rigid Plastic – Hard plastics that retain their shape
Examples: PET water bottles, HDPE containers (detergent, shampoo), plastic jars
- Category II: Flexible Plastic – Thin, flexible plastics that can be folded
Examples: Carry bags, plastic pouches, sachets, wrappers, plastic sheets
- Category III: Multi-layered Plastic (MLP) – Plastics combined with other materials (e.g., foil, paper)
Examples: Chip packets, biscuit wrappers, juice cartons, tea/coffee pouches
- Category IV: Plastic Sheets and Compostable Plastics – Includes plastic sheets and certified compostable materials

Examples: Compostable carry bags (with CPCB certification), agricultural plastic sheets

- Category V: Plastic sheet or like used for packaging as well as carry bags and commodities made of biodegradable plastics.

While these categories are appropriate for reporting and alignment with national regulations, their direct application during field-level monitoring may pose practical challenges. Riverine macroplastics collected through community-based monitoring, net towing, and monitoring at artificial barriers comprise a diverse range of materials, including packaging waste as well as non-packaging plastic items such as fishing gear, ropes, thermocol, footwear, sanitary waste, and fragmented plastics. Further, distinguishing between flexible plastics, multilayered plastics, compostable plastics, and biodegradable plastics may not always be feasible during field collection.

For the purpose of riverine macroplastic monitoring under this Protocol, a simplified classification system has been adopted to facilitate consistent field-level segregation, recording, and reporting across all monitoring methods. The classification is designed to be practical for field staff, fishers, and community participants, while ensuring adequate representation of the major types of plastic debris commonly observed across Indian river systems. This classification is intended solely for monitoring and data collection purposes and does not replace the categories prescribed under the Extended Producer Responsibility (EPR) framework of the PWM Rules. Where required, collected materials may subsequently be mapped to the relevant EPR categories during data processing and analysis. This approach would facilitate ease of implementation in the field while ensuring consistency with CPCB reporting requirements and comprehensive coverage of riverine macroplastic waste.

For monitoring purposes, all riverine macroplastics collected under the Protocol shall be segregated and recorded according to the simplified classification framework presented table below.

Table 2.1: Categories for macroplastic classification followed in the Protocol

Category	Simplified Category	Examples
I	Bottles and Containers	PET bottles, beverage bottles, detergent containers, jars
II	Bags, Wrappers and Packaging	Carry bags, wrappers, sachets, packets, films
III	Fishing and Utility Plastics	Fishing nets, ropes, nylon lines, floats
IV	Thermocol product	Thermocol pieces, sponges, foam cushions
V	Other Plastics and Composite Items	Footwear, sanitary items, toys, unidentified plastic fragments

Category	Simplified Category	Examples (All Plastic Items)
I	Bottles and Containers 	 PET bottles, beverage bottles, detergent containers, jars
II	Bags, Wrappers and Packaging 	 Carry bags, wrappers, sachets, packets, films, chips packets, pan masala type pouches
III	Fishing and Utility Plastics 	 Fishing nets, ropes, nylon lines, floats
IV	Thermocol Product 	 Thermocol pieces, sponges, foam, foam cushions
V	Other Plastics and Fragments 	 Footwear, toys, unidentified plastic fragments

Figure 2.1: Classification Categories for Riverine Macroplastics

2.3 Scope

- The protocol is aimed to cover monitoring of riverine macroplastics (>25 mm) across selected monitoring stations across Indian river systems.
- Monitoring shall be undertaken using the following standardized methods:
 - Community-based sampling using fishing nets
 - Monitoring at artificial barriers using fixed-dimension bags
 - Boat-based net towing with time-versus-quantity assessment
- The monitoring framework presently focus on assessment of macroplastics at the water surface, with provisions to progressively expand to additional environmental compartments, including the water column, sediments, and biota, to enable a more comprehensive understanding of plastic pollution dynamics.
- These methods collectively enable:
 - Basin-wide trend analysis.
 - Fixed-point accumulation assessment.
 - Flow-based plastic flux estimation.

3. Methodological Framework

3.1 Objective

To establish a standardized, multi-tiered monitoring framework for assessment of riverine macroplastics across Indian river systems, integrated field-based sampling, scientific measurements, and digital data systems are required to generate robust, comparable, and policy-relevant outputs for informed decision-making.

3.2 Overall Monitoring Framework

Monitoring of riverine macroplastics across Indian river systems shall be implemented through an integrated, multi-tiered approach designed to capture spatial variability, temporal trends, and quantitative estimates of macroplastic pollution across Indian river system. The framework combines complementary monitoring methods to ensure comprehensive coverage and reliability of data.

The monitoring framework integrates the following three approaches:

- **Community-based monitoring (Fishing-Based Method):** This approach leverages the routine activities of local fishing communities to enable continuous and cost-effective monitoring. It can provide an extensive spatial coverage and long-term datasets on floating macroplastics, particularly in areas with active fishing operations. It will also promote stakeholder participation and ownership at the local level.
- **Monitoring at artificial barriers (Fixed Volume Bag Method):** This fixed-point monitoring approach focuses on locations where floating debris naturally accumulates due to river infrastructure such as barrages, bridges, and trash interception systems. It enables consistent tracking of plastic accumulation over time, identification of pollution hotspots, and estimation of relative changes in debris load.
- **Sampling by net towing on boats (Time vs Quantity Method):** This is a scientific and quantitative method used to estimate macroplastic abundance and flux by collecting debris over a defined time period and known volume of water. It provides standardized and comparable data on plastic concentration and transport dynamics within the river.

Together, these methods ensure monitoring across upstream, midstream, and downstream stretches, capturing variations arising from hydrological conditions, seasonal changes (including monsoon impacts), and human activities such as urban discharge, industrial inputs, and riverfront usage.

3.3 Frequency of Monitoring Methods

- **Community-based Monitoring (Fishing-Based Method) – Monthly:** Plastic collection and monitoring shall be compiled on a monthly basis. Although plastic may be collected/observed daily as part of routine fishing activities, segregation, weighing and recording of the collected plastic shall be undertaken monthly.
- **Monitoring at Artificial Barriers (Fixed Volume Bag Method) – Monthly:** Monitoring and collection of accumulated plastics at designated artificial barriers shall be undertaken monthly, followed by segregation, weighing and recording of the collected material.
- **Sampling by Net Towing on Boats (Time vs. Quantity Method) – Monthly (Initial Phase):** During the initial phase (6 months), boat-based sampling shall be conducted monthly to establish baseline data on plastic abundance and transport. Once sufficient baseline data are established, the frequency may be revised to quarterly including seasonal variation (pre and post monsoon) or as required, based on site-specific conditions and monitoring requirements.

Drain outfall Monitoring: In addition to the three primary monitoring approaches, monitoring of plastic leakage through major drain outfalls discharging into the river may be undertaken by Urban Local Bodies (ULBs) or designated implementing agencies. Monitoring may be carried out at a fixed frequency (preferably daily) by installing a suitable collection net or screen at selected drain outfalls. Collected plastic material shall be periodically retrieved, segregated into the prescribed plastic categories, and recorded in terms of weight, or equivalent fixed-volume collection bags, as applicable. The data generated may be integrated with the basin-wide monitoring system to support identification of plastic leakage hotspots and prioritization of source-control interventions.

Event-Based Monitoring during Religious, Cultural and Mass Gatherings: In addition to the routine monitoring prescribed in the protocol, event-based monitoring shall be undertaken during major religious, cultural and mass-gathering events, including Kumbh Mela, Chhath Puja, Durga Puja, Kanwar Yatra and other major gatherings, considering their potential contribution to increased plastic loads in the River. During such events, all three monitoring methods prescribed in the protocol Community-based, monitoring at artificial barriers and Sampling by net towing on boats shall be employed, wherever feasible, to generate comprehensive data on macroplastic loads and to capture variations in plastic accumulation and transport under event-specific conditions.

It is particularly noted that during such events, when large quantities of plastic waste may accumulate in the river and become trapped at existing barriers, obstructions or other suitable locations, the artificial barrier-based method may provide valuable data on the accumulation and quantity of macroplastic waste. The suitability and feasibility of deploying or utilizing artificial barriers shall be assessed based on site conditions, river flow, accessibility and safety considerations.

The macroplastics collected through event-based monitoring shall be segregated into the five prescribed categories (I–V), weighed and recorded, and stored in 50-kg bags, following the same procedures prescribed in the protocol. However, the data generated during such events shall be recorded, analysed and reported separately as event-based monitoring data and shall not be combined with routine monitoring observations. The event-based dataset shall be used to assess the additional macroplastic loads associated with specific events and facilitate comparison with normal riverine conditions.

