Ganga River Basin Management Plan - 2015

Mission 2: Nirmal Dhara

January 2015

by

Consortium of 7 "Indian Institute of Technology"s (IITs)

IIT Bombay

IIT Delhi

IIT Guwahati

IIT Kanpur

IIT Kharagpur

IIT Madras

IIT Roorkee

In Collaboration with

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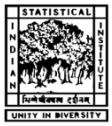

ISI Kolkata

Allahabad University

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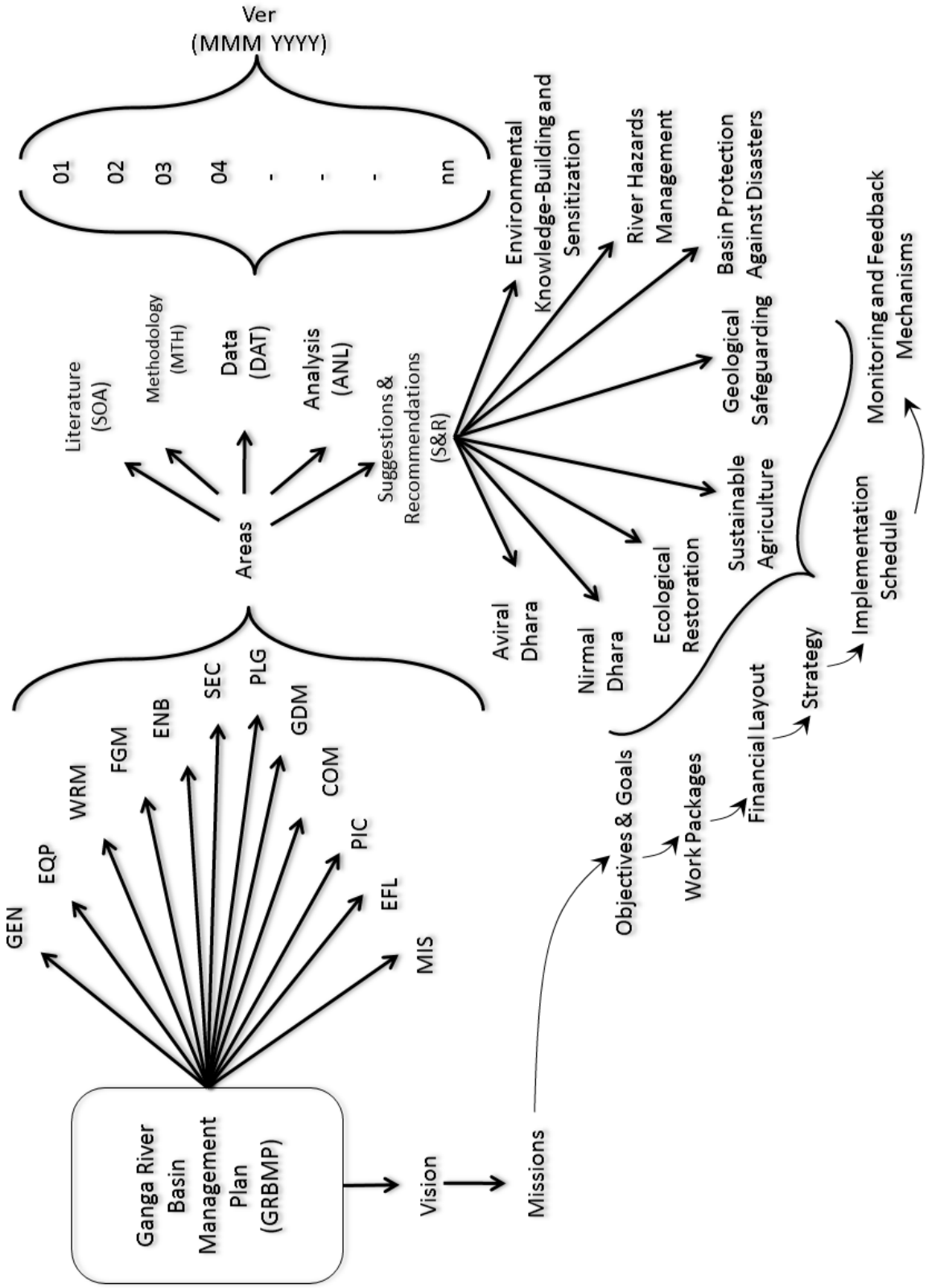
GRBMP Work Structure



Preface

In exercise of the powers conferred by sub-sections (1) and (3) of Section 3 of the Environment (Protection) Act, 1986 (29 of 1986), the Central Government constituted the National Ganga River Basin Authority (NGRBA) as a planning, financing, monitoring and coordinating authority for strengthening the collective efforts of the Central and State Government for effective abatement of pollution and conservation of River Ganga. One of the important functions of the NGRBA is to prepare and implement a Ganga River Basin Management Plan (GRBMP). A Consortium of seven "Indian Institute of Technology"s (IITs) was given the responsibility of preparing the GRBMP by the Ministry of Environment and Forests (MoEF), GOI, New Delhi. A Memorandum of Agreement (MoA) was therefore signed between the 7 IITs (IITs Bombay, Delhi, Guwahati, Kanpur, Kharagpur, Madras and Roorkee) and MoEF for this purpose on July 6, 2010.

The GRBMP is presented as a 3-tier set of documents. The three tiers comprise of: (i) Thematic Reports (TRs) providing inputs for different Missions, (ii) Mission Reports (MRs) documenting the requirements and actions for specific missions, and (iii) the Main Plan Document (MPD) synthesizing background information with the main conclusions and recommendations emanating from the Thematic and Mission Reports. It is hoped that this modular structure will make the Plan easier to comprehend and implement in a systematic manner.

There are two aspects to the development of GRBMP that deserve special mention. Firstly, the GRBMP is based mostly on secondary information obtained from governmental and other sources rather than on primary data collected by IIT Consortium. Likewise, most ideas and concepts used are not original but based on literature and other sources. Thus, on the whole, the GRBMP and its reports are an attempt to dig into the world's collective wisdom and distil relevant truths about the complex problem of Ganga River Basin Management and solutions thereof.

Secondly, many dedicated people spent hours discussing major concerns, issues and solutions to the problems addressed in GRBMP. Their dedication led to the preparation of a comprehensive GRBMP that hopes to articulate the

outcome of the dialog in a meaningful way. Thus, directly or indirectly, many people contributed significantly to the preparation of GRBMP. The GRBMP therefore truly is an outcome of collective effort that reflects the cooperation of many, particularly those who are members of the IIT Team and of the associate organizations as well as many government departments and individuals.

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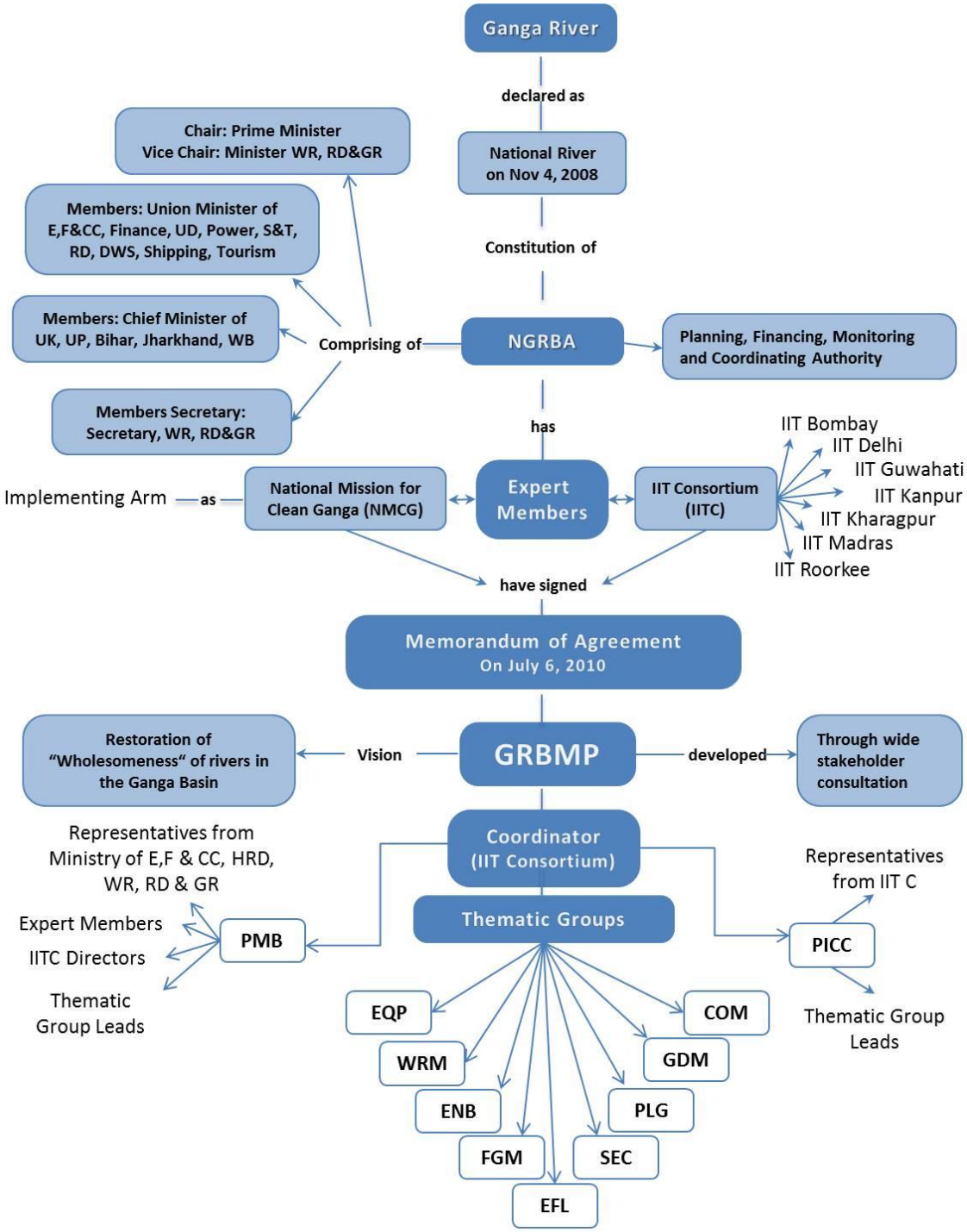
Organizational Structure for Preparing GRBMP



NGRBA: National Ganga River Basin Authority
NMCG: National Mission for Clean Ganga
MoEF: Ministry of Environment and Forests
MHRD: Ministry of Human Resource and Development
MoWR, RD&GR: Ministry of Water Resources, River Development and Ganga Rejuvenation
GRBMP: Ganga River Basin Management Plan
IITC: IIT Consortium
PMB: Project Management Board
PICC: Project Implementation and Coordination Committee

EQP: Environmental Quality and Pollution
WRM: Water Resource and Management
ENB: Ecology and Biodiversity
FGM: Fluvial Geomorphology
EFL: Environmental Flows
SEC: Socio Economic and Cultural
PLG: Policy Law and Governance
GDM: Geospatial Database Management
COM: Communication

Project Management Board [PMB]

Expert Members:

- Sri Swami Avimukteshwaranand Saraswati
- Sri Madhav Chitale
- Dr Bharat Jhunjhunwala

Project Implementation and Coordination Committee [PICC]

Representatives from IIT Consortium:

- Dr Shyam Asolekar, IIT Bombay
- Dr A K Mittal, IIT Delhi
- Dr Mohammad Jawed, IIT Guwahati
- Dr Vinod Tare, IIT Kanpur
- Dr D J Sen, IIT Kharagpur
- Dr Ligy Philip, IIT Madras
- Dr I M Mishra, IIT Roorkee

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- Dr Purnendu Bose, Environmental Quality and Pollution (EQP)
- Dr A K Gosain, Water Resource Management (WRM)
- Dr R P Mathur, Ecology and Biodiversity (ENB)
- Dr Rajiv Sinha, Fluvial Geomorphology (FGM)
- Dr Vinod Tare, Environmental Flows (EFL)
- Dr S P Singh, Socio Economic and Cultural (SEC)
- Dr N C Narayanan and Dr Indrajit Dube, Policy Law and Governance (PLG)
- Dr Harish Karnick, Geospatial Database Management (GDM)
- Dr T V Prabhakar, Communication (COM)

Composition of Thematic Groups

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2. Water Resource Management (WRM)

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3. Fluvial Geomorphology (FGM)

Lead: Rajiv Sinha, IIT Kanpur

Members: Vinod Tare (IIT Kanpur); Vikrant Jain (IIT Gandhi Nagar); J K Pati (Allahabad University); Kirteshwar Prasad, Ramesh Shukla (Patna University); Parthasarthi Ghosh, Soumendra Nath Sarkar, Tapan Chakarborty (ISI Kolkata); KalyanRudra (WBPCB); S K Tandon, Shashank Shekhar (University of Delhi); Saumitra Mukherjee (JNU Delhi)

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Members: A K Thakur, Vinod Tare (IIT Kanpur); Utpal Bora (IIT Guwahati); M D Behera (IIT Kharagpur); Naveen Navania, Partha Roy, PruthiVikas, R P Singh, Ramasre Prasad, Ranjana Pathania (IIT Roorkee); Sandeep Behera (WWF-India)

5. Socio Economic and Cultural (SEC)

Lead: S P Singh, IIT Roorkee

Members: Pushpa L Trivedi (IIT Bombay); Seema Sharma, V B Upadhyay (IIT Delhi); P M Prasad, Vinod Tare (IIT Kanpur); Bhagirath Behera, N C Nayak, Pulak Mishra, T N Mazumder (IIT Kharagpur); C Kumar, D K Nauriyal, Rajat Agrawal, Vinay Sharma (IIT Roorkee)

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Members: Shyam Asolekar, Subodh Wagle (IIT Bombay); Mukesh Khare (IIT Delhi); Vinod Tare (IIT Kanpur); Deepa Dube, Uday Shankar (IIT Kharagpur); G N Kathpalia, ParitoshTyagi (IDC, New Delhi)

7. Geo-Spatial Database Management (GDM)

Lead: Harish Karnick, IIT Kanpur

Members: N L Sharda, Smriti Sengupta (IIT Bombay); A K Gosain (IIT Delhi); Arnab Bhattacharya, Kritika Venkatramani, Rajiv Sinha, T V Prabhakar, Vinod Tare (IIT Kanpur)

8. Communication (COM)

Lead: T V Prabhakar, IIT Kanpur

Members: Purnendu Bose, Rajiv Sinha, Vinod Tare (IIT Kanpur)

9. Environmental Flows (EFL)

Lead: Vinod Tare, IIT Kanpur

Members: Shyam Asolekar (IIT Bombay); A K Gosain (IIT Delhi); P M Prasad, R P Mathur, Rajiv Sinha, Shivam Tripathi (IIT Kanpur); M D Behara (IIT Kharagpur); B S Murthy, N Balaji (IIT Madras); Pranab Mohaparta, Vikrant Jain (IIT Gandhinagar); S K Jain (NIH Roorkee); Nitin Kaushal (WWF-India, New Delhi); Sandeep Behera (NMCG, MoWR, RD & GR, New Delhi); A P Sharma K D Joshi (CIFRI, Barrackpore); Ravindra Kumar (SWaRA-UP); Ravi Chopra (PSI, Dehradoon); Paritosh Tyagi, (IDC, New Delhi)

Abbreviations and Acronyms

1.	CGWB	:	Central Ground Water Board.
2.	CWC	:	Central Water Commission.
3.	DBFO	:	Design-Build-Finance-Operate.
4.	E-Flows	:	Environmental Flows.
5.	IITC	:	IIT Consortium.
6.	FAO	:	Food and Agricultural Organization.
7.	GRBMP	:	Ganga River Basin Management Plan.
8.	MND	:	Mission Nirmal Dhara.
9.	MoEF	:	Ministry of Environment and Forests.
10.	MoEFCC	:	Ministry of Environment, Forests & Climate Change
11.	MoWR	:	Ministry of Water Resources.
12.	MoWRRDGR	:	Ministry of Water Resources, River Development & Ganga Rejuvenation
13.	NGO	:	Non-Governmental Organization.
14.	NGRBA	:	National Ganga River Basin Authority.
15.	NIH	:	National Institute of Hydrology (India).
16.	NMCG	:	National Mission for Clean Ganga.
17.	NRGB	:	National River Ganga Basin.
18.	NRGBMC	:	National River Ganga Basin Management Commission.
19.	PPP	:	Public-Private Partnership.
20.	SRI	:	System of Rice Intensification.
21.	UNEP	:	United Nations Environment Programme.
22.	URMP	:	Urban River Management Plan.