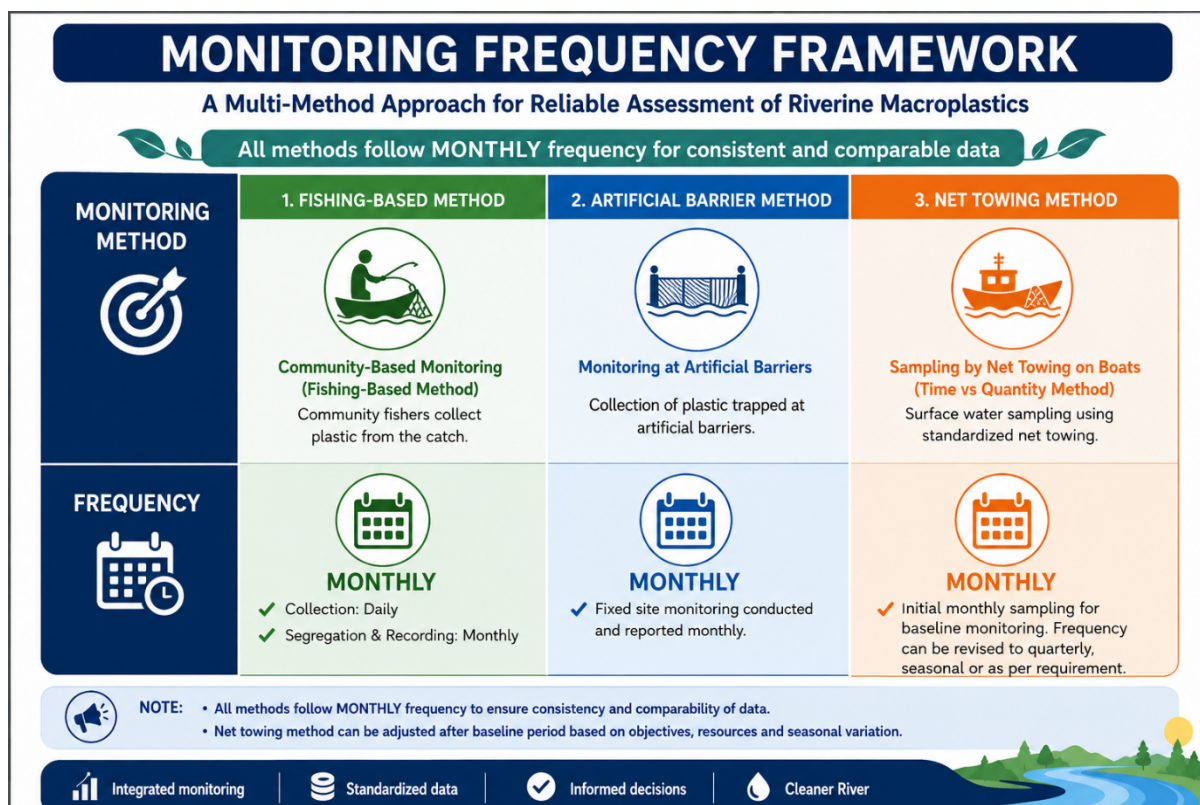


Figure 3.1: Frequency of Monitoring Methods Adopted

The framework emphasizes:

- **Spatial coverage:** Representation of diverse river stretches, tributaries, and pollution-prone zones
- **Temporal consistency:** Regular monitoring (daily, monthly, seasonal) to capture trends and variability
- **Quantitative assessment:** Estimation of plastic abundance, composition, and flux
- **Standardization:** Use of uniform protocols, formats, and classification systems across all methods

All data generated through these monitoring approaches shall be:

- Recorded using standardized field formats
- Geo-referenced and supported by photographic evidence (where ever applicable)
- Field-level reporting shall be digitized and integrated into a centralized data management system, enabling real-time data entry, geo-tagging, and photographic documentation by field personnel.
- The centralized monitoring system shall facilitate:
 - Data integration across methods and locations
 - Quality control and validation

- Basin-scale analysis and visualization (including GIS-based mapping)
- Identification of pollution hotspots to prioritise intervention areas
- Generation of periodic reports for policy and planning purposes

This integrated methodological framework ensures a robust, scalable, and data-driven system for assessing riverine macroplastics across Indian river systems, supporting effective management interventions and long-term monitoring objectives. Figure 3.2 presents the schematic workflow of the Riverine Macroplastic Monitoring Process and Figure 3.3 provides an overview of the different monitoring methods adopted under the Protocol for the assessment of riverine macroplastic pollution across Indian river systems.

3.4 Monitoring Network

An initial representative macroplastic monitoring network has been developed for the main stem of the River Ganga based on key site-selection criteria, including existing CPCB monitoring stations, CIPET-identified macroplastic hotspots, major barrages, existing trash skimmers/interception structures, and fish landing and fishing locations identified by ICAR-CIFRI. The proposed network will support baseline monitoring and may be further refined or expanded based on monitoring outcomes, site suitability and identified data gaps. Details of the selected monitoring locations and site-selection criteria are provided in Annexure 1.

RIVERINE MACROPLASTIC MONITORING – WORKFLOW



Figure 3.2: Workflow of the Riverine Macroplastic Monitoring Process

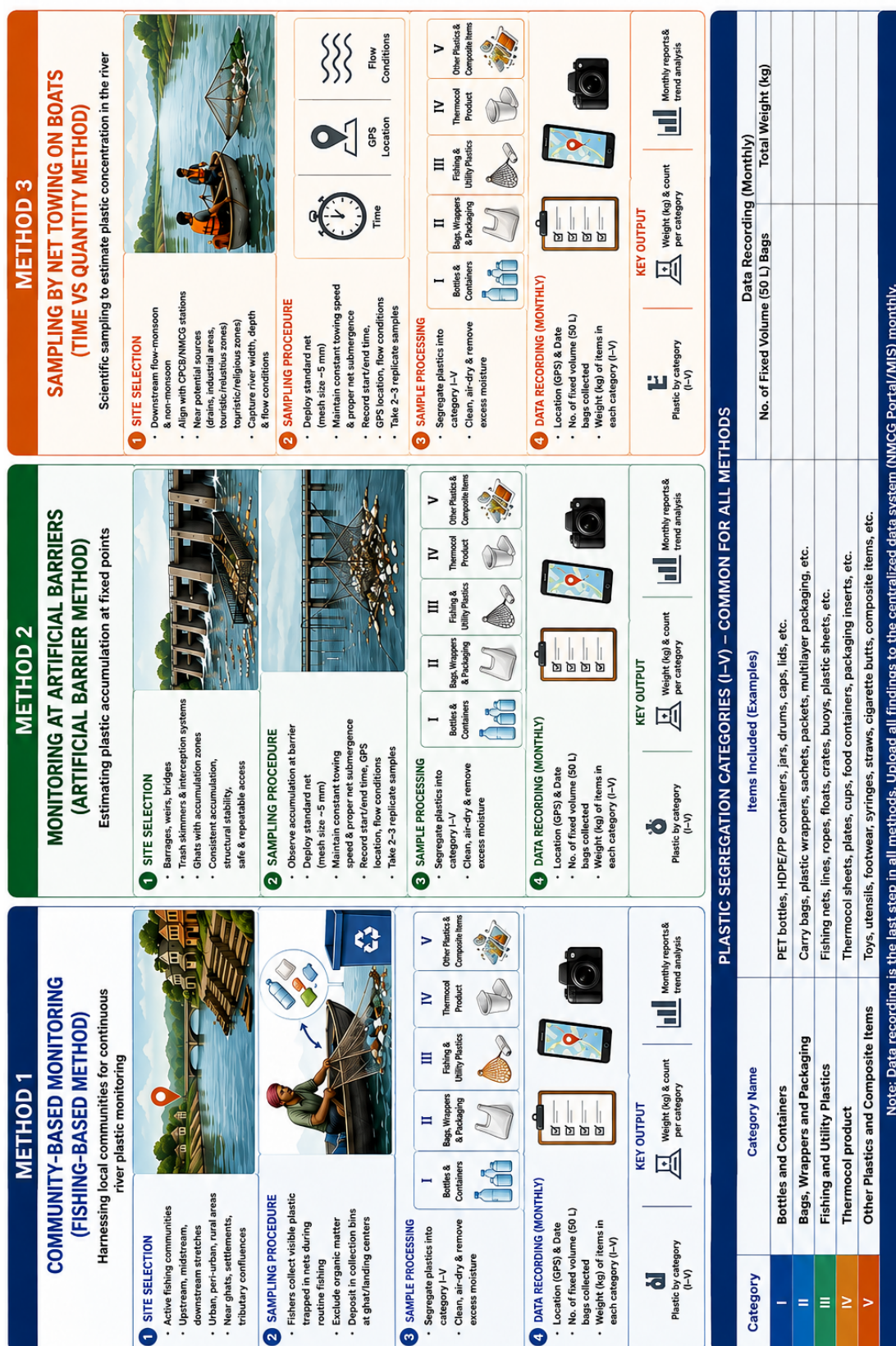


Figure 3.3: Overview of Monitoring Methods Adopted in the Protocol for Riverine Macroplastic Assessment

3.5 Comparability and Complementarity of Macroplastic Monitoring Methods

The Fishermen-based, Artificial Barrier and Boat Towing Methods are complementary and shall not be considered directly interchangeable, as each method captures a different aspect of riverine macroplastic dynamics. No single method can adequately represent the entire macroplastic load or transport behaviour of a river. Net-based, barrier-based and collection-based approaches differ in the fraction of plastic sampled and, in the accumulation, or transport processes captured. Accordingly, the selection of the appropriate monitoring method shall be based on site-specific conditions and monitoring objectives, including river characteristics, flow conditions, availability of suitable fishing activity or artificial barriers, accessibility and safety, and the feasibility of boat-based sampling. Results may be assessed using common parameters such as plastic mass, composition, monitoring location and temporal/seasonal variation, while retaining the method-specific outputs for appropriate interpretation.

A brief summary of the applicability, key outputs and major considerations of the three monitoring methods is provided in the Table 3.1.

The three methods should not be directly compared simply on the basis of kg collected, because they sample different components of the plastic system.

- Fishermen method → accumulation/collection
- Artificial barrier → interception/retention
- Boat towing → in-river floating plastic and transport

The Boat Towing Method is the most suitable of the three for estimating riverine plastic transport, provided adequate hydraulic and sampling data are available. The other two methods are valuable for identifying local accumulation, interception and hotspots. Together, the three methods provide a more complete understanding of plastic generation/accumulation → interception → river transport.

For the protocol, it is therefore recommended not forcing all three methods into one common numerical indicator. Instead, retain their method-specific primary outputs and use mass, composition (Categories I–V), location and temporal trends as common comparison parameters wherever appropriate.

Table 3.1: Summary of three monitoring methods

Monitoring Method	What is being measured	Primary Output	What it tells us
Fishermen-based Method	Macroplastic collected by fishermen from designated fishing/landing locations over a defined period	Mass of plastic collected per unit time (e.g., kg/month) and composition	Indicates local plastic accumulation and collection associated with fishing/landing areas
Artificial Barrier Method	Macroplastic accumulated or intercepted at a fixed barrier/structure	Mass of plastic intercepted per unit time (e.g., kg/month) and composition	Indicates plastic interception/accumulation at a specific fixed location and can help identify upstream plastic loads reaching the structure
Boat Towing Method	Floating macroplastic captured from the moving river water during a standardized towing operation	Mass captured per sampling effort; where sampled-water volume can be reliably determined, plastic concentration	Provides information on floating macroplastic present in the river and its transport through the monitored river reach

Note: Following completion of sampling and processing, all collected plastic shall be finally recorded category-wise (Categories I–V), including the corresponding weight and the number of 50-L bags collected. These common parameters shall facilitate comparison and interpretation of results across the three monitoring methods, while retaining the method-specific outputs.

4. Community-Based Monitoring (Fishing-Based Method)

Community-based monitoring through fishing activities provides a continuous and participatory approach to assess riverine macroplastic pollution in rivers. This method utilizes routine fishing operations to generate long-term data on plastic occurrence and distribution.

4.1 Planning and Site Selection

- Monitoring shall be conducted continuously with daily recording/collection and monthly segregation.
- Sampling locations shall be selected based on:
 - The presence of active fishing communities
 - Representation of river stretches (upstream, midstream, downstream)
 - Coverage of urban, peri-urban, and rural areas
 - Accessibility and willingness of community participation
- Priority shall be given to areas near urban settlements, ghats, and tributary confluences. Monitoring locations shall also include downstream stretches of major cities, industrial regions, drain outfall points discharging directly into the river. The monitoring of drains discharging into rivers shall be undertaken by Urban Local Bodies (ULBs), with consideration of meshes or barriers at drain outfalls to identify plastic inflow and sources.
- Local institutions and line agencies shall be actively engaged to ensure long-term sustainability.

4.2 Field Sampling and Data Collection

- Fishermen shall collect visible plastic debris trapped in fishing nets during routine operations. The collected plastic shall be placed in a designated collection bin at the fishing/landing site, and the relevant details shall be recorded in accordance with Table 4.1.
- As different types of fishing nets are used by the fishermen's, the specific gear used for each observation shall be clearly recorded using the standardized codes provided to ensure consistency and comparability of data.

Gill Net	Cast Net	Drag Net (Seine Net)	Lift Net	Fixed Net
GN	CN	DN	LN	FN

Note: The fishing gear coding system presented above has been adapted from the Mekong River Commission (MRC) monitoring framework to facilitate standardized data collection during the initial implementation phase of the Protocol. Based on field experience, consultations with fishing communities and implementing agencies across the Indian rivers, the classification and coding system may be reviewed and refined to better reflect locally used fishing gears and regional fishing practices.

- Organic matter (branches, leaves, wood chips, etc.) shall be excluded from sampling.
- Standardized collection bins shall be installed at ghats, fish landing centres, and designated locations.
- To improve consistency, basic orientation/training shall be provided to participating fishermen on identification and segregation of plastic waste.
- Collected material shall be deposited after each fishing trip, where feasible, periodic supervision by implementing agencies shall be undertaken to ensure data reliability and consistency.

4.3 Data Integration, Analysis and Visualization

- Samples shall be cleaned and air-dried (preferably sun-dried) prior to analysis. In the absence of adequate sunlight, samples may be dried indoors or in a clean, well-ventilated shaded area. Wet weight may be recorded where drying is not feasible.
- Collected plastics shall be segregated into different Categories i.e. Category I – Bottles and Containers; Category II – Bags, Wrappers and Packaging; Category III – Fishing and Utility Plastics; Category IV – Thermocol product; Category V - Other Plastics and Fragments. After segregation, the plastic shall be placed in standard 50 L collection bags. The weight of plastic in each bag shall be recorded, and the total number of bags and cumulative weight for each plastic category shall be documented, as provided in Table 4.2. This will help establish the approximate weight of plastic per 50 L bag for each category, which can subsequently be used to estimate the plastic weight when weighing is not feasible and to establish category-specific volume-to-weight conversion factors. Following sufficient data collection and validation, these conversion factors may be applied to estimate plastic quantities based on bag volume. However, weighing of samples may continue, wherever feasible, to support data validation and improve the accuracy of volume-based estimates. Over time, and subject to validation, the standardized fixed-volume bag method may be adopted across all monitoring methods to promote consistency, simplify field implementation, and enhance comparability of monitoring data.
- Measurements shall include:
 - Total weight (kg) and Number of Fixed Volume Bag (50l)

➤ Category-wise distribution

Note: Samples shall not be weighed or placed in collection bag with biofouling material attached, as this may significantly affect weight-based estimations. Where removal of biofouling is not feasible or the sample is weighed with biofouling material attached, this shall be clearly flagged in the monitoring record.

- Data shall be validated using QA (Quality Assurance) / QC (Quality Control)
 - protocols prior to final submission.
- Monthly datasets shall be integrated into a centralized database to enable Inter-site comparison, Identification of pollution hotspots and Temporal trend analysis etc
- Results shall be normalized using effort indicators (e.g., number of fishing trips or fishermen) to improve comparability across locations.
- Where required and feasible, the collected data may be integrated with relevant hydrological and spatial datasets and visualized using GIS tools to support basin-level assessment and analysis.

Note: Any non-plastic material inadvertently collected during sampling shall be segregated from the plastic waste and shall not be included in the recorded plastic quantity or monitoring dataset. Such non-plastic waste shall be removed from the sampling site and disposed of by the same agency responsible for the collection and disposal of the plastic waste, in accordance with the applicable waste management rules and prescribed procedures.

4.4 Data Recording and Reporting

- A standardized field register (physical/digital) shall be maintained at each site.
- Fishing gear shall be uniformly coded (e.g., GN, CN).
- Daily Data recorded shall include (Table 4.1):
 - Date
 - Fishing gear
 - Number of collection instances
- Collected plastic shall be segregated monthly into standardized categories (I–V), and details shall be recorded in the format provided in Table 4.2.
- Monthly summaries shall include total number of entries (effort indicator), Number of participating fishermen, Frequency of collection, etc.
- Field data shall be digitized and uploaded into a centralized MIS/portal.
- Standardized reporting formats shall be followed to ensure consistency and comparability across sites.

4.5. Equipment Requirements

- Collection boxes
- Sorting tools (tongs, trays)
- Weighing scales
- Fixed Volume Bag (sustainable)
- Record books and stationery
- Personal protective equipment (gloves, boots, life jackets, etc).

4.6 QA/QC – Community-Based Monitoring (Fishing-Based Method)

The fishing-based method relies on the routine participation of local fishing communities for continuous macroplastic data collection. Because field personnel are non-specialist community members operating largely without direct daily supervision, robust QA/QC procedures are especially critical to minimize variability, ensure category consistency, and produce data that are comparable across sites and seasons.

Pre-Field Preparation

Training and Capacity Building

- All participating fishers shall receive a structured orientation session before commencement of monitoring activities, covering: identification and segregation of plastic versus organic debris; assignment and use of standardized gear codes (GN, CN, DN, LN, FN); correct plastic category classification using the Categories I–V; and proper operation of weighing equipment and data recording forms.
- Orientation shall be repeated at least once per year and whenever significant turnover of participating fishers occurs.
- Laminated visual identification charts in local languages shall be issued to each fisher or fisher-group and replaced when worn or damaged. The charts shall include photographic examples of plastic categories and known contaminants to exclude (e.g., jute bags, organic matter).
- Designated Community Monitors (one per landing site or ghat) shall receive additional training to act as first-level supervisors for daily operations.

Equipment Verification

- Weighing scales shall be calibrated as per manufacturer specifications. Weighing scales used at each landing site shall be verified for accuracy before each monitoring cycle using a certified reference weight. If scale error exceeds $\pm 2\%$, the scale shall be repaired or replaced before use.
- Collection bins, sorting trays, tongs, and sample labels shall be inspected for condition and quantity at the start of each monthly cycle.
- A sufficient stock of standardized field register forms (physical or digital) shall be confirmed at each monitoring site before sampling commences.

Field / In-Situ Quality Controls

During Each Fishing Trip

- **Organic exclusion:** Fishers shall remove all organic material (fish, plant matter, soil, etc.) before placing debris in collection bins. Any doubt about whether an item is plastic shall default to exclusion. Community Monitors shall conduct visual spot-checks of deposited material at least twice per week.
- **Gear-type recording:** The standardized gear code (GN, CN, DN, LN, or FN) shall be recorded for every collection event. Entries with missing or ambiguous gear codes shall be queried before monthly aggregation.
- **Biofouling notation:** The presence or absence of biofouling (algae, mud, barnacles) on collected items shall be recorded in the field register. Items with biofouling shall not be weighed until the attached material has been removed during the processing stage.
- **Separation of contaminants:** Non-plastic debris (rubber, fabric, rope, wood) shall be separated. If non-plastic debris constitutes a notable proportion of a haul, this shall be recorded as a field note.
- **Minimum collection threshold:** If a fishing trip yields no plastic debris, a zero-catch entry shall still be recorded. Blanks must not be left unfilled, as zero-catch records are analytically important for calculating capture rates and effort-normalised estimates.

Supervision

- Community Monitors shall visit each active landing site or ghat at minimum twice per week during the initial three months of monitoring, reducing to weekly visits once data quality is confirmed to be consistent.

- Implementing agency supervisors shall undertake field verification visits to each site at least once per month, reviewing field registers, checking bin contents, and interviewing Community Monitors.

Sample Processing Quality Controls

Drying Protocol

- Collected plastics shall be air-dried (sun-drying preferred) before weighing. Each sample shall be spread on clean trays and dried in direct sunlight under clear-sky conditions, or for an extended period under overcast conditions, until adequately dried. During the monsoon, winter, or other periods when adequate sunlight is not available, samples may be dried indoors or in a clean, well-ventilated shaded area, protected from rain, moisture, and other sources of contamination, until adequately dried before weighing.
- Wet-weight measurement is permissible only when drying is not feasible within the reporting cycle; when wet weight is recorded, this shall be explicitly flagged in the data.
- Where samples from multiple trips are aggregated before drying, care shall be taken to prevent re-wetting; dried samples shall be stored in sealed, labelled containers until weighing.

Category Classification

- After drying, each sample shall be sorted into categories (I–V) by the Community Monitor using the visual reference chart. Where category assignment is uncertain, the item shall be photographed and escalated to the implementing agency supervisor for classification.
- Classification shall be cross-checked during monthly supervisory visits by comparing field-level records against independently re-sorted sub-samples. A sub-sample of at least 10% of items from each site shall be re-classified by the supervisor; a category disagreement rate exceeding 15% triggers re-training for that site.