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Summary

The Ganga River System consists of all rivers in the NRGB, including the main stem of river Ganga and all its tributaries/distributaries. The health of the Ganga River System is an important indicator of the overall condition of NRGB. The water quality of Ganga River System has been significantly impacted by disposal of wastes from anthropogenic sources into the rivers. This includes solid and liquid wastes of both hazardous and non-hazardous types from domestic, industrial and agricultural sources.

The objective of Mission Nirmal Dhara (MND) is to ensure that the flow in the Ganga River System is bereft of manmade pollution; hence the river water quality should not be affected by human activities.

Anthropogenic pollutant ingress into the Ganga River System is from both point and non-point (i.e., distributed) sources. The liquid and solid waste disposed into the Ganga River System from Class I, Class II, Class III towns, villages and various industries in the NRGB are the point sources of pollution. In addition, accumulation of garbage and the widespread practice of open defection results in the general accumulation of filth on the NRGB landmass. This waste is entrained in the surface runoff during rainy season and becomes a source for non-point pollution in the NRGB. The agricultural sector is also a major source for non-point pollution in NRGB. Fertilizers and pesticides applied on agricultural fields are leached into irrigation return flows or storm runoffs.

The MND provides a plan to gradually minimize the ingress of pollutants into the Ganga river system. This will require prohibiting and restricting certain activities in the NRGB. The prohibited activities include; discharge of sewage (either treated or untreated) from Class I towns; discharge of industrial effluents (either treated or untreated) from any large, medium or cluster of small industries; direct injection of sewage and industrial effluents (either treated or untreated) into the subsurface; disposal of un-burnt and partially burnt corpses and animal carcasses in rivers; open defecation and dumping of municipal/industrial solid wastes or sludge in any river or its active flood plain;

and construction of new residential, commercial or industrial structures in river flood plains. The restricted activities include; discharge of sewage (either treated or untreated) from Class II and smaller towns and villages; disposal of sewage or industrial sludge except in secure landfills/hazardous waste sites; discharge of industrial effluents (either treated or untreated) from small scale industry; disposal and/or discharge of mining and construction debris in any river or its floodplains; river bed farming and agricultural activities in the active flood plain; ritual immersion of idols; and floral and other offerings in rivers, washing of clothes, vehicles, etc., in rivers, and usage of chemical fertilizers and agrochemicals in the farming sector.

Enforcement of the above admonishments will require major improvements in the solid and liquid waste management practices prevalent in domestic/commercial, industrial and agriculture sectors in NRGB. This may be achieved by promoting certain activities in NRGB. The recommendations regarding activities to be promoted are grouped under the following categories: (A) Management of Solid and Liquid Wastes Generated from Domestic/Commercial Sources; (B) River-frame Development, Floodplain Management and Rejuvenation of Water Bodies; (C) Management of Solid and Liquid Waste Generated from Industrial Sources; and (D) Management of Polluted Agricultural Runoff. Actions consistent with the above recommendations should be undertaken in the NRGB to achieve the objectives of MND. These actions should be undertaken in a de-centralized phase-wise manner through the implementation of numerous projects.

Effective co-ordination of these activities is envisaged through a high-level constitutional body tentatively named the 'National River Ganga Basin Management Commission' (NRGBMC). Until the NRGBM Bill is considered by the appropriate legislature bodies and NRGBMC is formed, the role of NRGBMC may be carried out by the National Mission for Clean Ganga (NMGC), an executive arm of the National Ganga River Basin Authority (NGRBA) presently attached to the Ministry of Water Resources, River Development and Ganga Rejuvenation.

Project planning should begin with preparation of detailed Urban River Management Plans (URMPs) for Class I towns, and subsequently also for Class II and Class III towns. The URMPs should be followed by preparation of DPRs, following which funds should be allocated for project implementation. Fund allocation should be prioritized for projects designed to prevent direct discharge of large quantities of liquid waste into the River System (Priority Level I), followed by projects designed to prevent direct discharge of large quantities of solid waste into the River System (Priority Level II), followed by projects concerning river-frame development and restoration of floodplain in urban areas along the Ganga River System (Priority Level III). All funds budgeted by the central/state/local governments for Ganga Rejuvenation over the next 15 years must be only used for above types of projects.

Projects related to MND may be conceived by the central, state, local governments, NGOs and other private organizations/industries. Financing of these projects may be through funds budgeted by central/state governments for Ganga Rejuvenation, local revenue, corporate and private donations and grants, low cost debt from multinational organizations, commercial debts from banks and private equity. Wherever possible, project implementation including operation and maintenance should be contracted to 'service providers', i.e., public/private agencies with relevant expertise. Payments must be released to the 'service provider' only after monitoring by an independent third-party.

1. Introduction

Indian civilization grew up under the care of River Ganga, nourished by her bounties for thousands of years. The Ganga river – along with her many tributaries and distributaries – provided material, spiritual and cultural sustenance to millions of people who lived in her basin or partook of her beneficence from time to time. To the traditional Indian mind, therefore, River Ganga is not only the holiest of rivers and savior of mortal beings; she is also a living Goddess. Very aptly is she personified in Indian consciousness as "MOTHER GANGA". This psychic pre-eminence of River Ganga in the Indian ethos testifies to her centrality in Indian civilization and her supreme importance in Indian life.

The Ganga river basin is the largest river basin of India that covers a diverse landscape, reflecting the cultural and geographical diversity of the India. It is also a fertile and relatively water-rich alluvial basin that hosts about 43% of India's population [*MoWR, 2014*]. It is fitting, therefore, that the Indian government declared River Ganga as India's **National River** in the year 2008. But the declaration was none too early. River Ganga had been degrading rapidly for a long time, and national concern about her state had already become serious in the twentieth century. It was against this backdrop that the Ministry of Environment and Forests (Govt. of India) assigned the task of preparing a Ganga River Basin Management Plan (GRBMP) to restore and preserve National River Ganga to a "Consortium of Seven IITs". The outcome of this effort – the GRBMP – evolved an eight-pronged action plan, with each prong envisaged to be taken up for execution in mission mode.

A river basin is the area of land from which the river provides the only exit route for surface water flows. For understanding its dynamics, a basin may be viewed as a closely-connected hydrological-ecological system. Hydrological connections include groundwater flow, surface runoff, local evapotranspiration-precipitation cycles and areal flooding, while ecological links are many and varied (such as the food web and transport by biological agents). These linkages provide for extensive material transfer and communication between the river and her basin, which constitute the

functional unity of a river basin. Directly and indirectly, therefore, National River Ganga (along with her tributaries and distributaries), is a definitive indication of the health of the basin as a whole. Hence, GRBMP adopted the Ganga River Network as the primary environmental indicator of the National River Ganga Basin (NRGB).

River basin management needs to ensure that a basin's natural resources (biotic and abiotic) are adequately preserved over time. The main abiotic (or physical) resources of a river basin are *soil* and *water*, along with a multitude of minerals and compounds bound up with them. Now, water is a highly variable resource. Barring variations from year to year, the water in a basin follows an annual cycle of replenishment (primarily through atmospheric precipitation and groundwater inflows) and losses (primarily through river and groundwater outflows, evaporation, transpiration, and biological consumption). In contrast to water, formation of mature soils – from the weathering of parent material (rocks) to chemical decomposition and transformation – is a drawn-out process that may take hundreds or thousands of years [*Jenny, 1994; Wikipedia, 2014*]; but, once formed, soils can be fairly durable. Thus, changes in a basin's water resource status tend to be relatively faster and easily detected, while those of soils are slow and often go unnoticed for long periods. However, soil and water are affected by each other through many biotic and abiotic processes. Being thus interrelated, degradation of either soil or water has a concurrent effect on the other; hence neither can be considered in isolation.

It is not only soil and water that are mutually interactive, living organisms also interact with them and help shape the basin's environment. The biotic resources of a basin consist of plants, animals and micro-organisms. Since biota evolve over time to achieve a stable balance in a given environmental setting, the biotic resources of a river basin depend on its constituent ecosystems – rivers, wetlands, forests, grasslands, etc. However, with significant human activity in many ecosystems (as, for example, in agro-ecosystems and urban ecosystems), the complexity of human-technology-environment systems has increased manifold [*Pahl-Wostl, 2006*]. Nonetheless, GRBMP attempts to incorporate interactive natural resource dynamics and human-technology-environment considerations in the Basin Plan. For, with human activities multiplying and diversifying in the basin, the resulting environmental

consequences have also been pronounced in recent times. In sum, GRBMP focuses on the basin's overall resource environment and the major factors affecting it (especially diverse anthropogenic activities), and seeks ways and means to protect the basin and its resources against identifiable adverse impacts. For, only thus can we secure the environmental foundation of NRGB for the good of one and all.

2. Objective

The objective of Mission "Nirmal Dhara" (MND) is to ensure that the flow in the Ganga River System is bereft of manmade pollution; hence the river water quality should not be affected by human activities.

3. Importance of Nirmal Dhara for Ganga River Basin Management

Ganga river's water quality had been acclaimed in ancient times. Its life-giving and healing qualities are evident from the following description in Rajanirghanta (~300 AD) meaning *"The qualities of Ganga water are: Coolness, sweetness, transparency, high tonic property, wholesomeness, potability, ability to remove evils, ability to resuscitate from swoon caused by dehydration, digestive property and ability to retain wisdom"*:

अस्या जलस्य गुणाः शीतत्वम्, स्वादुत्वम, स्वछत्वम, अत्यन्तरुच्यत्वम्, पथ्तत्वम्, पावनत्वम्, पापहारित्वम्, तृष्णामोहध्वंसत्वम्, दीपनत्वम्, प्रज्ञाधारित्वंच, इति राजनिर्घण्टः

The properties of Ganga river's waters of earlier times quoted above are remarkable, to say the least. But, at present, the river water quality is abysmal, posing a grave threat to life in the region.

The change in water quality may have been occurring over many centuries. Ancient scriptures had cautioned against misusing the Ganga river. For instance, the following edict in Sanskrit prohibited thirteen types of human actions: (1) defecation, (2) gargling, (3) throwing of used floral offerings, (4) rubbing of filth, (5)flowing bodies (human or animal), (6)frolicking; (7) acceptance of donations; (8) obscenity; (9) considering other shrines to be

superior,(10) praising other shrines, (11) discarding garments; (12) bathing, and (13) making noise.

गंगां पुण्यजलां प्राप्य त्रयोदश विवर्जयेत्। शौचमाचमनं सेकं निर्माल्यं मलघर्षणम्।
गात्रसंवाहनं क्रीड़ां प्रतिग्रहमथोरतिम्। अन्यतीर्थरतिंचैवः अन्यतीर्थ प्रशंसनम्।
वस्त्रत्यागमथाघातं सन्तारंच विशेषतः॥

It is possible that such strictures got diluted over time. But, the environmental significance of many of these precautions is obvious to the modern mind. And, what is equally significant, they convey a sense of deep respect for National River Ganga.

The vision statement of GRBMP affirms the restoration of '*Nirmal*' dhara (unpolluted flow) in River Ganga and her tributaries as one of the goals of GRBMP. Measures to be implemented to achieve this objective have been specified in the present document describing the Mission 'Nirmal' Dhara (MND).

The necessary condition for restoration of 'Nirmal Dhara' in River Ganga and her tributaries, i.e., the Ganga river system, is the prevention of the ingress of pollutants into the rivers. It was realized that pollutant ingress into the Ganga River system cannot be controlled unless certain solid and liquid waste management and other practices in the NGRB were modified. This realization was the origin of the basin-wide approach for the formulation of MND.

4. Ganga River System: Sources of Pollutants

Various types for waste generation in NRGB have been identified in Figure 1. Two broad types of wastes generated in the NGRB, whose improper disposal adversely impact water quality of the Ganga system are, 1) solid wastes and 2) liquid wastes.

Solid waste can be broadly classified as, 1) non-hazardous and 2) hazardous. Non-hazardous solid waste is generated mostly from domestic, commercial

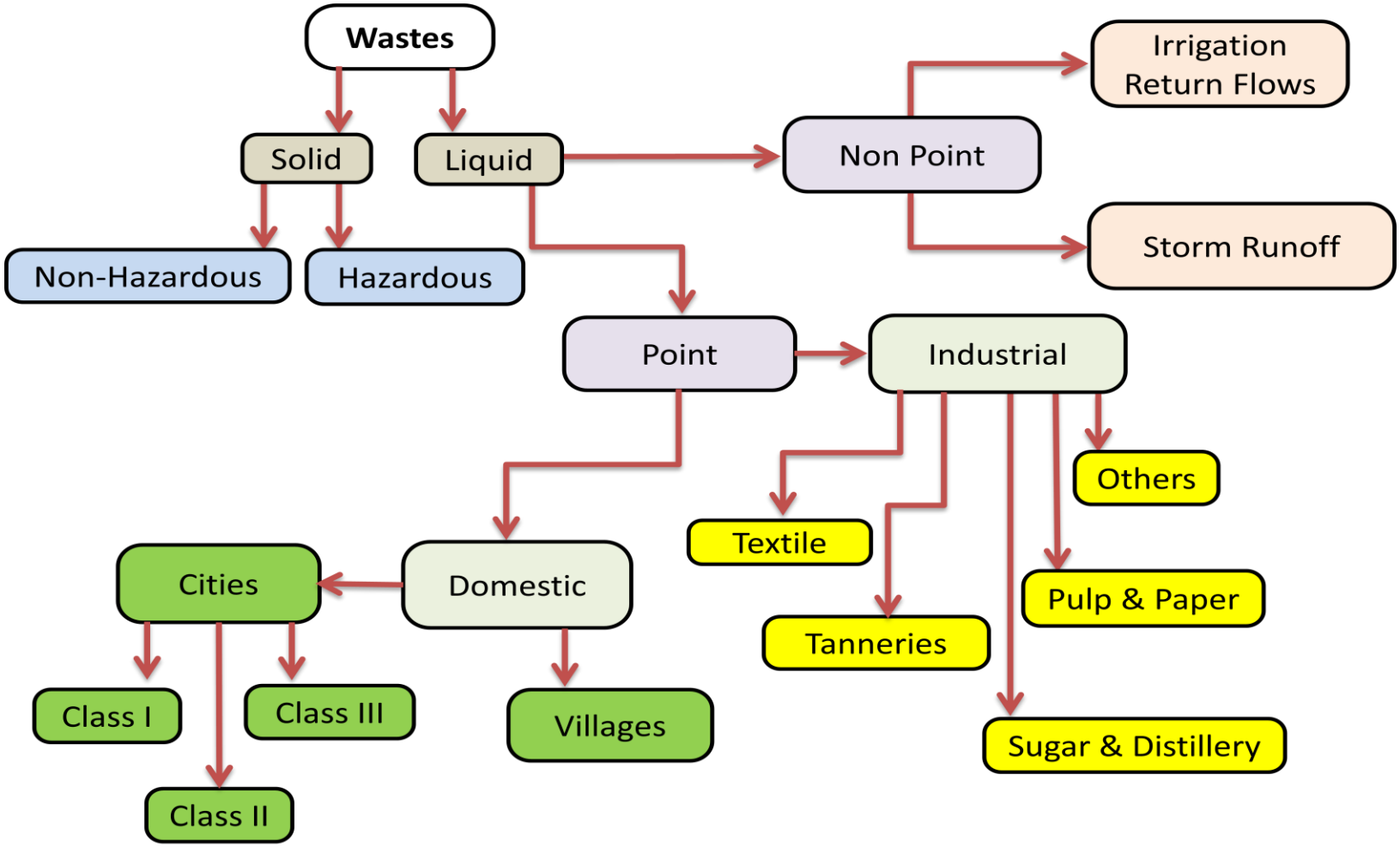


Figure 1: Various Types of Waste Generated in Ganga River Basin

and agricultural sources. Industrial activity may result in the generation of both non-hazardous and hazardous solid waste.

Liquid waste is produced when pollutants are intentionally dissolved or suspended in water for transport away from their point of generation. Such point sources of liquid waste generation are attributable to domestic, commercial and industrial activities. Thus all Class I, Class II, Class III towns and villages in the NRGB are point sources for liquid waste. Inaddition, the industries in NRGB including, sugar and distillery, pulp and paper, tannery, textiles and others are also major point sources of liquid waste.

Liquid waste is also generated from non-point (i.e., distributed) sources. The accumulation of garbage and the widespread practice of open defection results in the general accumulation of filth in the NRGB landmass. This is entrained in the surface runoff during rainy season and becomes a source for non-point pollution in the NRGB. The agricultural sector is also a major source for non-point pollution in NRGB. Fertilizers and pesticides applied on agricultural fields are leached into irrigation return flows or storm runoffs.

5. Ganga River System: Pollutant Ingress

Pollutant ingress into the Ganga river system occurs in three ways, 1) by direct discharge of pollutants, 2) discharge of polluted surface runoff into rivers, and 3) seepage of polluted subsurface flows into rivers.

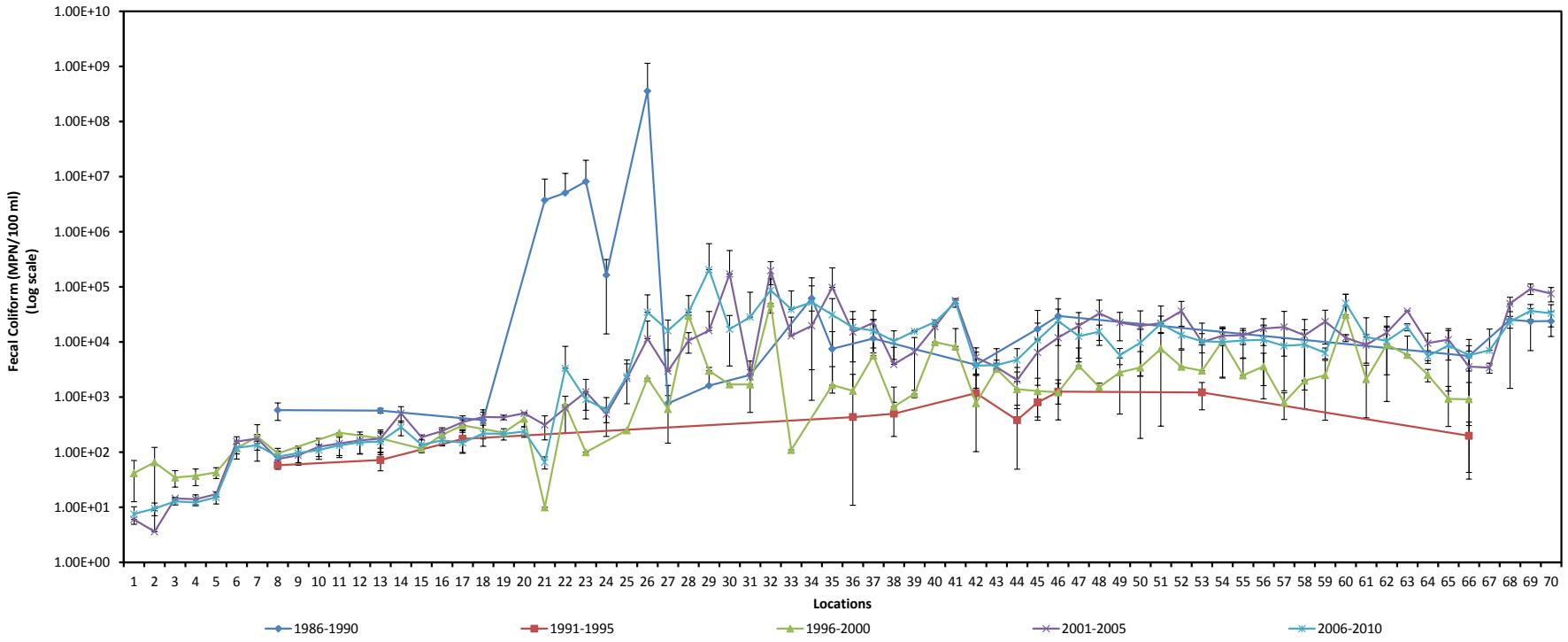
Direct discharge of pollutants into rivers occur due to, i) discharge of liquid wastes generated from point sources into rivers, ii) dumping of municipal and industrial solid waste, devotional offerings, animal carcasses, un-burned/partially burned human bodies, etc. into rivers, and iii) non-ritual bathing with the intention of cleaning body dirt, direct defecation, washing of clothes, washing of vehicles, washing/wallowing of animals, etc.

The origin of polluted non-point surface discharge into the Ganga river system are twofold, i) surface runoff containing leached fertilizers and pesticides applied on agricultural fields and ii) surface runoff containing entrained solid waste, i.e., garbage, industrial waste, human and animal feces, etc.

Some portion of the liquid waste generated from both point and non-point sources described above infiltrates into the subsurface and pollute the groundwater. Seepage of this polluted ground water also results in pollution of the Ganga river system.

6. Ganga River System: Pollution Status

Examination of Ganga water quality data indicates that at Dev Prayag (confluence of rivers Bhagirathi and Alaknanda) and further downstream, the fecal coliform numbers in Ganga River are on an average, 100 times more than the levels acceptable for bathing (Figure 2). Downstream of large cities like Kanpur, the fecal coliform numbers are 1000 times or more than acceptable levels. Fecal coliforms are bacteria normally found in human feces. Discharge of, i) untreated/partially treated domestic sewage into the river, and ii) storm runoff contaminated with human feces is mainly responsible for the high fecal coliform numbers observed.



1	Uttarkashi u/s (Bhagirathi)	15	Bijnore u/s (Ganga)	29	D/s Deehaghat	43	Hajipur u/s (River Gandak)	57	Sultanganj d/s
2	Uttarkashi d/s (Bhagirathi)	16	Bijnore d/s (Ganga)	30	Vindhyachal, PakkaGhat	44	Hajipur d/s (River Gandak)	58	Bhagalpur u/s
3	Devprayag u/s (Bhagirathi)	17	Garhmukteshwar u/s	31	Varanasi u/s	45	Patna u/s	59	Bhagalpur d/s
4	Devprayag u/s (Alaknanda)	18	Garhmukteshwar d/s	32	DashashawmedhGhat	46	Patna d/s	60	D/s Champanala
5	Devprayag d/s (Ganga)	19	Anoopshahr u/s (Ganga)	33	D/s at Kaithy	47	Fatuha u/s	61	Kahalgaon u/s
6	Ranipur u/s (Ganga)	20	Anoopshahr d/s (Ganga)	34	Near Malviya Bridge	48	Fatuha d/s	62	Kahalgaon d/s
7	Ranipur d/s (Ganga)	21	Fatehgarh u/s	35	Tarighat	49	Barh u/s	63	D/s NTPC Drain
8	Rishikesh u/s	22	Kannauj u/s (a/c with Ramganga & b/c with Kali)	36	Buxar u/s	50	Barh d/s	64	Sahebganj u/s
9	Rishikesh d/s	23	Kannauj d/s (a/c with Kali)	37	Buxar d/s	51	Mokama u/s	65	Sahebganj d/s
10	Haridwar u/s	24	Kanpur u/s (Bithoor)	38	Chapra u/s (Ghaghra)	52	Mokama d/s	66	Rajmahal d/s
11	Har-ki-Paudi	25	Kanpur d/s (Shuklaganj)	39	Chapra d/s (Chapra)	53	D/s Bata - McDowell	67	Berhampore (Middle)
12	Lalta Rao	26	Kanpur d/s (Jane Village)	40	Arrah u/s (River Gangi)	54	Munger u/s	68	Palta (Middle)
13	Dam Kothi	27	Allahbad u/s (Ujahni, Fatehpur)	41	Arrah d/s (River Gangi)	55	Munger d/s	69	Dakshineswar (Middle)
14	Mishrpur	28	Bathing Ghats at Sangam	42	Koliwar (River Sone)	56	Sultanganj u/s	70	Uluberia (Middle)

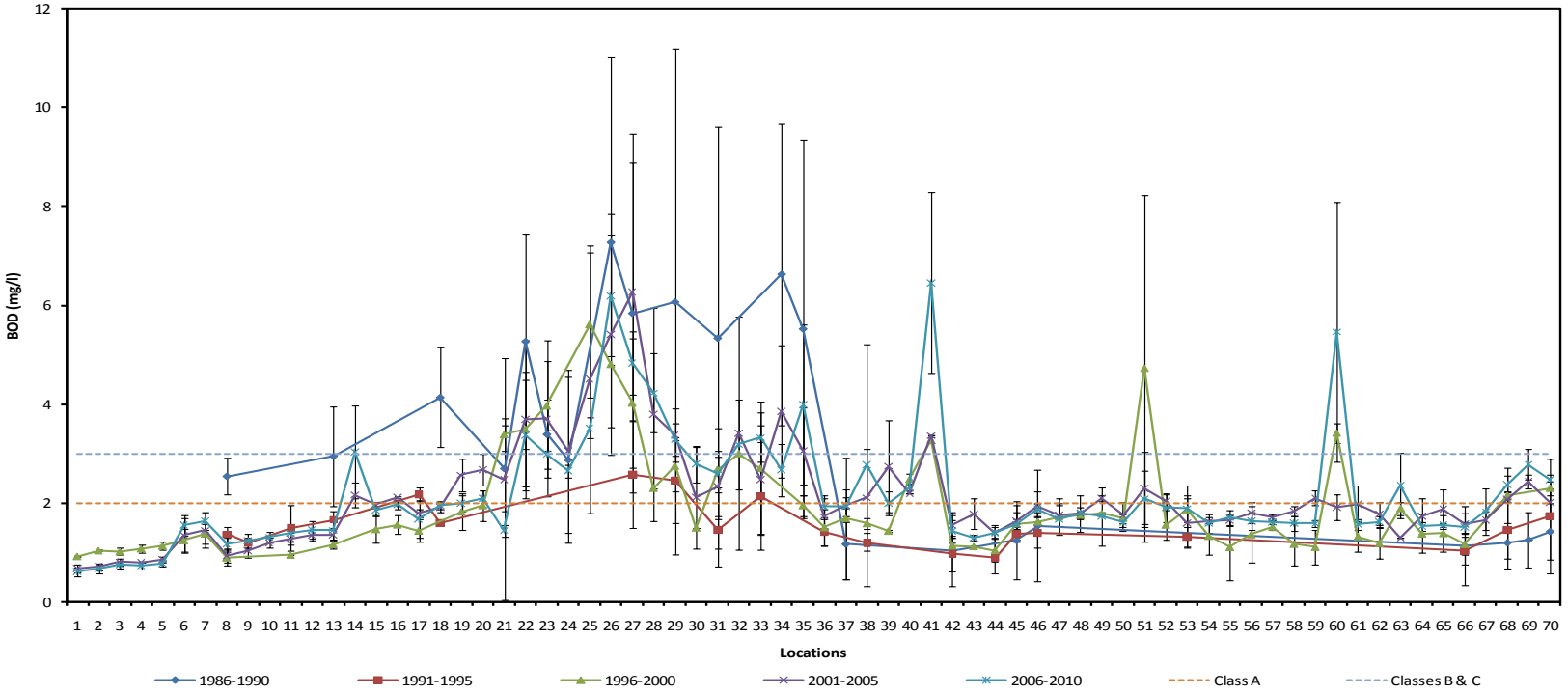
Figure 2: Variation in 5-year average Fecal Coliform at Various Locations along the Ganga River

The organic loading, as indicated by the Biochemical Oxygen Demand (BOD) is also high in some places of the Ganga river system (Figure 3). High BOD levels may result in low dissolved oxygen (DO) concentrations in water, which is injurious to the aquatic life in the rivers. The source of such pollution is mainly the point discharges of untreated/partially treated domestic sewage and industrial effluents into the rivers.

The nutrient, i.e., nitrogen and phosphorus loading are also high in some places in the middle and lower reaches of the Ganga river system. High nutrient loading leads eutrophication of the river, i.e., excessive growth of algae and aquatic plants, leading to the choking of the river. A glaring example of this can be seen at upstream of Okhla Barrage on river Yamuna in Delhi. The high nutrient loading is attributable to, i) point discharges of untreated/partially treated sewage and industrial effluents and ii) non-point loading of fertilizer, fecal and solid waste residues through surface runoff and seepage of groundwater. A ballpark estimation of pollutant load contributed through sewage generation in Class I and Class II towns (assuming that all sewage gets collected) in various NRGB states and NRGB Sub Basins is presented in Thematic Reports prepared by Consortium of 7 IITs [IITC, 2014a-k].

The issues of inorganic salt loading into the Ganga river system is mainly due to discharge of industrial effluents. Such loading is particularly high near tannery clusters in the Kanpur region. The data regarding loading of other pollutants i.e., pesticides and heavy metals into the Ganga river system is scanty [IITC, 2011b]. However, preliminary estimates indicate that concentration of pesticides and heavy metals in Ganga river system is low in most locations [IITC, 2011b].

Finally, it is estimated that approximately 70 percent of the volumetric pollution load on the Ganga river system is from domestic/commercial sources, i.e., from human urine/feces and solid waste. Major polluting industries along river Ganga are pulp and paper, sugar and distillery, tannery, textiles, etc. together with agricultural pollution contribute the remaining 30 percent pollution load to the river.