Weighing

- All samples shall be weighed to the nearest 1 g on a verified scale. Both item count and weight shall be recorded for each category.
- Wet-weight samples shall be clearly flagged and shall not be combined with dry-weight data in statistical summaries without applying an appropriate conversion factor.

4.7 Implementation Framework

A coordinating agency (Academic institution, Autonomous body or a private firm) may be appointed by NMCG to coordinate six steps brought out in protocol below:

Activity / Action	Frequency	Key Responsibility / Output
1. Identification and selection of fishing communities / landing sites	One-time; review as required	Identify suitable fishing communities, ghats/landing centres, participating fishermen and designated collection points.
2. Training, capacity building and awareness	Initial; refresher as required	Training on macroplastic identification and collection procedures, segregation into Categories I–V, proper use of monitoring equipment, field data recording, safety protocols, and appropriate handling of plastic and non-plastic materials
3. Provision and installation of collection & monitoring resources	Before commencement; maintenance as required	Provide collection bins/boxes, weighing scale, PPE, fixed-volume bags, field registers and other required monitoring resources at designated sites.
4a.) Collection and field recording (Daily)	Daily	Collect macroplastics during routine fishing operations, deposit them at the designated collection point, and record basic information such as date, collection event, gear code and requirement information in the field register.
4b.) Segregation, processing and quantification (Monthly)	Monthly	Clean and air-dry; remove non-plastic material; segregate into the five standardized categories; weigh the plastic and record the results in the prescribed format.
5. Data compilation, validation, GIS Integration and reporting	Monthly / Quarterly	Compile and digitize field data; undertake technical verification and periodic field review; validate and integrate data into the centralized monitoring system; prepare periodic monitoring reports.

Activity / Action	Frequency	Key Responsibility / Output
6. Transportation, recycling, disposal and end-of-life management	Monthly / as required	Transport segregated plastic from collection/processing points to designated authorized facilities and ensure recycling, co-processing or environmentally sound disposal. Non-plastic material shall be disposed of as per applicable Waste Management Rules and excluded from the plastic data.

Table 4.1: Riverine Macroplastic Record Book for Fishing-Based Method

Particulars		Details	
Name of Community			
Location of the Fishery Community		Latitude: _____	
		Longitude: _____	
Survey Period (Date)		From: _____	
		To: _____	
Date	Fishing Method (0-No plastic, 1- Plastic) / Gear Code (GN, CN, DN, LN, FN) (Refer Ch.4.2) Eg. (0/GN, 1/GN)	No. of Times Plastic Collected	
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			
11			
12			
13			
14			
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31			

Note: For the purpose of initial assessment, individual item-wise data on the number of pieces and corresponding weight shall be recorded. This systematic documentation will help in tracking and identifying the possible sources of plastic pollution in the river.

Table 4.2: Record for Plastic Product Item, Number and Weight (Monthly Record)

	Latitude:	Longitude:	
Survey Period:			
Monitoring Method:			
Remark:			
Category	Item Name	Weight (kg)	No. of 50L Bags
I. Bottles and Containers	PET water bottles		
	Soft drink bottles		
	HDPE containers (detergent/shampoo)		
	Plastic jars and containers		
	Cosmetic/toiletry bottles		
	Rigid cups, tubs and food containers		
II. Bags, Wrappers and Packaging	Plastic carry bags		
	Food wrappers (biscuits/snacks)		
	Milk packets		
	Sachets and pouches		
	Plastic sheets and films		
	Multilayer packaging (chips, chocolate, noodle packets, etc.)		
III. Fishing and Utility Plastics	Fishing nets and net fragments		
	Ropes and nylon lines		
	Floats and buoys		
	Plastic straps and binding materials		
	Crates, baskets and utility items		
IV. Thermocol Products	Thermocol pieces/fragments		
	Foam packaging materials		
	Disposable foam cups and plates		
	Sponge and cushioning materials		
V. Other Plastics and Fragments	Footwear (slippers, sandals, shoe parts)		
	Toys and household plastic items		
	Sanitary and personal care items		
	Plastic fragments (hard)		
	Plastic fragments (soft/flexible)		
	Unidentified plastic items		
Total			

5. Monitoring at Artificial Barriers (Fixed Volume Bag Method)

Monitoring at artificial barriers provides a fixed-location approach to assess accumulation and estimate flow of riverine macroplastics across the Indian rivers. This method is particularly useful for identifying plastic accumulation zones and estimating debris flux at key interception points.

5.1 Planning and Site Selection

- Monitoring shall be conducted monthly at fixed locations. Potential locations for monitoring at artificial barriers shall be selected based on the following criteria.
 - The presence of operational river infrastructure such as ports, ghats, barrages, or other permanent structures that may facilitate accumulation of floating debris
 - Representation across upstream, midstream, and downstream stretches within each state along the river to capture spatial variability
 - Preference for structures such as barrages, weirs, dams, sluice gates, and flood control structures that span or significantly influence the river cross-section, enabling effective interception or accumulation of floating plastics
 - Locations where regular maintenance and clean-up activities are undertaken by responsible agencies (e.g., Irrigation Departments, Urban Local Bodies), ensuring feasibility of sustained monitoring
- Ideal monitoring locations help in tracking changes in plastic accumulation over time and support estimation of plastic flow in rivers, and should meet the following criteria:
 - A safe and easily accessible place for observation.
 - A location that has a structure allowing constant accumulation of debris (i.e., the structure does not change over time and the accumulated debris does not drift due to boat movement).
- Fixed observation points shall be maintained to ensure temporal comparability.

5.2 Field Sampling and Data Collection

- Plastic accumulation shall be estimated using standardized Fixed Volume bag equivalence (typically 50 L).
- Observations shall be conducted through visual estimation, supported by reference (benchmark) images to minimize observer bias.
- The sampling procedure involves three key steps:

(i) Selection and Documentation of Site

- Identify a suitable artificial barrier (e.g., barrage, bridge, or trash interception point)
- During the first observation (Table 5.1):
 - Take photographs from multiple angles
 - Record location (latitude/longitude)
 - Document site characteristics and prepare a simple sketch for reference
- In subsequent surveys, the same location shall be monitored to assess temporal changes

(ii) Estimation of Plastic Accumulation

Estimation of accumulated plastic will be performed using the following methods:

a) Fixed Volume Bag Method

- Plastic accumulation shall be estimated by collecting debris into standard 50 L Fixed Volume collection bags, or by estimating the equivalent volume where direct collection is not feasible count debris in a representative portion (or full area, where feasible)
- Record (refer Table 5.1):
 - Number of equivalent bags
 - Percentage of area observed
 - Extrapolate to estimate total accumulation volume

b) Recording Composition

- Plastic accumulated at the artificial barrier shall be collected using a suitable method depending on site conditions, including a suitable net with a mesh size of approximately 4–5 mm. The collected material shall subsequently be sieved using a sieve with a mesh size of 22.4 mm, with the material retained on the sieve considered for macroplastic monitoring, followed by further separation and processing as specified in the Protocol.
- The collected plastic shall be air dried (preferably sun-dried or indoor in case of absence of adequate sunlight) and segregated into Categories I–V as specified in Table 5.3. The number of 50 L collection bags filled under each category shall be

recorded. Organic matter (branches, leaves, wood chips, etc.) shall be excluded from sampling.

- **Note:** Samples shall not be weighed or placed in collection bag with biofouling material attached, as this may significantly affect weight-based estimations. Where removal of biofouling is not feasible or the sample is weighed with biofouling material attached, this shall be clearly flagged in the monitoring record.
- Weighing is not mandatory under this method. However, during the initial phase of monitoring, periodic weighing of plastic collected in standard fixed-volume bags may be undertaken to establish volume-to-weight conversion factors. Once sufficient data are available and validated, routine weighing may be reduced or omitted, and plastic quantities may be estimated based on the standardized bag volume.

5.3 Data Integration, Analysis and Visualization

- Collected data shall be compiled into a centralized database for basin-level analysis.
- The number of bags and weight of plastic under each category (I–V) shall be recorded as the primary monitoring data. Data shall be analyzed to:
 - Identify plastic accumulation hotspots
 - Assess temporal trends in accumulation
- Data from artificial barriers shall be integrated with other monitoring methods (e.g., fishing-based and net towing) for comprehensive assessment. During the initial implementation phase, the weight of plastic under each category (I–V) shall also be recorded to support standardized data collection and comparison across monitoring methods.

5.4 Data Recording and Reporting

- Field data shall include (Table 5.1 or/and Table 5.2):
 - Location (latitude/longitude)
 - Date and time of observation
 - Estimated plastic volume (in litres or equivalent bags)
 - Percentage area observed
 - Approximate composition of plastic waste
- Geo-tagged photographic documentation is mandatory for each observation.
- Data shall be recorded in standardized formats and uploaded monthly into a centralized MIS/database.
- Monthly reporting shall include the details in Table 5.2

- Standardized tables shall be used for data entry and reporting, including:
 - Inventory of artificial barrier locations
 - Benchmark comparison records
 - Monthly plastic item summaries

5.5 Equipment Requirements

- Standardized Fixed Volume bags (50L) (sustainable)
- GPS Camera
- Net
- Weighing Scale
- Measuring tapes.
- Stainless steel sieve (mesh size 22.4 mm)
- Logbooks
- Safety equipment.

5.6 QA/QC – Monitoring at Artificial Barriers (Fixed Volume Bag Method)

The Fixed volume bag method relies on visual estimation, which is inherently subjective and susceptible to inter-observer variability. QA/QC procedures for this method are therefore structured primarily to standardize the estimation process through calibrated reference tools, mandatory photographic documentation, and rigorous supervisory cross-verification.

Pre-Survey Preparation

Site Documentation and Fixed-Point Setup

- For each monitoring site, a permanent photographic reference set shall be established during the first observation, comprising photographs taken from at least three fixed vantage points. These reference photographs shall include visible landmarks (e.g., structural features of the barrage, bridge pillar markings) to ensure consistent framing in subsequent surveys.
- Fixed observation coordinates (latitude/longitude) and a simple sketch of the monitoring zone shall be prepared and stored in both the field register and the digital platform. These shall not be altered without documented justification and approval from the implementing agency.
- All camera devices used for geo-tagged documentation shall have GPS functionality verified and time-stamps synchronized before each survey cycle.