1	Uttarkashi u/s (Bhagirathi)	15	Bijnore u/s (Ganga)	29	D/s Deehaghat	43	Hajipur u/s (River Gandak)	57	Sultanganj d/s
2	Uttarkashi d/s (Bhagirathi)	16	Bijnore d/s (Ganga)	30	Vindhyachal, PakkaGhat	44	Hajipur d/s (River Gandak)	58	Bhagalpur u/s
3	Devprayag u/s (Bhagirathi)	17	Garhmukteshwar u/s	31	Varanasi u/s	45	Patna u/s	59	Bhagalpur d/s
4	Devprayag u/s (Alaknanda)	18	Garhmukteshwar d/s	32	DashashawmedhGhat	46	Patna d/s	60	D/s Champanala
5	Devprayag d/s (Ganga)	19	Anoopshahr u/s (Ganga)	33	D/s at Kaithy	47	Fatuha u/s	61	Kahalgaon u/s
6	Ranipur u/s (Ganga)	20	Anoopshahr d/s (Ganga)	34	Near Malviya Bridge	48	Fatuha d/s	62	Kahalgaon d/s
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9	Rishikesh d/s	23	Kannauj d/s (a/c with Kali)	37	Buxar d/s	51	Mokama u/s	65	Sahebganj d/s
10	Haridwar u/s	24	Kanpur u/s (Bithoor)	38	Chapra u/s (Ghaghra)	52	Mokama d/s	66	Rajmahal d/s
11	Har-ki-Paudi	25	Kanpur d/s (Shuklaganj)	39	Chapra d/s (Chapra)	53	D/s Bata - McDowell	67	Berhampore (Middle)
12	Lalta Rao	26	Kanpur d/s (Jane Village)	40	Arrah u/s (River Gangi)	54	Munger u/s	68	Palta (Middle)
13	Dam Kothi	27	Allahbad u/s (Ujahni, Fatehpur)	41	Arrah d/s (River Gangi)	55	Munger d/s	69	Dakshineswar (Middle)
14	Mishrpur	28	Bathing Ghats at Sangam	42	Koliwar (River Sone)	56	Sultangan/s	70	Uluberia (Middle)

Figure 3: Variation in 5-year Average BOD_5 at Various Locations along the Ganga River

7. Mission 'Nirmal' Dhara: Broad Plan of Action

The MND provides a plan to gradually minimize the ingress of pollutants into the Ganga river system. This is to be achieved using a simultaneous two-pronged approach, i) by prohibiting/restricting certain activities in the NRGB, and ii) by promoting certain activities in NRGB through implementation of numerous projects.

To achieve the objectives of MND, certain activities must be prohibited in the NRGB as soon as possible. The list of prohibited activities in the NRGB include,

1) discharge of sewage (either treated or untreated) from Class I towns, either directly or indirectly, into any river;
2) discharge of industrial effluents (either treated or untreated) from any large, medium or cluster of small industries, either directly or indirectly, into any river;
3) direct injection of sewage and industrial effluents (either treated or untreated) into the subsurface;
4) disposal of un-burnt and partially burnt corpses and animal carcasses in any river or riverbank;
5) open defecation and dumping of municipal/industrial solid wastes or sludge in any river or its active flood plain;
6) Construction of new permanent structures in river flood plains for residential, commercial and industrial purposes, but excluding bridges and associated roads, jettys/ghats and hydraulic structures for storage/diversion/control/chanelisation of river waters.

Further, certain activities must be gradually restricted, i.e., permitted only with adequate safeguards or even prohibited in future. The list of restricted activities in NRGB include,

1) discharge of sewage (either treated or untreated) from Class II town and smaller towns and villages, either directly or indirectly, into any river;

2) disposal of sludge derived through treatment of sewage and industrial effluents except in secure landfills/hazardous waste sites;
3) discharge of industrial effluents (either treated or untreated) from small scale industry into any river;
4) disposal and/or discharge of mining and construction debris in any river's flood plain, river bank or the river itself;
5) river bed farming and agricultural activities in the active flood plain of any river;
6) ritual immersion of idols, and floral and other offerings in any river;
7) wallowing of domestic animals, washing of clothes, vehicles, etc., in any river;
8) widespread use of chemical fertilizers and pesticides in agriculture, horticulture, aquaculture, animal husbandry, forestry, etc. in NRGB.

8. MND: Implementation Strategy

Enforcement of the admonishments regarding prohibited and restricted activities stated above will require major improvements in the solid and liquid waste management practices prevalent in domestic/commercial, industrial and agricultural sectors in NRGB. Simultaneously, river-frame development, restoration of natural drains ('nala') / other surface water bodies and management of river flood plains need to be carried out in a coordinated manner. This can be achieved by promoting certain broad activities in NRGB. The specific activities to be promoted for implementation of MND have been grouped under four categories as follows.

8.1 Category A: Management of Solid and Liquid Waste Generated from Domestic/Commercial Sources

Broad recommendations for management of wastes generated from domestic/commercial sources from Class I, II and III cities and villages are the following,

1) All new colonies/townships and large multi-storied complexes must adopt a zero-liquid discharge policy, wherein domestic sewage

generated within the complex must be treated and recycled/reused within the complex itself.

2) Domestic sewage generated from all other sources should be collected and transported in closed conduits for treatment followed by reuse/recycle.

3) In cases where reuse/recycle is not possible, the treated sewage must be used for rejuvenation of surface water bodies and/or for irrigation.

4) Toilets must be provided in villages and in slums in urban areas, such that open defecation is eliminated. The waste/sewage generated from such toilets must be collected and treated in an acceptable manner.

5) Solid waste, sludge and septage generated in Class I, II, III towns and villages should be collected and either recycled or disposed in a scientifically acceptable manner.

6) Arrangements must be made for stoppage of practices like open defecation, disposal of un-burnt/half-burned human remains and animal carcasses in river banks/floodplains or into the rivers.

7) Adequate arrangements must be made for activities such as disposal and/or discharge of mining and construction debris in river flood plain, river bank or the river itself and ritual immersion of idols, floral and other offerings, wallowing of domestic animals, washing of clothes, vehicles, etc., in river banks/floodplains or in the rivers.

8.2 Category B: River-frame Development, Floodplain Management and Rejuvenation of Water Bodies

Broad recommendations for river-frame development, floodplain management and rejuvenation of water bodies are the following,

1) River-frame in urban centers should be cleared of encroachments and developed to encourage pilgrimage, commercial/recreational activities and tourism.

2) Ingress of domestic sewage into natural drains, canals, ponds, etc. in urban areas should be prevented and these water bodies must be

restored for improvement of urban drainage and for promotion of recreational/commercial activities.

3) Slum clusters and other encroachments should be removed from river flood plains at all places. Wherever possible, river flood plains may be used for the development of ecological parks, surface water recharge structures, etc.

4) Agricultural activity in the river floodplains and riverbeds must be properly managed.

8.3 Category C: Management of Solid and Liquid Waste Generated from Industrial Sources

Broad recommendations for management of wastes generated from industrial sources are the following,

1) All large industries in the NRGB, i.e., tannery, sugar and distillery, pulp and paper and textiles, etc. should adopt a zero liquid discharge (ZLD) policy with recycle/reuse of treated effluent.

2) Combined Effluent Treatment Plants (CETPs) to be set up for industrial clusters/estates based on ZLD principles.

3) Arrangements made for stoppage of the discharge of industrial effluent into municipal sewers.

4) Suitable infrastructure to be provided for conveyance of effluent from dispersed small-scale industries to CETPs or for efficient management of ETPs. A cluster of ETPs could be managed by a single Service Provider.

5) All solid waste generated from industries to be disposed as per scientifically accepted norms/principles.

8.4 Category D: Management of Polluted Agricultural Runoff

Broad recommendations for management of polluted agricultural runoff are the following,

1) Introduction of organic farming for agricultural activities in the active flood plain and river bed.

2) Increased use of organic fertilizers and pesticides in agriculture, horticulture, aquaculture, animal husbandry, forestry, etc. in NRGB;

Actions consistent with the above recommendations should be undertaken in the NRGB to achieve the objectives of MND. These actions should be undertaken in a de-centralized phase-wise manner through the implementation of numerous projects.

9. Coordination: National River Ganga Basin Management Commission (NRGBMC)

Coordinating the activities concerning all missions of GRBMP (including MND) is a complex task that requires dedicated and specialized expertise. It is proposed that the central government enacts legislation in parliament to constitute a constitutional body tentatively named the 'National River Ganga Basin Management Commission' (NRGBMC). NRGBMC is envisaged as a non-executive body which shall act as the 'voice' of River Ganga and thus will be the custodian of NRGB and responsible for implementation of GRBMP (including MND). A draft "National River Ganga Basin Management Bill" has been prepared as a part of GRBMP.

NRGBMC shall ensure coordination between various ministries/departments of the central, state and local governments as required for the efficient implementation of MND. Specifically, it shall have the responsibility for, i) overall monitoring of the implementation of various projects related to MND, ii) providing project management and technical advice to public/ private organizations entrusted with the responsibility of executing projects related to MND, and, iii) acting as an interface for facilitating the participation by non-governmental organizations (NGOs) and others in the implementation and monitoring of various projects related to MND. In addition it is envisaged that the NRGBMC shall have quasi-judicial powers for ensuring that the admonishments in the MND report regarding prohibited/restricted activities in the NRGBB are enforced.

Projects related to MND may be conceived by the central, state, local governments, NGOs and other private organizations/industries. The detailed project proposals (DPRs) vetted by NRGBMC for technical soundness and

overall relevance to the objectives of MND will be termed “MND Projects” and will receive due consideration for funding under Ganga rejuvenation programmes (e.g. Namami Gange).

Until the NRGBM Bill is considered by the appropriate legislative bodies and NRGBMC is formed, the role of NRGBMC may be carried out by the National Mission for Clean Ganga (NMGC), an executive arm of the National Ganga River Basin Authority (NGRBA) presently attached to the Ministry of Water Resources, River Development and Ganga Rejuvenation.

10. Project Planning: Urban River Management Plan (URMP)

As a prelude to conception and implementation of MND projects, all Class I towns of the NRGB must compulsorily prepare Urban River Management Plans (URMP). The URMPs should have all relevant data regarding the water availability, sewage generation, solid-waste disposal, sanitation conditions, drainage conditions, etc. prevalent in the town. Further details on URMP are available elsewhere [IITC, 2010a]. Additionally, the URMPs should also provide a complete analysis regarding measures which need to be implemented in a town as per the recommendations of MND. These measures must be listed in the form of work packages, which can later be developed as detailed project reports (DPRs) for implementation as MND projects. Central and state funding should be made available to all Class I towns in the NRGB for reimbursement of the cost for preparing URMPs. URMPs should be prepared by professional organizations with the cooperation of urban local bodies (ULBs).

For a start, URMPs for some towns, selected on the basis of geographical, topographical, socio-cultural and industrial distinctiveness, should be prepared most urgently. Towns like Uttarkashi, Shrinagar, Rishikesh, Haridwar (all in Uttarakhand), Garhmukteshwar, Mathura, Vrindawan, Agra, Moradabad, Lucknow, Kanpur, Allahabad, Varanasi (all in Uttar Pradesh), Indore, Ujjain, Dewas (all part of most polluted Kshipra Sub-Basin of NRGB in Madhya Pradesh), Patna, Bhagalpur (both in Bihar), Kolkata and Delhi NCR, are most suitable for preparing the initial URMPs. It is also highly desirable that the

Consortium of 7 IITs (IITC) actively engages with the concerned Central, State and Local agencies in selecting a panel of professional organizations for preparing URMPs and subsequently guides the process of URMP preparation for the abovementioned towns. This will ensure that the IITC vision on the implementation of MND will get transferred in a proper manner to the ground level. Using the above URMPs as templates, the process of preparing URMPs for all other towns in NRGB can be continued and completed as soon as possible.

11. Project Planning: Other Cases

It is desirable that in addition to Class I towns, URMPs should gradually be prepared for all Class II and Class III towns of the NRGB and government funds must be available for this purpose. Further, all industries and industry clusters in NRGB should individually come up with comprehensive plans for management of industrial effluent and solid waste generated within their premises as per MND recommendations. Implementation of MND recommendations in rural areas will mainly be through projects concerning i) provisioning of toilets, ii) septage and solid waste management, iii) provisioning of low cost sewage conveyance systems, and 4) provisioning of natural biological systems for sewage treatment.

12. MND Projects: DPR Preparation and Implementation

Data available in URMPs and other sources should be used to prepare the DPRs for various projects. In order to receive due consideration under the Ganga rejuvenation program as 'MND projects', the DPRs need to be of high quality and vetted by NRGBMC for technical soundness and overall relevance to the objectives of MND. The skilled manpower required for preparation of high quality DPRs for 'MND projects' may not be readily available at all levels. Hence it is recommended that these responsibilities should be, wherever possible, contracted to 'service providers', i.e., reputed public or private sector entities with relevant expertise. It is proposed that Ganga rejuvenation funds

may be set aside for preparation of such DPRs by expert agencies in deserving cases.

Project implementation will start after approval of DPRs by NGRBMC and arrangement of funds. Wherever possible, project implementation including operation/maintenance should be contracted to 'service providers', i.e., public/private agencies with relevant expertise. However, the primary responsibility for contract administration, and release of payments to the 'service providers' must remain with the project proponent. Payments must be released to the 'service provider' only after monitoring of the progress of the project implementation by an independent third-party. If required, adequate sensitization and training must be provided to the project proponents for adopting this role as project administrators.

Projects concerning recommendations listed in Category A should be conceived by local governments, or by authorities set up for administering new urban developments. Projects concerning recommendations listed in Category B should be mostly conceived by local or state governments. Projects concerning recommendations in category C should be conceived by individual industries/industry clusters/industry associations. Projects concerning recommendations in Category D should be conceived by state governments.

13. Important Projects from MND Perspective

It is important to prioritize projects on which the funds available for implementation of MND are utilized. Projects which are designed to prevent direct discharge of large quantities of liquid waste into the Ganga River System must be given the highest priority (Priority Level I) for implementation. Projects designed to prevent direct discharge of large quantities of solid waste into the Ganga River System are to be given the next level of priority (Priority Level II). Projects concerning river-frame development and restoration of floodplain in the urban areas along the Ganga River System must be next in the priority level (Priority Level III). Ideally, for the next 15 years, all available funds for Ganga rejuvenation must be spent on above types of projects.

13.1 Examples: Projects in Priority Level 1

Projects dealing with management of liquid waste from Class I and Class II towns and large/medium industrial units fall in this category. The MND vision regarding this is as follows, 1) discharge of such wastes into natural drains in Class I and Class II cities must be stopped and the drains must be re-converted into storm water drains, 2) STPs must be renovated/constructed to treat all the sewage generated in Class I and Class II towns to tertiary levels suitable for recycle/reuse, 3) provisions for use of treated sewage for rejuvenation of natural surface water bodies or for irrigation must be made, and 4) all large/medium industrial units must adopt the ZLD concept, wherein the industrial effluent is treated and reused. Basis and justification for this is given elsewhere [IITC, 2010b; IITC, 2011a; IITC, 2011c; IITC, 2012; IITC, 2014m].Typical projects in this class are as follows,

- ***restoration of natural drains in Class I and Class II towns***
  Currently most natural drains ('nalas') carry untreated/partially treated domestic sewage and industrial effluent into the Ganga River System from all Class I and Class II towns in NRGB. This situation must be changed such that these nalas are recovered to drain storm water with minimal or no urban flooding, and during the non-monsoon season remain dry or carry only tertiary treated sewage. Ideally, all such nalas should become habitat for freshwater organisms. It is recommended that projects must be conceived for restoration of such drains. This would involve preventing sewage discharge into such drains by constructing intercepting sewers parallel to the drains. The sewage collected in the intercepting sewers must be diverted to at multiple locations along the drain to existing STPs with spare capacity. Alternatively, decentralized STPs may be constructed in the vicinity of the drains or over the drains. All STPs must treat sewage up to tertiary levels. The treated water from such STPs must be recycled/reused or used for other beneficial purposes. After diversion of sewage, the drains may be cleaned and restored for carrying storm drainage. There should be no discharge from such drains into rivers during dry season. Disposal of solid waste into or along the banks of such drains must be prevented. The restored drains and the area surrounding

such drains may be cleared of encroachments and utilized for recreational/commercial purposes.

- ***sewage treatment in Class I and Class II towns using ZLD system***
  Projects for renovation of existing sewage treatment plants (STPs) in Class I and Class II towns of the NRGB for tertiary level treatment of sewage are welcome. All new treatment plants constructed at sewer outfalls or other places must be designed for tertiary level treatment of sewage. The treated sewage cannot be discharged, either directly or indirectly, into the river. The plan for utilization of the treated sewage must be clearly specified in the project.

- ***reuse/recycling of treated sewage in Class I and Class II towns***
  Considering the goal that no discharge of treated sewage into rivers is allowed in Class I and Class II towns, projects must be conceived for reuse/recycling of tertiary treated sewage in Class I and Class II towns. Such reuse may be either for commercial, industrial or horticultural purposes that generate revenue stream for partially or fully meeting the expenditure on sewage treatment. Makeup water for industrial/commercial applications must invariably be tertiary treated sewage. To achieve this condition, the price of freshwater for such applications must be kept much higher than the cost of recycling industrial/commercial effluents. The objective is to make sewage treatment sustainable without continuous long term support from Central/State Government.
- ***use of treated sewage for restoration/creation of surface water bodies***
  In areas with limited opportunities of reuse of treated sewage projects for use of treated sewage for restoration/creation of surface water bodies is encouraged. Direct injection (i.e. without surface storage and subsequent percolation through soils) of treated sewage/industrial effluents into sub-surface/ground – waters should invariably be not allowed, i.e., is prohibited.
- ***use of treated sewage for irrigation***
  Projects facilitating release of treated sewage into canals (flowing away from rivers) for irrigation purposes are encouraged.

Note on Sewage Management:

All STPs and associated sewage pumping stations in the NGRB should be operated by 'service providers', i.e. public or private agencies with expertise in such activities. It is also desirable that STPs should be funded using innovative financing models such as design-build-finance-operate (DBFO) wherein the 'service provider' makes the initial capital investment in the STP (including VGF, if any) and is paid back in annuities, based on satisfactory operation of the created infrastructure. Further, our vision is that all sewage generated in Class I and Class II towns of NGRB will be treated to tertiary levels as above and reused for various beneficial purposes. It is also envisaged that a business model involving sale of treated sewage may be developed to partially or fully defray the cost of sewage treatment.

- ***sewage management in new/existing colonies, housing societies using ZLD system***

  Projects for onsite sewage management as per the ZLD system in existing/ new housing colonies/apartment complexes and townships are encouraged. However, major share of funding for such projects must be borne by the project proponents. The projects must ensure that there is no discharge of treated sewage outside the premises. To achieve this, the price of freshwater must be kept much higher than the cost of recycling sewage.

Note on Sewage Management in New/Existing Colonies/Townships:

We envisage an accelerated pace of urbanization in NGRB in the next few decades. This should not put additional load on sewage infrastructure in place. It is hence recommended that all large planned urban developments, i.e., townships, housing colonies, large multi-storied apartment complexes, etc. adopt a ZLD policy, wherein all sewage generated in such entities should be treated and reused within the complex itself. Similar policy should be extended to existing colonies also, wherever possible.

- ***zero-liquid discharge (ZLD) systems for large/medium industries, including TDS management***

  Projects for implementation of ZLD systems in large/medium industries and industrial clusters, (including CETPs)are encouraged. The treated effluent from such systems must be reused in the industry itself. The proposed systems must include, if necessary, a comprehensive plan for TDS management. Major share of funding for such projects must be borne by the project proponents. However, concessional loans, etc. may be made available for some projects in a case-by-case basis.

Note on Sewage Management:

All STPs and associated sewage pumping stations in the NGRB should be operated by 'service providers', i.e. public or private agencies with expertise in such activities. It is also desirable that STPs should be funded using innovative financing models such as design-build-finance-operate (DBFO) wherein the 'service provider' makes the initial capital investment in the STP (including VGF, if any) and is paid back in annuities, based on satisfactory operation of the created infrastructure. Further, our vision is that all sewage generated in Class I and Class II towns of NGRB will be treated to tertiary levels as above and reused for various beneficial purposes. It is also envisaged that a business model involving sale of treated sewage may be developed to partially or fully defray the cost of sewage treatment.

Note on Effluent Management in Large/Medium Industries in NGRB:

All large and medium industries/industrial clusters, etc. in the NRGB must adopt a ZLD policy. Industries must form SPVs for implementing this policy. The SPVs must appoint expert 'service providers' for effluent treatment. Effluent treatment plants may be set up by the 'service providers' using DBFO or other financing models. The treated effluent will be sold back to the industries at a contracted price, such that the 'service provider' is adequately compensated.

13.2 Examples: Projects in Priority Level II

Projects dealing with dumping of solid waste and other undesirable activities in river, riverbank and river floodplains in Class I and Class II towns and from large/medium industrial units fall in this category. The MND envisages stoppage/control of the following activities, 1) dumping of solid and industrial waste, 2) disposal of corpses and animal carcasses, 3) open defecation, 4) disposal of mining waste and construction debris, 5) immersion of idols, floral

and other offerings, wallowing of domestic animals, washing of clothes, vehicles, etc., and 6) movement of stray and domesticated animals, e.g., cows, pigs, dogs, etc. Typical projects in this class are as follows,

- ***prevention of disposal of corpses/human remains and animal carcasses in river, riverbank or river floodplain.***
  Projects concerning improvements in cremation facilities, improved disposal of animal carcasses, etc. with an objective of eliminating such practices, will be given due consideration

- ***prevention of open defecation in river, riverbank or river floodplain in Class I and Class II towns.***
  Projects involving construction of public/community toilets and associated public awareness campaign for prevention of open defection, with the objective of eliminating such practices, will be given due consideration.

- **Removal of stray (e.q., dogs) and domesticated animals (e.g., cows, buffaloes, pigs, etc.) from river, riverbank or river floodplain in Class I and Class II towns.**
  Projects involving the development of the infrastructure and systems for capture and relocation of stray animals and relocation of domestic animals will be given due consideration.

- ***prevention of disposal of municipal and industrial solid waste in river, riverbank or river floodplain in Class I and Class II towns.***
  Projects for construction of municipal and hazardous waste landfills or other facilities as an alternative to disposal of such wastes on river banks and floodplains shall be given due consideration.

- ***prevention of disposal of mining and construction debris in river, riverbank or river floodplain.***
  Projects concerning scientific disposal/reuse of construction and mining debris as an alternative to disposal of such wastes on river banks and floodplains shall be given due consideration.

- ***control of activities such as immersion of idols, floral and other offerings, wallowing of domestic animals, washing of clothes, vehicles in Class I and Class II towns.***

  Projects concerning development and implementation of alternative arrangements for immersion of idols, floral and other offerings, wallowing of domestic animals, washing of clothes, vehicles, etc. to be given due consideration.

13.3 Example: Projects in Priority Level III

Projects dealing with comprehensive river-frame restoration and development and river floodplain management in Class I and Class II towns will be given due consideration. MND envisages 1) comprehensive river frame development with due aesthetic considerations, and, 2) restoration of river floodplain in all Class I and Class II towns. Typical projects in this class are as follows,

- ***river-frame restoration and development in Class I and Class II towns***

  Projects concerning comprehensive river-frame restoration and development including removal of encroachments, developments of ghats, walkways, etc., development of pilgrimage and tourist spots, recreational and commercial activities will be considered.

- ***river floodplain restoration in Class I and Class II towns***

  Projects concerning removal of encroachment from river flood plain and development of projects such as ecological parks, water recharge structures, etc. will be considered.

14. Other MND Projects

Implementation of projects in the priority levels IV-VII will reduce the relatively small direct pollution loads and also the diffused pollution load from surface runoff and sub-surface seepage to the Ganga River System. The impact of these projects vis-a-vis the MND objectives is somewhat limited. Hence, implementation of these types of projects has a lower priority vis-à-vis the goals of MND. Funds earmarked for MND should be released for these

projects only when the funding requirements of projects in priority levels I-III have been largely addressed.

14.1 Examples: Projects in Priority Level IV

Projects dealing with management of liquid effluents from small industrial clusters and dispersed small industrial units, and solid waste from all industrial sources in NGRB fall in this category. The MND vision for such industrial units is, 1) liquid effluent generated must be discharged separately, i.e., not allowed to mix with domestic sewage, 2) the collected effluent must be treated in-house or in CETPs as per ZLD norms and recycled in the industries itself, 3) all hazardous and non-hazardous solid waste must be collected and reused/disposed as per norms. Typical projects in this class are as follows,

- ***hazardous and non-hazardous industrial solid waste management***
  Projects concerning collection, transport, disposal and recycle/reuse of industrial solid waste will be given due consideration.

- ***CETPs for small industrial clusters based on ZLD concept***
  Projects concerning CETPs for clusters of small industries or ETP Clusters for small industries in industrial estates/clusters will be given due consideration.

- ***Effluent collection and treatment from dispersed small industries***
  Projects concerning separation of industrial and domestic waste streams in mixed neighborhoods and collection and treatment of industrial effluent in such cases will be considered.

14.2 Examples: Projects in Priority Level V

Implementation of projects of this type will lead to general improvement of sanitation and general cleanliness in Class I and Class II towns and hence are essential from the urban renewal/development perspective. The MND vision for Class I and Class II towns is that, 1) all sewage generated must be collected and transported through closed conduits, 2) open defecation must be completely eliminated, and 3) proper systems for solid waste collection and

management must be developed, and 4) systems for septage collection and management must be developed. Typical projects in this class are as follows,

- ***conventional sewer systems in urban areas in Class I and Class II towns***
  Projects may be formulated for laying sewers in un-sewered areas, renovation of existing sewers, replacement of open drains with sewers, etc. In addition projects concerning construction of trunk sewers, pumping stations, etc. will also be given due consideration.

- ***sewage collection systems in congested urban areas in Class I and Class II towns***
  Projects may be formulated for providing small-bore sewer systems in old congested areas/unauthorized colonies/urban villages, etc. where providing conventional sewer systems may not be possible. Provision of interceptor tanks and septage management must be an integral part of such proposals.

- ***septic tank effluent and septage management in Class I and Class II towns***
  Projects may be formulated for providing small-bore sewers for conveyance of septic tank effluents and septage management, including evacuation, conveyance and treatment.

- ***provision of community/public toilets in urban slums in Class I and Class II towns***
  Projects may be formulated for providing community toilets where many households may not have toilets. Projects may also be formulated for providing public toilets for itinerant or homeless population. Such toilets must be either pour flush or mechanical flush type with complete provision of fecale sludge and/or sewage management.

- ***municipal solid waste collection and disposal in Class I and Class II towns***
  Projects formulated for municipal solid waste collection and disposal, including recycling/reuse and waste to energy projects and other innovative solutions will be given due consideration.

14.3 Projects in Priority Level VI

Implementation of projects of this type will lead to general improvement of sanitation and general cleanliness in Class III towns and rural areas and such projects are desirable for overall sanitation and cleanliness even in smaller human habitations. The MND vision for such cases is that, 1) all sewage generated must be collected and transported through closed conduits, 2) open defecation must be completely eliminated, and 3) proper systems for solid waste collection and management must be developed, and 4) systems for septage collection and management must be developed. Typical projects in this class are as follows,

- ***provision of toilets in Class III towns/rural areas***
  Projects may be formulated for providing toilets in households without toilets, or community toilets in areas where many households may not have toilets. Such toilets must provide a sustainable sanitation solution.

- ***sewage collection in Class III towns/rural areas***
  Projects may be formulated for providing small-bore sewer systems in areas were sewage generation is not sufficient to support a conventional sewage network or in congested areas where laying conventional sewers is impossible. Provision of interceptor tanks and septage management must be an integral part of such proposals.

- ***sewage treatment in Class III towns/rural areas***
  Projects formulated for using natural biological systems/pond systems for sewage treatment may be considered.

- ***solid waste and septage management in Class III towns/rural areas***
  Projects formulated for municipal solid waste collection and disposal, including recycling/reuse and waste to energy projects and other innovative solutions will be given due consideration.

14.4 Projects in Priority Level VII

Implementation of projects of this type will result in the control of pollution from agricultural sources, i.e., reduction in nutrient and pesticide loading to the Ganga River System. However, projects of this type should only be undertaken once pollution ingress into the Ganga River system from domestic/commercial and industrial sources is largely controlled. Typical projects in this class are as follows,

- ***promotion of sustainable riverbank farming***
  Projects promoting organic farming and other sustainable farming practices on dry riverbeds and flood plains will be given due consideration.

- ***promotion of use of bio-fertilizers and bio-pesticides in agriculture, horticulture, aquaculture, forestry, etc.***
  Projects designed to minimize nutrient and pesticide loading from agricultural activities to the rivers will be considered.

15. MND Projects: Financial Structuring, Project Management and Sustainability

Funding patterns for MND projects can vary depending on the type of project and availability of funds from different sources. Funding may come from various sources; Ganga rejuvenation fund budgeted by the central government, funds available with other ministries/departments of central/state governments, local revenue, corporate and private donations and grants, low cost debt from multinational organizations/banks, commercial debts from banks and private equity. Generally for all projects, the project proponents must be willing to bear at least some cost of the project using local resources.

Funds will not only be required for initial capital cost of the infrastructure but also for operation/maintenance and renovation/reinvestment in the created infrastructure. Many projects in related areas have failed in the past because

no enforceable guarantee for operation/maintenance and renovation/reinvestment in the created infrastructure was forthcoming during sanctioning of the project. The present recommendation is that MND projects must be sanctioned only after enforceable commitments are obtained regarding funding availability for both construction and operation/maintenance phases over at least 15 years from the project inception.

Category A Recommendations: For projects dealing with implementation of Category A recommendations concerning liquid and solid waste from domestic/commercial sources, central funds available under Ganga rejuvenation program and low cost debts from multi-national organizations may form a substantial part of the project cost. However, additional funds from state and local governments and a revenue generation model from such projects may also be required. The present recommendation is that such projects must be implemented in the public-private partnership (PPP) mode by specialized 'service providers' who are skilled in designing, building, operating and maintaining the created infrastructure. Various modes of financing such PPP ventures may be explored, including the design-build-finance-operate (DBFO) model, wherein the 'service provider' provides the initial investment (with or without viability-gap funding) and is assured of returns on the investment based on performance appraisal though the construction and operation/maintenance phases of the project.

Category B Recommendations: For projects dealing with implementation of Category B recommendations concerning river-frame development and river floodplain management, the availability of central funds should be limited. Such projects should mostly depend on state and local funds or low cost loans from multi-national organizations. A strong revenue model is desired for river-frame development projects. River-frame development projects must be implemented in the public-private partnership (PPP) mode by specialized 'service providers' who are skilled in designing, building, operating and maintaining the created infrastructure. Investment of private equity in such projects is desirable.

Category C Recommendations: Projects dealing with Category C recommendations concerning liquid and solid waste management in the industrial sector should mostly be funded by industries themselves. However, central funds or low cost loans from multi-national organizations may be available for this purpose to small-scale industries/industrial clusters on a case-by-case basis. Industrial clusters may form special-purpose-vehicles (SPVs) for implementation of such projects. Individual industries/SPVs should employ specialized 'service providers' for designing, building, operating and maintaining the created infrastructure.