- Measurement uncertainty and recovery/collection efficiency shall be documented, wherever feasible.

Equipment Check

- Weighing scales shall be calibrated as per manufacturer specifications.
- Standard 50 L garbage bags used as reference units shall be of consistent dimensions and color across all monitoring sites and time periods to ensure volumetric equivalence. Bag specifications (manufacturer, dimensions, capacity) shall be documented and batch numbers recorded.
- Measuring tapes, safety equipment, and logbooks shall be verified for availability and condition before each survey.

Field / In-Situ Quality Controls

During Each Observation Event

Geo-tagged photography: Mandatory at the start of each observation event. A minimum of three photographs shall be taken from the pre-defined fixed vantage points for each survey. Photographs shall capture the full accumulation zone and include a date-visible element (e.g., a field whiteboard with date, or digital timestamp). Surveys without adequate photographic documentation shall be considered non-compliant and the data flagged for supervisory review.

- **Benchmark comparison:** Observers shall use the benchmark image comparison approach for all visual estimations rather than making unanchored “free estimates.” The selected benchmark image(s) shall be recorded alongside the estimate.
- **Zone subdivision:** Where plastic distribution is non-uniform across the accumulation area, the zone shall be subdivided into representative sections and each estimated separately. The number of sections and the rationale for subdivision shall be recorded.
- **Percentage coverage:** The percentage of the total accumulation zone that was directly observed (versus extrapolated) shall be recorded for every survey event. Extrapolated estimates shall be accompanied by a written justification for any assumptions made.
- **Composition recording:** Approximate item counts and plastic categories (I-V.) shall be recorded as per Table 5.2 of the Protocol.

Adverse conditions: If observation is impeded by low visibility (fog, darkness, high turbidity), excessive debris other than plastic (vegetation, silt), or structural obstruction, this shall be recorded and the survey marked as ‘partial’ or ‘conditions-impaired.’ Partial-survey data shall be flagged during analysis.

5.7 Implementation Framework

A coordinating agency (Academic institution, Autonomous body or a private firm) may be appointed by NMCG to coordinate six steps brought out in protocol below:

Activity / Action	Frequency	Key Responsibility / Output
1. Identification and selection of fishing communities / landing sites	One-time; review as required	Identify suitable fishing communities, ghats/landing centres, participating fishermen and designated collection points.
2. Training, capacity building and awareness	Initial; refresher as required	Training on macroplastic identification and collection procedures, segregation into Categories I–V, proper use of monitoring equipment, field data recording, safety protocols, and appropriate handling of plastic and non-plastic materials
3. Provision and installation of collection & monitoring resources	Before commencement; maintenance as required	Provide collection bins/boxes, weighing scale, PPE, fixed-volume bags, field registers and other required monitoring resources at designated sites.
4a) Collection and field recording (Daily)	Daily	Collect macroplastics during routine fishing operations, deposit them at the designated collection point, and record basic information such as date, collection event, gear code and requirement information in the field register.
4b) Segregation, processing and quantification (Monthly)	Monthly	Clean and air-dry; remove non-plastic material; segregate into the five standardized categories; weigh the plastic and record the results in the prescribed format.
5. Data compilation, validation, GIS Integration and reporting	Monthly / Quarterly	Compile and digitize field data; undertake technical verification and periodic field review; validate and integrate data into the centralized monitoring system; prepare periodic monitoring reports.
6. Transportation, recycling, disposal and end-of-life management	Monthly / as required	Transport segregated plastic from collection/processing points to designated authorized facilities and ensure recycling, co-processing or environmentally sound disposal. Non-plastic material shall be disposed of as per applicable Waste Management Rules and excluded from the plastic data.

Table 5.1: Artificial Barriers Selected as Potential Monitoring Locations

S. No.	Artificial Barrier	Latitude	Longitude	Stakeholder	Scheduled Clean-up Activities	Bench Mark Photo	50 l Bag	Remark
1								
2								

Table 5.2: Record for Plastic Product Item, Number and Weight (Monthly Record)

Site Name:	Latitude:	Longitude:	
Survey Period:			
Monitoring Method:			
Remark:			
Category	Item Name	Weight (kg)	No. of 50L Bags
I. Bottles and Containers	PET water bottles		
	Soft drink bottles		
	HDPE containers (detergent/shampoo)		
	Plastic jars and containers		
	Cosmetic/toiletry bottles		
	Rigid cups, tubs and food containers		
II. Bags, Wrappers and Packaging	Plastic carry bags		
	Food wrappers (biscuits/snacks)		
	Milk packets		
	Sachets and pouches		
	Plastic sheets and films		
	Multilayer packaging (chips, chocolate, noodle packets, etc.)		
III. Fishing and Utility Plastics	Fishing nets and net fragments		
	Ropes and nylon lines		
	Floats and buoys		
	Plastic straps and binding materials		
	Crates, baskets and utility items		
IV. Thermocol Products	Thermocol pieces/fragments		
	Foam packaging materials		
	Disposable foam cups and plates		
	Sponge and cushioning materials		
V. Other Plastics and Fragments	Footwear (slippers, sandals, shoe parts)		
	Toys and household plastic items		
	Sanitary and personal care items		
	Plastic fragments (hard)		
	Plastic fragments (soft/flexible)		
	Unidentified plastic items		
Total			

6. Sampling by Net Towing on Boats (Time vs Quantity Method)

Sampling by net towing on boats provides a quantitative and flow-based approach to assess macroplastic transport in rivers. This method enables estimation of plastic abundance by collecting debris over a defined time period and filtered water volume.

Net towing from a moving boat is a standardized approach to collect floating and suspended macroplastics. Where site conditions do not permit towing, sampling may be undertaken using a stationary (anchored) boat. The method involves deploying a net near the centre of the river channel to obtain representative samples, followed by controlled towing under defined speed and duration.

Sampling is conducted at a steady speed (typically 0.5–1.0 m/s) for a fixed duration (generally 15–20 minutes), ensuring consistent filtration and minimizing clogging. The net is maintained within the upper layer of the water column, where most floating plastics are transported. Upon completion, the net is carefully retrieved and washed to collect all debris for further analysis.

This method supports estimation of macroplastic concentration and transport, and provides critical inputs for understanding spatial and temporal variations in plastic pollution across the river system.

6.1 Planning and Site Selection

- During the initial phase (6 months), monthly monitoring shall be undertaken to generate sufficient baseline data. Following completion of the baseline assessment, the monitoring frequency will be revised to quarterly covering seasonal variation or as otherwise required, based on observed variability, monitoring results and programme requirements. Sampling shall, however, cover non-monsoon and monsoon/post-monsoon periods to capture seasonal variations.
- Monitoring undertaken during festivals, mass gatherings or other specific high-footfall events shall be treated as event-based monitoring and recorded separately from routine monitoring. Such data shall be clearly flagged and shall not be combined with routine baseline/seasonal datasets or used for routine trend analysis, as these events may result in temporary spikes in plastic loads.

- Survey locations shall represent upstream, midstream, and downstream stretches, including:
 - Downstream of urban areas and major drains (including drain outfall points discharging into the river, with consideration of installation of meshes or barriers at such locations to identify plastic inflow and sources)
 - Near tributary confluences
 - Fishing zones and water intake locations
 - Key tributaries
- Wherever feasible, monitoring sites shall be aligned with existing stations of CPCB and NMCG to enable data integration and efficient resource utilization.

6.2 Field Sampling and Data Collection

Sampling shall be conducted by towing a net from a boat along the central river flow to obtain representative samples of floating macroplastics.

Sampling Net Specifications

- A rectangular or square-frame net shall be used, with size not exceeding 1 m × 1 m, depending on vessel capacity.
- A mesh size of 4–5 mm is recommended for macroplastic sampling.
- The net shall be equipped with floats (top) and weights (bottom) to maintain stable orientation during towing.
- Net immersion depth shall be maintained within the upper 0.5–1.0 m of the water column, where the majority of floating plastics are transported.
- The net shall be inspected for cleanliness, structural integrity, and clogging before and after each sampling event.

Flow Measurement and Estimation of Plastic Concentration

- Macroplastic abundance shall be expressed as number of items or mass per unit water volume or surface area.
- Plastic concentration may be estimated as:

$$C_p = \frac{M_p}{V}$$

$$V = Q \cdot t = A_n \cdot u \cdot t$$

Where:

- C_p = Plastic concentration (kg/m³)
- M_p = Mass of collected plastic (kg)

- V = Volume of water filtered (m^3)
- Q = River Discharge at sampling net (m^3/s)
- A_n = Net opening area (m^2)
- u = Flow velocity (m/s)
- t = Sampling duration (s)

(Filtered water volume or area is obtained by multiplying the tow distance by the filtered area (net width x net immersion depth). It is advisable to use a flowmeter for calculating tow distances.)

- A flowmeter is recommended for accurate measurement of filtered water distance during towing. The flowmeter shall be attached to the net frame, and readings shall be recorded before and after each tow.
- In the absence of a flowmeter, tow distance may be estimated using GPS tracking and vessel speed. The selected flowmeter shall be suitable for accurate measurement across varying towing speeds.

Sampling Procedure

- The net shall be securely fixed to the boat, preferably at the bow, to minimize disturbance.
- The net shall be lowered into the water ensuring proper submergence and alignment.
- Record start time and GPS coordinates prior to towing.
- The net shall be towed at a steady speed of 1–2 knots (0.5–1.0 m/s).
- Sampling duration shall typically be 15–20 minutes, or until sufficient sample volume is obtained.
- Record end time and GPS coordinates upon completion of towing.
- The net shall be carefully retrieved and washed externally to transfer all collected material into the cod-end.
- Collected material shall be transferred into labelled containers, and plastic debris shall be separated manually from non-plastic materials.
- In case of net clogging, the net shall be cleaned and sampling resumed.