Category D Recommendations: Projects dealing with Category D recommendations concerning control of agricultural pollutants should mostly be funded by central and state governments

16. MND: Cost of Implementation

The total cost of providing sanitation facilities, 1) including toilets (if necessary), 2) sewage conveyance in closed conduits, 3) 'nala' restoration works, including the necessary sewage interception and diversion works for protection of natural water bodies, 3) sewage pumping, and 4) sewage treatment to tertiary levels in all urban and human areas of the NGRB have been calculated (see Table 1).Further details are available elsewhere [IITC,2013]. The overall cost for domestic/commercial liquid waste management amounts to Rs. 7.75/person/day (present prices).

Similarly total cost of providing municipal solid waste management facilities, including, 1) cost of collection, 2) cost of transport, 3) cost of restoring existing dumpsites including those along rivers and in floodplains, and 4) cost of solid waste disposal in the NRGB have also been calculated (see Table 2).Further details are available elsewhere [IITC, 2014l]. The overall cost for municipal solid waste management thus amounts to Rs. 1.15/person/day (present prices).

The overall cost of other projects associated with MND, including, 1) reuse/recycle of treated sewage, 2) use of treated sewage for construction/rejuvenation of water bodies, 3) use of treated sewage for

irrigation purposes, 4) river-frame management and restoration, 5) river floodplain management and restoration, 6) industrial liquid and solid waste management, and 7) abatement of agricultural pollution, could not be calculated due to wide site specific variations in the cost of implementation of such projects.

The cost of supply of treated sewage for various beneficial purposes should be between 10 – 50 percent of the cost of sewage treatment. It is envisaged that this cost may be fully or partially recovered from the users, once proper incentive and regulatory structure for this purpose is put into place. The cost of industrial waste management, including reuse/recycle of treated sewage is to be largely borne by the industries themselves with minimal support from central/state governments. Our preliminary studies show that the industries can absorb such costs and in long run this will help in sustained growth of industries through internalizing the environmental costs. Some indications on expenditures for achieving Zero Liquid Discharge (ZLD) for some of the industrial sectors (e.g. Tanneries in Kanpur and Pulp and Paper industries in NRGB) are given elsewhere [IITC, 2011c; IITC, 2014m]. The costs of river-frame and flood plain restoration and management projects are expected to vary widely from project to project. Some support from central government is required for such projects. However, substantial infusion of private equity is desirable in river frame restoration projects. The projects for the abatement of agricultural pollution are of a relatively low priority at the present time.

Table 1: Total Cost* of Providing Sanitation in NRGB

State	Population (millions)	CAPEX Rs. (crore)	CAPEX (annualized) Rs. (crore/yr)	OPEX Rs. (crore/yr)	TOTAL Rs. (crore/yr)
Uttar Pradesh	**200.95**	89278	21372	34908	56280
Himachal P	**6.87**	2966	710	1229	1939
Uttarakhand	**10.16**	4531	1085	1776	2861
Haryana	**25.35**	11843	2835	4442	7277
Delhi	**19.25**	8448	2022	2894	4916
Rajasthan	**68.75**	31508	7543	12263	19806
Bihar	**104.48**	45827	10971	18435	29406

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State	Population (millions)	CAPEX Rs. (crore)	CAPEX (annualized) Rs. (crore/yr)	OPEX Rs. (crore/yr)	TOTAL Rs. (crore/yr)
West Bengal	**92.67**	41391	9909	15935	25844
Jharkhand	**33.28**	15220	3644	5846	9489
Chhattisgarh	**25.66**	11882	2844	4563	7408
Madhya P	**73.64**	33367	7988	12835	20823
Total	**661.06**	**296260**	**70922**	**115125**	**186047**

Note: * Total Cost covers cost for management of all liquid waste generated from domestic and commercial sources in both rural and urban areas. This includes cost of sewage conveyance in closed conduits, sewage pumping and sewage treatment in all types of human settlements including congested/unauthorized colonies, slums and rural areas. It also includes the cost of septage management, conveyance and treatment of septic tank effluent and providing community/public toilets as required; *annualized over 15 year period assuming an interest rate of 10% p.a.

Table 2: Cost Estimates on Solid Waste Management in GRB

State	Population (millions)	CAPEX Rs. (crore)	CAPEX (annualized) Rs. (crore/yr)	OPEX Rs. (crore/yr)	TOTAL Rs. (crore/yr)
Uttar Pradesh	**200.95**	9978	2180	6281	8461
Himachal P	**6.87**	341	74	214	289
Uttarakhand	**10.16**	504	110	317	428
Haryana	**25.35**	1258	275	792	1067
Delhi	**19.25**	956	176	601	778
Rajasthan	**68.75**	3413	746	2148	2894
Bihar	**104.48**	5188	1133	3265	4399
West Bengal	**92.67**	4601	1005	2896	3902
Jharkhand	**33.28**	1652	359	1040	1399
Chhattisgarh	**25.66**	1274	278	802	1080
Madhya P	**73.64**	3657	799	2302	3101
Total	**661.06**	**32826**	**71340**	**20663**	**27802**

Note: Includes cost of collection, conveyance and treatment; *annualized using 12 % interest over 5 years for equipment and machinery and 12 % interest over 20 years period for infrastructure and construction work.

17. MND: Immediate Actions

Ganga rejuvenation works should be phased in a manner such that visible improvements in the condition of some rivers of NRGB are visible within 4 years of the start of implementation of MND. The most polluted portion of the NRGB with associated streams/rivers, towns and industrial sectors are shown in Figure 4. Thus the initial MND projects must be taken up in areas/sectors which exhibit gross pollution.

It is thus proposed that MND projects must immediately be implemented for reducing domestic sewage ingress into Ganga River system in the following towns of NRGB,

- In Kshipra Sub-basin of NRGB as a pilot covering Indore, Ujjain and Dewas towns;
- On Yamuna river: Delhi, Faridabad, Vrindavan, Mathura and Agra;
- On Ramganga river: Moradabad;
- On Gomati river: Lucknow;
- On Ganga river: Haridwar, Garhmukhteshwar, Kanpur, Allahabad and Varanasi;

The steps in the implementation schedule include,

1. Preparation of URMPs for above towns. The required time-period for this activity is 18 months.
2. Preparation of DPRs by expert agencies for Priority Level I projects in these towns using data available in UPMPs and other sources. The required time period for this activity is 4 months.
3. Vetting of the DPRs by competent agencies and arrangement of funds. The required time period for this activity is 3 months.
4. Implementation of DPRs concerning i) 'Nala' restoration, ii) construction of STPs, and iii) reuse/recycle and other beneficial uses of tertiary treated sewage. The required time period for construction phase is 24 – 36 months.

In addition, MND projects must be undertaken immediately for the reduction of gross pollution to the Ganga River system from industrial sources. The

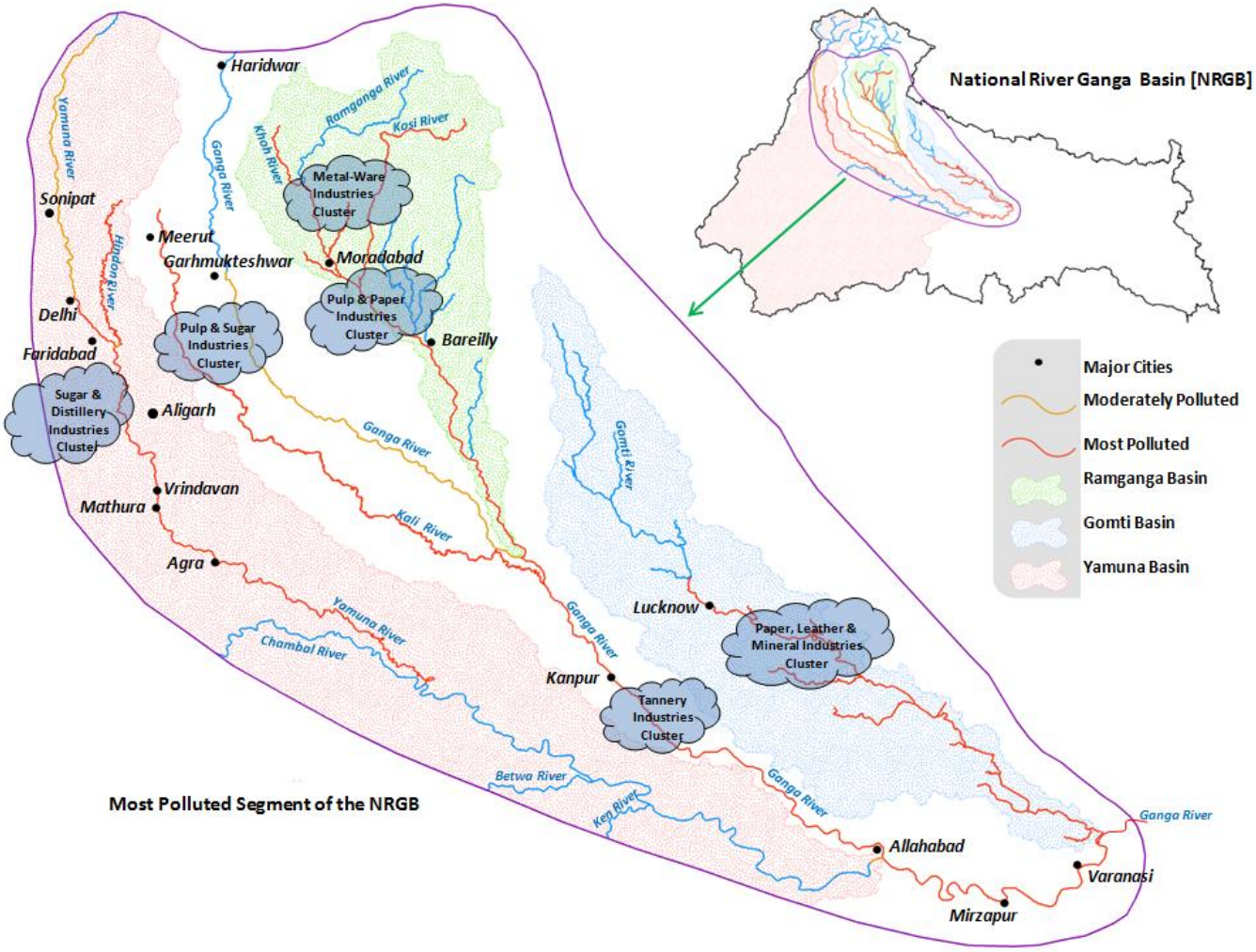

Figure 4: Most Polluted Stretches and their Pollution Sources in NationalRiver Ganga Basin

industries to be targeted for this purpose are the paper and pulp, sugar and distillery, tannery and pharmaceutical industries in Uttarkhand and Uttar Pradesh. Industrial effluent treatment for these industries should be based on ZLD concept (including salt management) and recycle of treated industrial effluent within the industry itself. All above industries (including CETPs associated with such industries) must be required to prepare comprehensive plan for management of industrial effluent and should be required to move towards installation of ZLD system within 24-36 months.

18. MND: Budget Outlay

In addition to the immediate actions above, other projects under Ganga Rejuvenation program should be undertaken as per the recommendations in this report in a phase-wise manner over the next 15 years. This shall constitute the Phase I of MND. The proposed Central Government budget outlay for Ganga Rejuvenation over next 15 years has been suggested with the assumption that all projects associated with recommendations in Priority Levels I-III will be funded within the next 15 years. The proposed budget outlay for specific 'project types' is given in the next few pages.

Project Type: **Restoration of natural drains in Class I and Class II towns of NRGB** **[Priority Level I]**

Activities: Natural drains ('Nalas') carry untreated/partially treated domestic sewage and industrial effluent into the Ganga River System from all Class I and Class II towns in NRGB. It is recommended that projects must be conceived for restoration of such drains. This would involve preventing sewage discharge into such drains by constructing intercepting sewers parallel to the drains. The sewage collected in the intercepting sewers must be diverted to multiple locations along the drain to existing STPs with spare capacity. Alternatively, decentralized STPs may be constructed in the vicinity of the drains or over the drains. Treated sewage cannot be discharged back into the 'nalas'. After diversion of sewage, the 'nalas' may be cleaned and restored for carrying storm drainage. Thus, there should be no discharge from such drains into rivers during dry season. Disposal of solid waste into or around such drains must be prevented. The area surrounding such drains may be cleared of encroachments and utilized for recreational/commercial purposes.

Budget under Ganga Rejuvenation Program:

Values as on date (in Rs. Crore) for the CAPEX and OPEX for restoration of 'nalas' in Class I Towns: 247 towns

Year	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	Total
CAPEX	1080	2160	2160	2160	2160	2160	1080	1080	1080	1080	1080	1080	1080	1080	1080	**21615**
OPEX	0	305	915	1525	2135	2745	3355	3660	3964	4269	4574	4879	5184	5489	5794	**48794**
Total	**1080**	**2465**	**3075**	**3685**	**4295**	**4905**	**4435**	**4740**	**5045**	**5350**	**5655**	**5960**	**6265**	**6570**	**6875**	**70409**

After 15 years, Rs. 6100 crore/yr (value as on date) will be required for operation/maintenance (including renovation) of the created infrastructure

Values as on date (in Rs. Crore) for the CAPEX and OPEX for restoration of 'nalas' in Class II Towns: 139 towns

Year	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	Total
CAPEX	97	194	194	194	194	194	97	97	97	97	97	97	97	97	97	**1940**
OPEX	0	30	91	152	213	274	335	365	395	426	456	487	517	548	578	**4867**
Total	**97**	**225**	**286**	**346**	**407**	**468**	**432**	**462**	**493**	**523**	**553**	**584**	**614**	**645**	**675**	**6810**

After 15 years, Rs. 608 crore/yr (value as on date) will be required for operation/maintenance (including renovation) of the created infrastructure

Source of Funds: 90 % of the project costs (including CAPEX and OPEX over 15 years) will be available from the above budget allocated by central government under the Ganga Rejuvenation program

Project Type: **Tertiary sewage treatment in Class I and Class II towns of NRGB** **[Priority Level I]**

Activities: In addition to STPs associated with 'nala' restoration, projects for construction of new STPs and renovation of existing STPs at sewer outfalls and other locations in Class I and Class II towns of the NRGB are welcome. All STPs(including associated sewage pumping stations and other appurtenances) must be designed for tertiary level treatment of sewage. The treated sewage cannot be discharged, either directly or indirectly, into the river. The plan for utilization of the treated sewage must be clearly specified in the project proposal.

Budget Under Ganga Rejuvenation Program:

Values as on date (in Rs. Crore) for the CAPEX and OPEX for tertiary sewage treatment in Class I Towns: 247 towns																
Year	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**Total**
CAPEX	270	540	540	540	540	540	270	270	270	270	270	270	270	270	270	**5404**
OPEX	0	76	229	381	534	686	839	915	991	1067	1144	1220	1296	1372	1449	**12198**
Total	**270**	**617**	**769**	**922**	**1074**	**1227**	**1109**	**1185**	**1261**	**1338**	**1414**	**1490**	**1566**	**1643**	**1719**	**17602**

After 15 years, Rs. 1525 crore/yr (value as on date) will be required for operation/maintenance (including renovation) of the created infrastructure

Values as on date (in Rs. Crore) for the CAPEX and OPEX for tertiary sewage treatment in Class II Towns: 139 towns																
Year	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**Total**
CAPEX	24	49	49	49	49	49	24	24	24	24	24	24	24	24	24	**486**
OPEX	0	8	23	38	53	68	84	91	99	106	114	122	129	137	144	**1217**
Total	**24**	**56**	**71**	**87**	**102**	**117**	**108**	**116**	**123**	**131**	**138**	**146**	**154**	**161**	**169**	**1702**

After 15 years, Rs. 152 crore/yr (value as on date) will be required for operation/maintenance (including renovation) of the created infrastructure

Source of Funds: 90 % of the project cost (including CAPEX and OPEX) over the first 15 years will be available from the above budget allocated by central government under the Ganga Rejuvenation program

Project Type: **Reuse/recycling of treated sewage in Class I and Class II towns** **[Priority Level I]**

Activities: Considering that no discharge of treated sewage into rivers is allowed from any STP, projects must be conceived for reuse/recycling of tertiary treated sewage in Class I and Class II towns. Such reuse may be either for commercial, industrial or horticultural purposes such that the generated revenue stream can be used for partially or fully meeting the operating expenditure for reuse/recycling schemes and sewage treatment. This would make sewage treatment sustainable without continuous long term support from Central Government.

Budget under Ganga Rejuvenation Program:

Values as on date (in Rs. Crore) for the CAPEX for reuse/recycle of treated sewage in Class I Towns: 247 towns																
Year	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**Total**
CAPEX	100	500	500	500	1000	1000	1000	500	500	500	500	200	200	200	100	**7300**

*OPEX (including renovation cost) to be recovered from the revenue generated from the sale of treated sewage.

Values as on date (in Rs. Crore) for the CAPEX for reuse/recycle of treated sewage in Class II Towns: 139 towns																
Year	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**Total**
CAPEX	10	50	50	50	100	100	100	50	50	50	50	20	20	20	10	**730**

*OPEX (including renovation cost) to be recovered from the revenue generated from the sale of treated sewage.

Source of Funds: 90 % of the project cost (only CAPEX) will be available from the above budget allocated by central government under the Ganga Rejuvenation program. However, funds will be sanctioned only when an enforceable guarantee for the OPEX (including renovation cost) for at least 15 years is available from other sources.

Project Type: **Use of treated sewage for restoration/creation of surface water bodies** **[Priority Level I]**

Activities: In areas with limited requirement of treated sewage for reuse, projects for use of this treated sewage for restoration/creation of surface water bodies in the immediate vicinity is encouraged.

Budget under Ganga Rejuvenation Program:

Values as on data (in Rs. Crore) for the CAPEX for rejuvenation/creation of surface water bodies in Class I Towns: 247 towns																
Year	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**Total**
CAPEX	50	250	250	250	500	500	500	250	250	250	250	100	100	100	50	**3650**

*OPEX (including renovation cost) to be pledged by the state/local government

Values as on date (in Rs. Crore) for the CAPEX for rejuvenation/creation of surface water bodies in Class II Towns: 139 towns																
Year	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**Total**
CAPEX	5	25	25	25	50	50	50	25	25	25	25	10	10	10	5	**365**

*OPEX (including renovation cost) to be pledged by the state/local government

Source of Funds: 90 % of the project cost (only CAPEX) will be available from the above budget allocated by central government under the Ganga Rejuvenation program. However, funds will be sanctioned only when an enforceable guarantee for the OPEX (including renovation cost) for at least 15 years is available.

Project Type: **Use of treated sewage for irrigation** **[Priority Level I]**

Activities: In areas with limited demand for reuse of treated sewage, projects facilitating release of treated sewage into canals (flowing away from river) for irrigation purposes are encouraged.

Budget under Ganga Rejuvenation Program:

Values as on date (in Rs. Crore) for the CAPEX for use of treated sewage for irrigation in Class I Towns: 247 towns

Year	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	Total
CAPEX	30	150	150	150	300	300	300	150	150	150	150	60	60	60	30	**2190**

*OPEX (including renovation cost) to be pledged by the state/local government

Values as on date (in Rs. Crore) for the CAPEX for use of treated sewage for irrigation in Class II Towns: 139 towns

Year	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	Total
CAPEX	3	15	15	15	30	30	30	15	15	15	15	6	6	6	3	**219**

*OPEX (including renovation cost) to be pledged by state/local government

Source of Funds: 90 % of the project cost (only CAPEX) will be available from the above budget allocated under this head by central government under the Ganga Rejuvenation program. However, funds will be sanctioned only when an enforceable guarantee for the OPEX (including renovation cost) for at least 15 years is available.

Project Type: **Sewage management in housing colonies/societies and large multi-stories complexes using ZLD system [Priority Level I]**

Activities: Projects for onsite sewage management as per the ZLD system in existing/new housing colonies/apartment complexes and townships are encouraged. However, major share of funding for such projects must be borne by the project proponents. The projects must ensure that there is no discharge of untreated/treated sewage outside the premises.

Budget under Ganga Rejuvenation Program:

Values as on date (in Rs. Crore) for the CAPEX for installation of ZLD systems in colonies/housing complexes																
Year	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**Total**
CAPEX	3	15	15	15	30	30	30	15	15	15	15	6	6	6	3	**219**

*OPEX (including renovation cost) to be pledged by the project proponents

Source of Funds: In most cases, the entire project cost (including CAPEX and OPEX) to be borne by the project proponents themselves. However, some budget (as above) is available for funding of the CAPEX of demonstration projects for existing colonies/housing projects etc., up to a maximum of 50 % of the CAPEX. However, such funds will be sanctioned only when an enforceable guarantee for the OPEX (including renovation cost) for at least 15 years is available.

Project Type: **Zero Liquid Discharge (ZLD) systems for large/medium industries, including TDS management** **[Priority Level I]**

Activities: Projects for implementation of ZLD systems in large/medium industries and industrial clusters (including in associated CETPs) is encouraged. The treated effluent from such systems must be reused in the industry itself. The proposed systems must include, if necessary, a comprehensive plan for TDS management. Major share of funding for such projects must be borne by the project proponents.

Budget under Ganga Rejuvenation Program:

Values as on date (in Rs. Crore) of the CAPEX for zero-liquid discharge (ZLD) systems for large/medium industries, including TDS management

Year	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	Total
CAPEX	30	150	150	150	300	300	300	150	150	150	150	60	60	60	30	**2190**

*OPEX (including renovation cost) to be pledged by project proponents

Source of Funds: 30 % of the project cost (only CAPEX) may be available from the above budget allocated by central government under the Ganga Rejuvenation program. However, funds will be sanctioned only when an enforceable guarantee for the remaining CAPEX and OPEX (including renovation cost) for at least 15 years is available.

Project Type: **Prevention of disposal of corpses/human remains and animal carcasses in river, riverbank or river floodplain.**
[Priority Level II]

Activities: Projects concerning improvements in cremation facilities, improved disposal of animal carcasses, etc. will be given due consideration

Budget under Ganga Rejuvenation Program:

Values as on date (in Rs. Crore) for the CAPEX and OPEX for projects concerning prevention of disposal of corpses/human remains and animal carcasses in river, riverbank or river floodplain.
in Class I Towns: 247 towns
in Class II Towns: 139 towns

Year	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	Total
CAPEX	55	111	111	111	111	111	55	55	55	55	55	55	55	55	55	**1108**
OPEX	0	17	52	87	122	157	192	209	227	244	262	279	296	314	331	**2789**

After 15 years, Rs. 349 crore/yr (value as on date) must be budgeted for operation/maintenance (including renovation) of the created infrastructure

Source of Funds: 90 % of the CAPEX and 50% of the OPEX (including renovation cost) over 15 years will be available from the above budget allocated by central government under the Ganga Rejuvenation program. However, funds will be sanctioned only when an enforceable guarantee for the balance CAPEX and OPEX for at least 15 years is available.

Project Type: **Prevention of open defecation in river, riverbank or river floodplain in Class I and Class II towns.**

[Priority Level II]

Activities: Projects involving construction and operation/maintenance of public/community toilets and associated public awareness campaign and other actions leading to the prevention of open defection will be given due consideration.

Budget under Ganga Rejuvenation Program:

Values as on date (in Rs. Crore) for the CAPEX and OPEX for projects concerning prevention of open defecation in river, riverbank or river floodplain in Class I and Class II towns.

in Class I Towns: 247 towns
in Class II Towns: 139 towns

Year	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	Total
CAPEX	55	111	111	111	111	111	55	55	55	55	55	55	55	55	55	**1108**
OPEX	0	35	105	174	244	314	384	418	453	488	523	558	593	628	662	**5579**

After 15 years, Rs. 697 crore/yr (value as on date) must be budgeted for operation/maintenance (including renovation) of the created infrastructure

Source of Funds: 90 % of the CAPEX and 50% of the OPEX (including renovation cost) over 15 years will be available from the above budget allocated by central government under the Ganga Rejuvenation program. However, funds will be sanctioned only when an enforceable guarantee for the balance CAPEX and OPEX for at least 15 years is available.

Project Type: **Removal of stray (e.g., dogs) and domesticated animals (cows, buffaloes, pigs, etc.) from river, riverbank or river floodplain in Class I and Class II towns. [Priority Level II]**

Activities: Projects involving the development of the infrastructure and systems for capture and relocation of stray animals and relocation of domestic animals will be given due consideration.

Budget under Ganga Rejuvenation Program:

Value as on date (in Rs. Crore) for the CAPEX and OPEX for projects concerning removal of stray (e.g., dogs) and domesticated animals (cows, buffaloes, pigs, etc.) from river, riverbank or river floodplain in Class I and Class II towns.

in Class I Towns: 247 towns

in Class II Towns: 139 towns

Year	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	Total
CAPEX	28	55	55	55	55	55	28	28	28	28	28	28	28	28	28	**554**
OPEX	0	17	52	87	122	157	192	209	227	244	262	279	296	314	331	**2789**

After 15 years, Rs. 349 crore/yr (value as on date) must be budgeted for operation/maintenance (including renovation) of the created infrastructure

Source of Funds: 90 % of the CAPEX and 50% of the OPEX (including renovation cost) over 15 years will be available from the above budget allocated by central government under the Ganga Rejuvenation program. However, funds will be sanctioned only when an enforceable guarantee for the balance CAPEX and OPEX for at least 15 years is available.

Project Type: **Prevention of disposal of municipal and industrial solid waste in river, riverbank or river floodplain in Class I and Class II towns. [Priority Level II]**

Activities: Projects for construction of municipal and hazardous waste landfills or other facilities as an alternative to disposal of such wastes on river banks and floodplains shall be given due consideration.

Budget under Ganga Rejuvenation Program:

Values as on date (in Rs. Crore) for the CAPEX and OPEX for projects concerning prevention of disposal of municipal and industrial solid waste in river, riverbank or river floodplain in Class I and Class II towns.

in Class I Towns: 247 towns

in Class II Towns: 139 towns

Year	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	Total
CAPEX	55	111	111	111	111	111	55	55	55	55	55	55	55	55	55	**1108**
OPEX	0	52	157	262	366	471	575	628	680	732	785	837	889	941	994	**8368**

After 15 years, Rs. 1046 crore/yr (value as on date) must be budgeted for operation/maintenance (including renovation) of the created infrastructure

Source of Funds: 90 % of the CAPEX and 50% of the OPEX (including renovation cost) over 15 years will be available from the above budget allocated by central government under the Ganga Rejuvenation program. However, funds will be sanctioned only when an enforceable guarantee for the balance CAPEX and OPEX for at least 15 years is available.

Project Type: **Prevention of disposal of mining and construction debris in river, riverbank or river floodplain.**

[Priority Level II]

Activities: Projects concerning scientific disposal/reuse of construction and mining debris as an alternative to disposal of such wastes on river banks and floodplains shall be given due consideration.

Budget under Ganga Rejuvenation Program:

Values as on date (in Rs. Crore) for the CAPEX and OPEX for projects concerning prevention of disposal of mining and construction debris in river, riverbank or river floodplain.

in Class I Towns: 247 towns

in Class II Towns: 139 towns

Year	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	Total
CAPEX	28	55	55	55	55	55	28	28	28	28	28	28	28	28	28	**554**
OPEX	0	17	52	87	122	157	192	209	227	244	262	279	296	314	331	**2789**

After 15 years, Rs. 349 crore/yr (value as on date) must be budgeted for operation/maintenance (including renovation) of the created infrastructure

Source of Funds: 90 % of the CAPEX and 50% of the OPEX (including renovation cost) over 15 years will be available from the above budget allocated by central government under the Ganga Rejuvenation program. However, funds will be sanctioned only when an enforceable guarantee for the balance CAPEX and OPEX for at least 15 years is available.

Project Type: **Control of activities such as immersion of idols, floral and other offerings, wallowing of domestic animals, washing of clothes, vehicles, non-ritual bathing, etc. in Class I and Class II towns [Priority Level II]**

Activities: Projects concerning development and implementation of alternative arrangements for immersion of idols, floral and other offerings, wallowing of domestic animals, washing of clothes, vehicles, non-ritual bathing, etc. to be given due consideration.

Budget under Ganga Rejuvenation Program:

Values as on date (in Rs. Crore) for the CAPEX and OPEX for Projects Concerning Control of activities such as immersion of idols, floral and other offerings, wallowing of domestic animals, washing of clothes, vehicles, non-ritual bathing, etc. in Class I and Class II towns

in Class I Towns: 247 towns

in Class II Towns: 139 towns

Year	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	Total
CAPEX	55	111	111	111	111	111	55	55	55	55	55	55	55	55	55	**1108**
OPEX	0	35	105	174	244	314	384	418	453	488	523	558	593	628	662	**5579**

After 15 years, Rs. 697 crore/yr (value as on date) must be budgeted for operation/maintenance (including renovation) of the created infrastructure

Source of Funds: 90 % of the CAPEX and 50% of the OPEX (including renovation cost) over 15 years will be available from the above budget allocated by central government under the Ganga Rejuvenation program. However, funds will be sanctioned only when an enforceable guarantee for the balance CAPEX and OPEX for at least 15 years is available.

Project Type: **River-frame restoration and development in Class I and Class II towns** **[Priority Level III]**

Activities: Projects concerning comprehensive river-frame restoration and development including removal of encroachments, developments of ghats, walkways, etc., development of pilgrimage and tourist spots, recreational and commercial activities will be considered.

Budget under Ganga Rejuvenation Program:

Values as on date (in Rs. Crore) for the CAPEX for projects concerning river-frame restoration and development in Class I and Class II towns

in Class I Towns: 247 towns
in Class II Towns: 139 towns

Year	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	Total
CAPEX	250	500	500	500	500	500	250	250	250	250	250	250	250	250	250	**5000**

*OPEX (including renovation cost) to be pledged by the project proponents

Source of Funds: 70 % of the CAPEX will be available from the above budget allocated by central government under the Ganga Rejuvenation program. However, funds will be sanctioned only when an enforceable guarantee for the balance CAPEX and OPEX (including renovation costs) for at least 15 years is available.

Project Type: **River floodplain restoration in Class I and Class II towns** **[Priority Level III]**

Activities: Projects concerning removal of encroachment from river flood plain and development of projects such as ecological parks, water recharge structures, etc. on the floodplains will be considered.