Sample Measurement

- Following sample collection, all relevant field observations and measurements shall be carefully recorded in Table 6.1, based on which plastic concentration and

other applicable monitoring parameters shall be calculated in accordance with the Protocol.

- Samples are air dried (preferably sun-dried or indoor in case of absence of adequate sunlight) and sieved using sieves with a mesh size of 22.4mm.
- Plastic samples shall be segregated, counted, and classified in I-V category (Table 6.2).
- Measurement shall include total weight, with dry weight preferred where feasible. Samples with biofouling (mud, algae, or silt attached) shall be rinsed and the attached material removed prior to weighing, and biofouling presence shall be noted in the field record. Samples may also be collected in standard fixed-volume collection bags (e.g., 50 L capacity) and weighed during the initial phase of monitoring to establish volume-to-weight conversion factors. Following sufficient data collection and validation, these conversion factors may be applied to estimate plastic quantities based on bag volume. However, weighing of samples may continue, wherever feasible, to support data validation and improve the accuracy of volume-based estimates. Over time, and subject to validation, the standardized fixed-volume bag method may be adopted across all monitoring methods to promote consistency, simplify field implementation, and enhance comparability of monitoring data
- Data shall be recorded in standardized formats (Table 6.1 and Table 6.2) for further analysis and comparison.

Safety Considerations

- Use of life jackets shall be mandatory for all personnel.
- Sampling shall be avoided during high flow conditions or adverse weather.
- Proper handling of equipment and adherence to safety protocols shall be ensured at all times.

Table 6.1: Record form for the survey summary of Boat Towing method

Section	Parameter	Sub-Parameter	Results/Input	Unit
Sampling Date and Location	Sample Name/ID			-
	Time Difference from GMT			-
	Sampling Date			-
	Sampling Time (Initial)			-
	Sampling Time (Final)			-
	Season			-
	Sampling Location (Name)			-
	GPS Log (Initial Position)	Latitude		N
		Longitude		E

Section	Parameter	Sub-Parameter	Results/Input	Unit
Sampling Equipment	GPS Log (Final Position)	Latitude		N
		Longitude		E
	Classification of Net Frame	Type of Net Frame		-
		Model Number and Manufacturer		-
	Net Aperture	Shape of Net Aperture		-
		Width		m
		Height		m
		Area		m ²
	Length of Net			m
	Mesh	Opening Size		mm
		Model Number and Manufacturer		-
Tow Parameters	Tow Distance	Distance		m
		Calculation Method		-
		Calculation Formula		-
	Trawl Sweep Area	Sweep Area		m ²
		Calculation Formula		-
	Filtered Water Volume	Water Volume		m ³
		Calculation Formula		-
	Tow Duration			min
	Vessel Speed			m/s
	Tow Position			-
	Distance from Vessel			m
	Net Immersion	Net Immersion Depth		m
		Percentage of Net Immersion Depth to Size of Net Frame		%
		Change in Immersion Depth During Tow (Yes/No)		-
	Tow Direction	Current Direction		-
		Wind Direction		-
	Blank Tests	Whether Blank Tests Conducted (Yes/No)		-
		Results		particles/sample

6.3 Data Integration, Analysis and Visualization

- Data from all monitoring methods shall be integrated across spatial and temporal scales.
- Integration shall include linkage with hydrological, land-use, and population datasets.
- Interoperability with existing NMCG and national databases shall be ensured.
- Standard analytical tools shall be used to assess distribution, abundance, and composition.

- GIS-based mapping shall be used for hotspot identification and spatial analysis.
- Trend analysis shall be conducted to assess seasonal and long-term patterns.

6.4 Data Recording and Reporting

- The following information shall be recorded for each sampling event (Table 6.1):
 - Date, time, and duration of tow
 - GPS coordinates (start and end points)
 - Tow speed and distance
 - Net specifications (size, mesh, immersion depth)
 - Flowmeter readings (if used)
 - Number, weight of plastics by category and also the fixed volume bags of Plastic
 - River and weather conditions
- Plastic concentration is calculated as per recorded data.
- Plastic is Segregated Category wise I-V and weight and other data recorded as per Table 6.2
- QA/QC protocols shall be applied at all stages, including field entry, validation, and processing.
- All data shall be entered into a centralized digital database/MIS platform to enable basin-wide analysis and reporting.
- Findings shall be compiled into monthly, quarterly, and annual reports.
- Reports shall include summary statistics, spatial maps, and key indicators.
- Outputs shall be presented in a policy-relevant format for decision-makers.
- Data shall support evidence-based planning, intervention prioritization, and performance monitoring.

6.5 Equipment Requirements

- Tow nets (4–5 mm mesh).
- Boats and anchoring systems.
- Flowmeter
- Sample containers
- Stainless steel sieve (mesh size 22.4 mm)
- GPS devices
- Safety and sanitation equipment.

6.6 QA/QC – Sampling by Net Towing on Boats (Time vs Quantity Method)

The net towing method is the most quantitative and scientifically rigorous of the three monitoring approaches. Its QA/QC framework must ensure accuracy across equipment performance, field execution, sample processing, and the calculated concentration metrics. Errors in any of these stages will propagate directly into estimates of plastic flux and load, which form a critical evidence base for policy and management decisions.

Pre-Sampling Preparation

Net Inspection and Condition Check

- Before each sampling event, the net shall be inspected for: structural integrity (tears, fraying, collapsed mesh sections); cleanliness (absence of debris or biological material from previous deployments); mesh blockage or compaction that could reduce filtration efficiency.
- Any tears or deformations affecting more than 5% of the net aperture area shall require net repair or replacement before sampling proceeds.
- Net dimensions (aperture width and height) shall be physically measured and recorded at the start of each sampling campaign or when a new net is deployed. Nominal dimensions shall not be assumed without verification.
- The cod-end collecting bag shall be verified for condition and clean status before each tow.

Flowmeter Calibration

- If a flowmeter is used, it shall be calibrated at the start of each field campaign as per manufacturer specifications. Calibration results shall be recorded in the field logbook.
- A spare flowmeter shall be available at each field station; if the primary unit fails mid-campaign, sampling shall be suspended until replaced or the GPS-based alternative is activated.
- Where tow distance is estimated from GPS and vessel speed in lieu of a flowmeter, the GPS device shall be verified for signal accuracy at the start of each campaign. The method used for tow distance calculation (flowmeter vs GPS) shall always be recorded as it affects uncertainty estimates.

Weighing Scale Verification

- Weighing scales shall be calibrated as per manufacturer specifications. Field scales shall be checked against a reference weight of known mass ($\pm 1\%$) before each

sampling campaign. If scale error exceeds 2%, the scale shall be recalibrated or replaced.

- Scales shall be levelled and wind-sheltered during weighing to minimize environmental error.

GPS and Field Instrument Check

- GPS shall be calibrated as per manufacturer specifications
- GPS devices shall be verified for satellite lock and coordinate accuracy before departure. Start coordinates shall be recorded while the vessel is stationary at the designated sampling point.
- Date, time synchronization across all field instruments (GPS, camera, flowmeter if digital) shall be confirmed before each sampling event.

Field / In-Situ Quality Controls

Pre-Tow Checks

- Vessel speed shall be verified using GPS or a calibrated speedometer before towing commences. Tow speed shall be set and maintained within the prescribed range of 0.5–1.0 m/s (1–2 knots). Deviations from this range shall be corrected before the tow begins.
- Net deployment depth (targeting the upper 0.5–1.0 m of the water column) shall be confirmed visually using a calibrated depth marker on the net cable or frame before starting the tow timer.
- River and weather conditions (flow level, presence of flood debris, wind speed) shall be assessed and recorded before each tow. If conditions are outside the safe operational window specified in Section 8 of the Protocol (Health and Safety Protocols), sampling shall be postponed.

During Towing

- Start time, start GPS coordinates, and flowmeter reading (if used) shall be recorded at the moment towing begins.
- Tow speed shall be monitored continuously. If vessel speed deviates from the target range for more than 30 seconds, the deviation, duration, and corrected speed shall be recorded in the field log.
- If net clogging occurs during the tow (indicated by a sudden reduction in flowmeter readings or visible debris blockage), the tow shall be paused. The net shall be partially retrieved, cleared of large obstructing debris, and the tow resumed. The clogging

incident shall be documented, including estimated time and proportion of tow duration affected. If clogging is severe (>50% of tow duration affected), the tow shall be voided and repeated.

Post-Tow Checks

- End time, end GPS coordinates, and final flowmeter reading shall be recorded immediately upon net retrieval.
- The exterior of the net shall be washed with river water into the cod-end before the net is lifted clear of the water, ensuring all adherent material is transferred to the sample.
- Tow distance shall be independently computed from (a) flowmeter readings and (b) GPS start/end coordinates. If the two estimates deviate by more than 15%, the discrepancy shall be noted and the flowmeter value used as the primary estimate; the reason for discrepancy shall be recorded.

Sample Processing Quality Controls

Biofouling and Contaminant Removal

- All collected material shall be sorted to remove non-plastic items (vegetation, sediment, organic matter, non-plastic debris). Non-plastic fractions shall not be weighed with plastic samples.
- Biofouling material (algae, mud, sediment attached to plastic surfaces) shall be removed by gentle rinsing before weighing. Presence and extent of biofouling shall be recorded in the field sheet.
- Samples with extensive biofouling that cannot be adequately rinsed in the field shall be sealed in labelled containers and processed (rinsed and dried) at the nearest laboratory or field station before final weighing.

Drying and Weighing

- Dry weight is the preferred measurement. Samples shall be air-dried (sun-drying preferred) before final weighing. Wet weight may be recorded in exceptional circumstances and shall always be clearly flagged in the dataset.
- Total weight and item count shall be recorded for the full sample, followed by category-level sorting (Categories I–V) with weight and count recorded per category.
- Tare weights of sample containers shall be verified at the beginning of each campaign and after any container change.

Calculation Quality Controls

Plastic Concentration (Cp) Verification

- Calculated plastic concentration values ($C_p = M_p/V$, where $V = A_n \times u \times t$) shall be independently re-calculated by a second reviewer using raw field values before entry into the final dataset.
- Net opening area (A_n) shall be re-derived from field-measured net dimensions rather than assumed from nominal values.
- In calculations using GPS-derived tow distance, the GPS track log shall be retrieved and the actual distance computed from waypoints, rather than using straight-line end-to-end distance, to account for vessel trajectory deviation.
- Concentration values that differ by more than one order of magnitude from the site's seasonal baseline (or from nearby sites sampled in the same event) shall be flagged and subjected to a detailed review of all raw field inputs before inclusion in trend analyses.

Event and Seasonal Flagging

- Data collected during or within five days of major festival events (e.g., Kumbh Mela, Chhath Puja, and other mass riverfront gatherings) shall be flagged as "Festival" and stored in a separate data stratum. These shall not be used for routine trend analysis but shall inform festival-specific waste management assessments.
- Data collected during the monsoon season shall be flagged as "Monsoon" to allow seasonally disaggregated analysis.

6.7 Implementation Framework

A coordinating agency (Academic institution, Autonomous body or a private firm) may be appointed by NMCG to coordinate seven steps brought out in protocol below:

Activity / Action	Frequency	Key Responsibility / Output
1. Identification, selection and geo-referencing of monitoring stretches / towing sites	One-time for each selected site; review as required	Identify and select suitable river stretches and standardized towing locations as per the approved sampling design; geo-reference monitoring sites and establish standardized sampling routes.

Activity / Action	Frequency	Key Responsibility / Output
2. Training, capacity building and safety orientation	Initial; refresher as required	Train designated personnel in standardized boat and net-towing operations, sample collection and handling, macroplastic identification and categorization into Categories I–V, field documentation, safety procedures and QA/QC requirements.
3. Provision, calibration and deployment of equipment	Before commencement; maintenance/calibration as required	Provide suitable boats, standardized towing nets/collection equipment, GPS and other monitoring instruments, weighing scales, PPE, sample containers, field registers and other required resources; ensure proper maintenance and calibration.
4. Boat and net-towing, sample collection and field documentation	Quarterly*	Undertake standardized boat and net-towing operations along designated stretches; record towing duration, distance/route, sampling conditions, equipment details and other prescribed field parameters; collect, label and securely store samples.
5. Sample processing, categorization and quantification	After each sampling cycle / as prescribed	Process collected samples; remove and segregate non-plastic material; categorize macroplastic into Categories I–V; quantify and record plastic using the prescribed methodology and monitoring effort.
6. QA/QC, data validation, GIS integration and reporting	Each sampling cycle / Monthly	Undertake QA/QC, verify field and processing records, compile and validate data, integrate geo-referenced observations into the centralized monitoring system and prepare periodic monitoring reports.
7. Transportation, recycling, co-processing and authorized disposal	After each sampling cycle / as required	Ensure safe handling and transportation of collected plastic to authorized facilities for recycling, co-processing or environmentally sound disposal. Non-plastic material shall be excluded from the monitoring dataset and appropriately disposed of as per applicable rules.

** During the initial six-month period, monitoring shall be undertaken monthly. Thereafter, monitoring shall be undertaken quarterly covering seasonal variation as per the protocol.*

Table 6.2: Record for Plastic Product Item, Number and Weight (Monthly Record)

Site Name:	Latitude:	Longitude:	
Survey Period:			
Monitoring Method:			
Remark:			
Category	Item Name	Weight (kg)	No. of 50L Bags
I. Bottles and Containers	PET water bottles		
	Soft drink bottles		
	HDPE containers (detergent/shampoo)		
	Plastic jars and containers		
	Cosmetic/toiletry bottles		
	Rigid cups, tubs and food containers		
II. Bags, Wrappers and Packaging	Plastic carry bags		
	Food wrappers (biscuits/snacks)		
	Milk packets		
	Sachets and pouches		
	Plastic sheets and films		
	Multilayer packaging (chips, chocolate, noodle packets, etc.)		
III. Fishing and Utility Plastics	Fishing nets and net fragments		
	Ropes and nylon lines		
	Floats and buoys		
	Plastic straps and binding materials		
	Crates, baskets and utility items		
IV. Thermocol Products	Thermocol pieces/fragments		
	Foam packaging materials		
	Disposable foam cups and plates		
	Sponge and cushioning materials		
V. Other Plastics and Fragments	Footwear (slippers, sandals, shoe parts)		
	Toys and household plastic items		
	Sanitary and personal care items		
	Plastic fragments (hard)		
	Plastic fragments (soft/flexible)		
	Unidentified plastic items		
Total			

7. Institutional Framework

1. **NMCG** shall act as the nodal agency for overall coordination, protocol standardization, and centralized data management.
2. **CPCB** shall provide technical guidance and alignment with national monitoring standards.
3. **SPCBs** or any other agency nominated by NMCG for Ganga Basin shall serve as nodal agencies for periodic (monthly and seasonal) monitoring activities across Indian rivers and its tributaries.
4. **State Mission for Clean Ganga (SMCGs)** shall oversee implementation, site selection, and supervision at the state level for Ganga Basin.
5. **a) District Ganga Committees (DGC)** (including Fisheries Departments) shall support fishermen's mobilization and daily field participation.
b) Line departments (Irrigation, Urban Local Bodies, Fisheries, etc.) shall support field execution and logistics.
c) Urban Local Bodies (ULBs) shall specifically undertake city-level implementation support, including monitoring of drain outfalls discharging into rivers.
d) Infrastructure-operating agencies (barrages, ghats, ports, trash skimmers) shall support monitoring at artificial barriers.
6. **Community groups and fishing communities** shall be engaged for data collection under the fishing-based method.
7. **Technical/Academic institutions** shall assist in data validation, plastic characterization, research collaboration, and capacity building through their network of centres and technical expertise across the country etc.
8. **Periodic Reporting:** The designated implementing agencies shall compile and submit periodic monitoring reports to NMCG, as per the frequency, format, data requirements and reporting mechanism defined in the Protocol.

8. Health and Safety Protocols

- All field personnel engaged in riverine plastic monitoring shall be briefed on applicable health and safety protocols prior to commencement of sampling activities.
- Use of life jackets/personal floatation devices shall be mandatory for all personnel undertaking boat-based or near-water sampling. Suitable gloves and protective clothing shall be worn during plastic handling and characterization to prevent exposure to contaminants.
- Sampling shall not be conducted during adverse weather conditions, flash flood events, or when river flow exceeds safe operational thresholds.
- An emergency contact and first-aid provisions shall be maintained at all monitoring sites.
- Implementing agencies shall ensure that all fishermen and community-level monitors involved in the programme are covered under welfare schemes, and that their participation is voluntary and duly compensated as per relevant guidelines.
- Sampling at barrages, ghats, drains, bridges, trash skimmers and other infrastructure shall be undertaken only from designated safe access points, with due caution around fast-flowing water and operational equipment.
- Safe access and exit routes shall be identified before commencing monitoring at each site, particularly at barrages, ghats, drains and other river structures.
- Boat-based monitoring shall be undertaken using suitable and properly maintained boats and equipment, operated by trained personnel and within safe operating capacity.
- Personnel shall exercise caution while handling sharp, broken, contaminated or unidentified materials encountered during collection and sorting.

9. Data Management

- A centralized data management system shall be developed and deployed for field-level reporting across all monitoring methods. The system shall enable real-time data submission, geo-referencing, photographic documentation, and automatic preliminary validation checks.
- All data shall be stored in a standardized digital format within centralized MIS/database, with defined access levels for implementing agencies, state bodies, and national-level reviewers. The database shall be interoperable with existing NMCG and CPCB monitoring platforms.
- Hotspot locations and priority monitoring stretches identified by Task Force members and CPCB shall be systematically documented and integrated into the GIS-based monitoring framework to enable targeted surveillance and intervention planning.
- Compiled datasets shall be used to generate monthly, quarterly, and annual reports for submission to NMCG, CPCB, and the Task Force on Plastic Pollution. Outputs shall be presented in a policy-relevant format to support evidence-based decision-making and river basin management.

References

1. Central Pollution Control Board (CPCB) – National Water Quality Monitoring Programme
2. CPCB, *Standard Operating Procedure (SOP) for Assessment & Characterization of Plastic Waste*, 2024
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Initial Macroplastic Monitoring Network and Site Selection – Ganga Main Stem

An initial representative macroplastic monitoring network has been developed for the main stem of the River Ganga based on multiple site-selection criteria, including (i) existing CPCB monitoring stations, (ii) macroplastic hotspots identified by CIPET, (iii) major barrages along the Ganga main stem, (iv) locations of existing trash skimmers/interception structures, and (v) fish landing and fishing locations identified by ICAR-CIFRI. The initial network is intended to provide representative spatial coverage for baseline monitoring and may be reviewed, expanded or refined subsequently based on monitoring results, site suitability, data gaps and programme requirements.

CIPET, Bhubaneswar has identified 17 macroplastic hotspot locations (TABLE A1), while 19 fish landing/fishing locations have been identified by ICAR-CIFRI, Kolkata (TABLE A2). These locations have been assessed along with existing CPCB monitoring stations and major barrages along the Ganga main stem through spatial/GIS assessment to identify suitable monitoring locations, hotspot areas and potential monitoring gaps.

Table A1: Hotspot Identified from CIPET, Bhubaneswar for Ganga River Main stem

S.no	Site	District / City	Latitude	Longitude	Population*	Major industries	Approx. no. of industries	Major pollution sources
1	Jajmau	Kanpur	26.478584	80.35992	Kanpur Urban Agglomeration: 4.3 million; Jajmau: 0.7 million	Leather tanning and finishing, leather chemicals, footwear components, chrome recovery units, glue and gelatine units	340–420 registered tanneries (government reports vary by year); 350 included to the 20 MLD CETP in recent UP	Chromium-rich tannery effluent, sulphides, chlorides, high BOD/COD wastewater, municipal sewage, solid tannery waste
2	Tannery Town	Kanpur	26.440372	80.398465	4.3 millions	Leather processing, leather finishing, export-oriented tanneries, hide processing	Approximately 350 operational tanning units within the Jajmau industrial belt	Untreated/pre-treated tannery wastewater, chromium dyes, organic matter, suspended solids
3	Rani Ghat	Kanpur	25.322507	83.029983		No major industries immediately adjacent; influenced by upstream	—	Municipal sewage, storm-water drains, domestic solid waste, runoff from densely

						industrial discharge		populated urban areas
4	Triveni Sangam	Prayagraj	25.431671	81.886427	2.3 million	Printing, food processing, engineering, fertilizer, small-scale manufacturing	Several hundred MSMEs; pollution is dominated by municipal sources rather than heavy industry	Municipal sewage, religious offerings, festival waste, tourism-related solid waste, runoff
5	Assi Ghat (Varanasi)	Varanasi	25.280089	83.006588		Silk weaving, handicrafts, tourism, hospitality	Thousands of small silk weaving and handicraft units across the city	Municipal sewage, religious offerings, cremation residues, tourism-generated waste
6	Dashashwamedh Ghat (Varanasi)	Varanasi	25.306099	83.010155	3.9 million	Tourism, hotels, retail, religious economy	—	Municipal sewage, floral offerings, plastic waste, ritual activity, boating

7	Sheetala Ghat (Varanasi)	Varanasi	25.317526	83.019941		Tourism, hospitality, local commerce	—	Domestic wastewater, ritual waste, floating litter, urban runoff
8	Buxar	Buxar District	25.593009	83.983862	226,632	Rice mills, flour mills, edible oil mills, brick kilns, agro- processing, small engineering workshops	>250 MSMEs	Municipal sewage, agricultural runoff, oil mill effluent, domestic solid waste
9	Mahendru Ghat (Patna)	Patna	25.622639	85.154614		Food processing, rice mills, edible oil, pharmaceutical s packaging, construction materials, transport hubs	>8,000 registered MSMEs across Patna district	Municipal sewage, domestic wastewater, religious offerings, floating plastic waste, storm- water drains
10	Barh / Doriganj	Patna / Saran	25.728912	84.833148	1.68 million	NTPC Barh Super Thermal Power Station (3 × 660 MW operational units), construction materials,	One major thermal power plant plus hundreds of ancillary industries and MSMEs	Thermal power plant discharge, fly ash handling, municipal sewage, agricultural

						fertilizer storage, agro-processing		runoff, river transport
11	Munger	Munger	25.367052	86.46486	824,990	Indian Railways Jamalpur Railway Workshop, tobacco processing, food processing, dairy, steel fabrication, engineering workshops, agricultural processing	>1,000 MSMEs plus one of India's oldest railway engineering workshops	Municipal sewage, industrial wastewater, railway workshop effluent, domestic waste
12	Vikramshila Gangetic Dolphin Sanctuary	Bhagalpur	25.269856	87.02604	343,369	Limited industries within sanctuary; surrounding areas include silk weaving, fisheries, agriculture, food processing	Small-scale industries outside protected zone	Agricultural runoff, domestic sewage, fishing activities, boat traffic, upstream industrial inputs

13	Farakka Barrage	Murshidabad	24.807565	87.939899	Murshidabad District: 8.79 million	NTPC Farakka Super Thermal Power Station (2,100 MW), Farakka Barrage Project, Inland Waterways Authority facilities, stone crushing, transport, small engineering	One of India's largest thermal power stations + numerous ancillary industries	Thermal power plant discharge, fly ash, municipal sewage, river engineering activities, upstream sediment and pollutant transport
14	Nabadwip	Nadia	23.416678	88.449046	District: 5.8 million	Handloom and textile weaving, terracotta products, printing, tourism, religious economy, food processing	Thousands of cottage industries and MSMEs	Municipal sewage, pilgrimage waste, floral offerings, domestic wastewater, plastic litter
15	Barrackpore	North 24 Parganas	22.765988	88.342287	District: 11.34 million	Jute mills (Titagarh, Kankinara), jaggery, paper mills, textile units, chemicals, engineering	Hundreds of medium and large industries across the Barrackpore Industrial Belt	Industrial effluent, municipal sewage, plastic waste, river-water runoff, storm-water transport

						industries, railway workshops		
16	Babughat (Kolkata)	Kolkata	22.5671	88.340286	Kolkata Metropolitan Area: 22.45 million	Kolkata Port, shipping, engineering, chemicals, food processing, leather, pharmaceutical s, logistics, tourism	More than 10,000 registered industries within Kolkata Metropolitan Area	Municipal sewage, port activities, ferry transport, tourism, religious offerings, plastic waste, urban runoff
17	Diamond Harbour	South 24 Parganas	22.18711	88.189189	District: 9.8 million	Fishing industry, fish processing, cold storage, river transport, tourism, agriculture	Hundreds of fisheries and allied enterprises	Estuarine pollution, shipping activities, fishing operations, municipal sewage, agricultural runoff, tidal transport of floating debris

Table A2: Proposed Monitoring Station by ICAR-CIFRI, Kolkata

S.No.	Name	Latitude	Longitude
1	Ballia	25.7556	84.1439
2	Patna	25.6152	85.1383
3	Tehri	30.3831	78.4416
4	Balagarh	23.1191	88.4647
5	Barrackpore	22.7773	88.3357
6	Farakka	24.7794	87.9177
7	Buxar	25.6007	83.9777
8	Varanasi	25.3176	82.9739
9	Bhagalpur	25.3478	86.9824
10	Narora	28.1968	78.3814
11	Kanpur	26.6587	80.2706
12	Farrukhabad	27.4626	79.7125
13	Haridwar	29.9778	78.1861
14	Ghazipur	25.5233	83.2907
15	Prayagraj	25.4144	81.9113
16	Bijnor	29.3877	78.0465
17	Mirzapur	25.1856	82.5598
18	Malda	25.010841	88.141095
19	Chunar	25.113942	82.860331

Based on the above assessment, 12 monitoring stations have been identified along the main stem of the River Ganga (Figure A). These locations provide representative spatial coverage and may serve as the initial macroplastic monitoring network for Ganga main stem.

The three-monitoring methods community-based monitoring (fishermen), artificial barrier-based monitoring and boat-towing net sampling may be employed at the identified stations, depending on site-specific conditions, accessibility, river flow, availability of fishing activity, presence of suitable barriers/barrages and feasibility of conducting the respective method.

The remaining CIPET-identified hotspots and other suitable locations not covered in the initial network may be considered for inclusion at a later stage, based on monitoring results, identified gaps and field requirements.

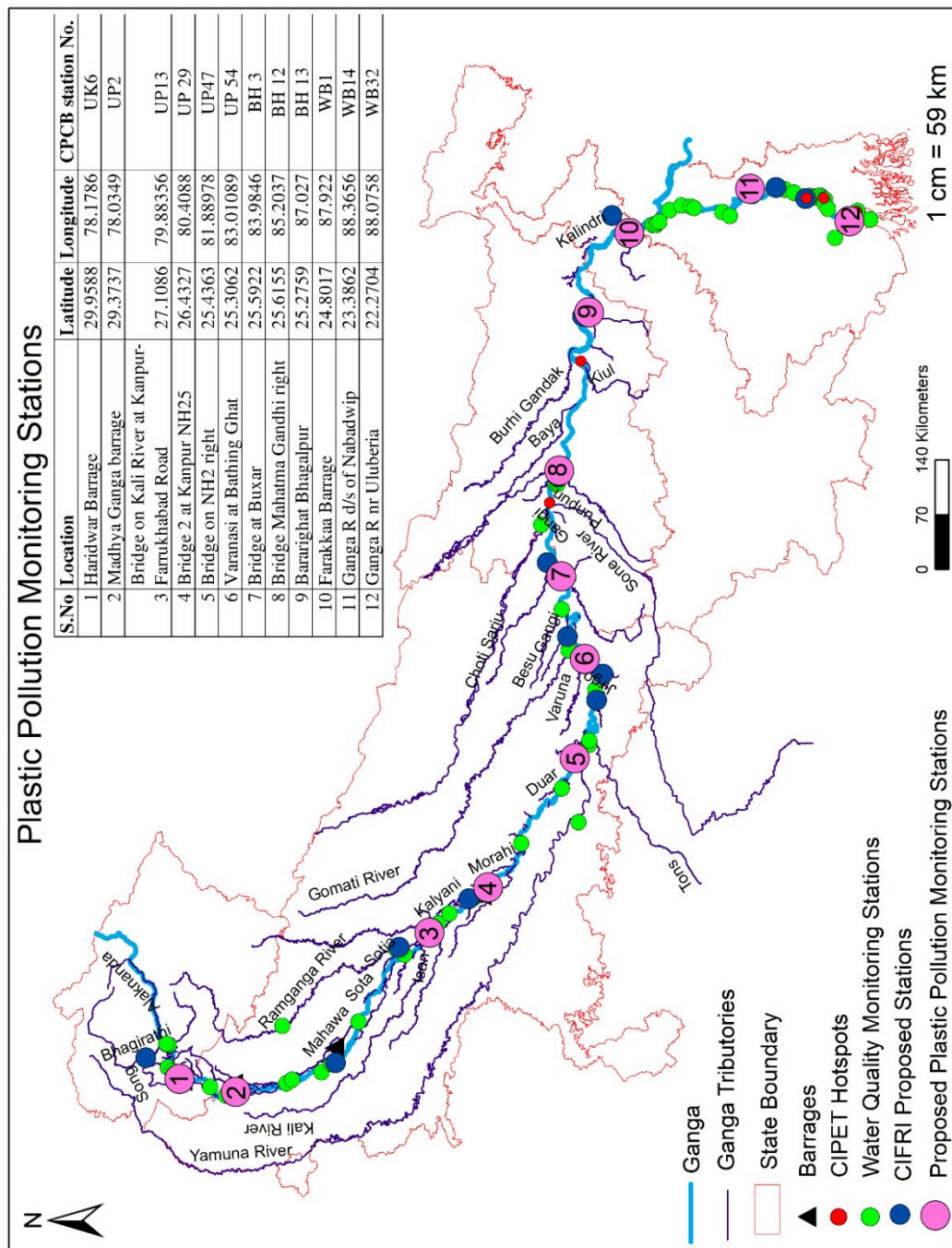


Figure A: Macroplastic Monitoring Network along the Main Stem of the Ganga River