Budget under Ganga Rejuvenation Program:

Values as on date (in Rs. Crore) for the CAPEX and OPEX for Projects concerning river floodplain restoration in Class I and Class II towns

in Class I Towns: 247 towns
in Class II Towns: 139 towns

Year	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	Total
CAPEX	250	500	500	500	500	500	250	250	250	250	250	250	250	250	250	**5000**
OPEX	0	50	150	250	350	450	550	600	650	700	750	800	850	900	950	**8000**

After 15 years, Rs. 1000 crore/yr (value as on date) must be budgeted for operation/maintenance (including renovation) of the created infrastructure

Source of Funds: 90 % of the CAPEX and 50% of the OPEX (including renovation costs) over 15 years will be available from the above budget allocated by central government under the Ganga Rejuvenation program. However, funds will be sanctioned only when an enforceable guarantee for the balance CAPEX and OPEX for at least 15 years is available.

Proposed Budget(value as on date) for the next 15 years under Ganga Rejuvenation Program

	Values as on date (in Rs. Crore) of the CAPEX and OPEX for Projects in Priority Levels I – III in NRGB in Class I Towns: 247 towns in Class II Towns: 139 towns															
	Year	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**Total**
Allocation for URMP Preparation and Vetting																	
URMP Preparation		95	190	190	190	190	190	95	95	95	95	95	95	95	95	95	**1900**
URMP Vetting		5	10	10	10	10	10	5	5	5	5	5	5	5	5	5	**100**
Allocation for DPR Preparation and Vetting																	
DPR Prep. Support		76	380	380	380	380	380	304	190	190	190	190	190	190	190	190	**3800**
DPR Vetting		4	20	20	20	20	20	16	10	10	10	10	10	10	10	10	**200**
Allocation for 'MND Projects'																	
Priority Level	**Year**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	
I	**CAPEX**	1702	4098	4098	4098	5253	5253	3781	2626	2626	2626	2626	1933	1933	1933	1702	**46288**
I	**OPEX**	0	419	1258	2096	2935	3773	4613	5031	5449	5868	6288	6708	7126	7546	7965	**67075**
II	**CAPEX**	277	554	554	554	554	554	227	227	227	227	227	227	227	227	227	**5090**
II	**OPEX**	0	174	523	872	1220	1569	1918	2092	2266	2441	2615	2789	2964	3138	3312	**27894**
III	**CAPEX**	500	1000	1000	1000	1000	1000	500	500	500	500	500	500	500	500	500	**10000**
III	**OPEX**	0	50	150	250	350	450	550	600	650	700	750	800	850	900	950	**8000**
TOTAL		**2659**	**6895**	**8183**	**9470**	**11912**	**13199**	**12009**	**11376**	**12018**	**12662**	**13306**	**13257**	**13900**	**14544**	**14956**	**170,346**

19. Financing MND Projects

The financing of every single aspect of the rejuvenation of River Ganga is a gigantic task requiring large amounts of capital running into lakhs of crores of rupees. The Government as a source of finance, although significant, cannot be depended upon as the only source. Efforts must be made to tap into global capital pool so as to ensure timely delivery of capital. Delay in financing not only results in opportunity cost but can also lead to redundant efforts since the physical conditions of the projects might have changed.

Financing of projects mustn't also be set in a monolithic framework. The diverse nature of the problems within NRGB requires multitudes of financing structures to be established. The structures are better devised and implemented if assessed through their needs and categorized as follows.

19.1 Projects that can Utilize a PPP Structure

Projects that have a clear revenue generation model are best funded through a PPP structure. It is recommended that a large portion of total projects are funded through this mechanism as it puts the onus of successful delivery onto the investor/financier. This will result in better design of projects from both technological as well as economic standpoint. The Government's role in the PPP structure is to ensure creation of a robust risk management model to enable increased capital flow into the underlying projects. Projects that fall under this category include:

- Industrial effluent treatment
- Sewage treatment where there is a clear revenue model
- Solid waste management
- Public toilets where a user-fee is possible

19.2 Projects that can only be Funded through Government Financing Mechanism

There are projects in which there is no clear revenue model and must only be financed through the Government sources. Although the Government will finance these projects, it must also adopt a Total Lifecycle Cost (TLC) approach so that all elements including capital expenditure (Capex), operational expenditure (Opex), repairs and maintenance are factored into the financial planning of the asset. This approach will ensure that the assets are well managed and deliver the desired results. Projects that fall under this category include:

- Restoration of natural drains (nalas)
- Constructing and managing a sewerage network
- Sewage treatment plants (where there is no clear revenue model)
- Public toilets where no user fee is possible
- Encroachment removal from river floodplain
- Maintenance/construction of surface water bodies/water recharge structures

19.3 Projects that can be Delivered through an Annuity Model

These are typically brown-field projects or those that require a long term operations and maintenance of assets. Projects that fall under this category include:

- Retrofitting existing and poorly operating STPs/ETPs
- Operations & Maintenance of STPs/ETPs

19.4 Projects that can be Funded through Sale or Leasing of Assets

The land owned by Government at various locations along the river belt can be sold or given out on a long-term lease model to private/third-party developers. The sale of proceeds can be utilized to finance a number of projects. Projects that fall under this category include:

- River-frame development
- Restoration of Ghats
- River floodplain restoration
- Cremation Facilities

19.5 Projects that can be Funded through a Licensing Mechanism

In cases where PPP models are not applicable but where there is a clear revenue stream associated, a licensing mechanism can generate substantial resources for the Government to finance projects. Examples include licensing fee generated through vendors, hawkers, kiosks, tourism operators and other service providers that operate on the banks of the rivers. Projects that fall under this category include

- Keeping riverside clean
- Prevention of disposal of corpses/human remains

19.6 Enabling the PPP Framework

In order to develop and deliver an effective PPP framework, the most crucial element that all stakeholders need to address is the risk within the system. All parties involved in the project are responsible for identifying and mitigating these risks. It is the Government's primary responsibility to develop a market framework that attracts private sector investment into the project.

Financing wastewater treatment projects using a PPP construct, be it sewage or industrial effluents, is only possible if payments to the 'service provider' is guaranteed through enforceable contracts. There must be clear and well enforced guidelines by the Government that prevents discharge of sewage or industrial effluent (either treated or untreated) to the rivers. In case of industries, the polluter must deploy a zero liquid discharge framework. In case of municipal wastewater, the Urban Local Body (ULB) must first try to sell treated sewage before using for other purposes. If anyone is discharging untreated wastewater then there must be a heavy penalty which will act as a deterrent.

19.7 Local Area Water Markets

In order to establish a revenue model for treated wastewater, the ULBs must establish the local area water market framework. This process will identify the producers of wastewater and bulk buyers. Each ULB can do this exercise in a relatively short span of time which will help it identify the market stakeholders as well as create an effective market.

19.8 Addressing Industrial Effluent Treatment

For industrial units without proper Effluent Treatment Plant (ETP), factoring the CAPEX and OPEX of the ETP into the economic model of the business may come as an unwelcome surprise. Some industries will find the cost increase rather difficult to absorb whilst others will simply not be able to spare or raise adequate capital to fund the establishment of the ETP.

The BOOT (Build-Own-Operate-Transfer) framework can help such businesses that find financing the ETP a challenge. A third party developer will assume the responsibility to design, finance and operate such an ETP. It will recover its investment and the return on capital by entering into a long term agreement with the industry needing such an ETP. An effluent treatment or a water purchase agreement will have to be signed between the two parties clearly listing the base tariff and escalation parameters. However bankability of such projects will remain a challenge for entities that have relatively poor credit rating. The following steps can be employed to make such projects more bankable:

1. Open Book Planning

Engineering, Procurement and Construction (EPC) costs depend on quantity and characteristics of effluents. A realistic assessment of these costs is essential or the financing of the project will remain a challenge. Neither party should try to conceal or hide any facts or truths from one another. The industry owner must be open and forthcoming about their actual effluent discharge volumes and characteristics. If the fundamental objective is to treat 100% of the effluent coming out of the plant with subsequent capacity expansion, then the developer has to take these into account when scoping the capacity and

other parameters of the plant that have a direct impact on the cost of setting one up and operating it.

Similarly the developer must also be fully transparent on its true Engineering, Procurement and Construction (EPC) costs. The developer will also charge a premium and build that into the tariff agreement to recover its cost and the return on capital investment. It is prudent that the developer does an open book accounting and cost of capital modeling with upfront ROI targets agreed by the industry owner.

Mutual trust and collaborations are the keywords underpinning this relationship.

2. Having Skin in the Project

The project developer is taking a significant risk by setting up such a project which is not a standalone business. If things go sour it isn't that the developer can simply dismantle the plant and take it away elsewhere. It is important for the industry owner to co-invest with the project developer in the setting up of the ETP. Although it is fairly evident that the main driver behind such a project relationship is of industry owner's lack of capital, even a small contribution to the tune of 20% of developer's capital investment will go a long way in demonstrating confidence.

3. Waterfall Revenue Arrangement and Pooling

Just because the ETP is at the very end of the process chain doesn't mean that it is at the very end of the chain when receiving its income through the agreed tariff. It is important that the ETP is considered as one of the most important elements of an industrial process and that the tariff for the plant should be set aside as soon as the revenues of the industrial unit owner are received.

4. Resource Allocation

Well structured EPC and O&M contracts that provide for a buffer in case of any payment defaults will help improve the credit rating of the project. The parties should keep aside 6-12 months of O&M tariff through use of resource allocation instruments such as Letters of Credit (L/C) or an escrow account.

5. Default Backstops through Counterparty Guarantee

In the event the industry owner defaults, winds the business down or is unable to make the payments, there should be recourse to other assets within the group. This is one of the most important points that will improve the bankability of the projects. In case the off-taker is a Government agency, the backstop arrangement can be provided through a sovereign or sub-sovereign guarantee.

6. Project Insurance

Putting in place a robust insurance policy that is globally recognized will give a lot of comfort to lenders and investors of the project. There are a number of specialist brokers who can source such a policy.

7. Credit Rating

Once a number of aforementioned credit enhancement mechanisms are put in place, the project developers should get the project rated through a credible ratings agency. This will greatly enhance the bankability as project lenders can quantify the level of risk and ascertain a premium as per the rating.

Not having a credit rating, no matter how good the project is, can adversely affect its bankability.

8. Take-out Financing through Bond Issuance

Commercial lenders are mostly unable to lend for longer tenures. Therefore if a project has a commercial rating, its developers should consider issuing a bond so that the fixed income investors can then take the banks out at the end of the tenure.

9. Global Green Capital

There is ample capital available for good quality environmental projects. The project developers should look at global sources to mobilize such capital through dedicated green- infra-funds, development finance institutions and other quasi Governmental agencies. These agencies will take a more positive

view to financing the projects than normal commercial institutions and their risk appetite level will also be much larger.

10. Better Procurement through Export Credit Assistance Schemes

Many developed nation economies are facing a slower growth and the Governments are putting measures and schemes to boost exports through providing various financial instruments to either the exporter or the project. These come in various forms such as export guarantee, equipment financing or straight non-recourse concessionary project lending. Procuring equipment strategically from such markets will also increase the probability of financing the projects.

19.9 Government Created Financial Frameworks

The Government may also take proactive measures and create a slew of instruments that will enable greater flow of investments into addressing the restoration and rejuvenation of river Ganga.

1. Ganga Bonds

Issuing long term bonds in Indian or international capital markets can generate significant capital base for the Government. These long term bonds can finance most of the sewage treatment plants and sewerage network that needs to be built in the NRGB.

2. Technology Upgrade Fund

A specialist fund targeted at MSME industry segment that find it challenging to access to best technologies and global best practices.

3. Shadow Tariffs

If industry is unable to pay for the entire O&M tariff for the efficient operation of the industrial effluent treatment plant, then a shadow tariff mechanism paid through a specialist fund can help bring the requisite revenues to the plant owner/operator.

4. Long-term Low Cost Loans

Government can provide long term low cost loans to entities willing to set up effluent treatment facilities. Lowering the cost of capital will reflect in lower tariffs that will lower the burden on industry or other users paying for treatment of water.

5. Foreign Currency Hedging

Many industry units will be able to borrow through external commercial borrowing route. If Government helps in absorbing the hedging costs or fixing the foreign currency conversion rates, then it will allow industry owners to tap into a larger pool of capital which will also lower the cost of finance.

6. Credit Rating

Government should make it mandatory for all parties to credit-rate their projects and achieve a minimum credit rating if they are to avail of the Government sponsored facilities. This will bring significant fiscal discipline and improve the quality of underlying credit thereby attracting both domestic and international lenders/investors.

7. Take-Out Financing

One of the most crucial instruments, take-out-financing is long term capital that comes in after the commercial lenders finish their tenures. This is crucial to be put in place right at the beginning so that it gives comfort to the lenders and investors.

8. Water Quality Trading

This instrument can effect major transformation in the water sector. It is based on the same principles of carbon trading but is applied at a very local level. The trading happens between two parties that are discharging different quantities of effluents. The one below the pre-defined threshold level sells credits to the one that is above the threshold level. The thresholds can be applied both on quality and quantities. This creates a local market which can be monitored by a Government agency.

9. Credit Risk Pooling

A government sponsored credit pool can allow either municipalities and/or industrial effluent treatment plant managers to pool their risk into a single vehicle. This diversifies risk for the insurer and thereby reduces the cost of capital.

20. MND Projects: Monitoring and Feedback

The overall objective of Mission "Nirmal Dhara" (MND) is to ensure that the flow in the Ganga River System is bereft of manmade pollution, such that water quality of the Ganga River System is not substantially affected by human activities in NRGB. Ingress of all anthropogenic pollutants into the Ganga River System must ultimately be eliminated to achieve this goal.

However, the more limited objective of MND over the next 15 years is to implement numerous projects in the industrial and domestic/commercial (Class I and II towns) sectors designed to, A) prevent direct discharge of large quantities of liquid waste into the Ganga River System, B) prevent direct discharge of large quantities of solid waste into the Ganga River System, and C) promote river-frame development and restoration of floodplain in Class I and II towns along the Ganga River System.

The amount of funding available for MND projects over the next 15 years is obviously a big determinant for the ultimate success of MND. In case of Class I and II towns in NGRB, major share of funding required for 'MND projects' must be available from Ganga Rejuvenation funds earmarked by the central government. In case of industries, majority of the required funding must come from industries itself.

DPRs for relevant projects will be presented by project proponents for vetting and approval to NGRBMC. High quality DPRs consistent with the objectives of MND will be approved as 'MND Projects' and hence will be eligible for partial funding from the Ganga rejuvenation budget. A DPR will only be given the final 'green signal' for implementation when an enforceable guarantee for funding

(CAPEX, OPEX and renovation/re-investment cost) is finalized for at least 15 years from the time of project commencement.

All 'MND projects' will have an in-built mechanism for announced/unannounced independent third-party inspections coordinated by NGRBMC. NGOs and other civil society organizations (CSOs) may be involved in this effort. The payments to the contractor/'service provider' should be closely linked to the results of such inspections.

The overall success of MND over next 15 years will ultimately depend on the success of towns and large/medium scale industries and industrial clusters in NGRB in implementing 'MND projects'. It is recommended that NGRBMC should come up with suitable metrics related to project outcomes to assess the success of MND at the level of individual towns, industries and even states as a whole. The scores obtained against these metrics can be published each year such that comparisons can be made across towns, industries and even states regarding the effectiveness of MND implementation.

References

1. IITC [2010a], “Guidelines for the Preparation of Urban River Management Plan (URMP) for Class I Towns in Ganga River Basin”, 002_GBP_IIT_EQP_S&R_01_Ver 1_Dec 2010.
2. IITC [2010b], “Sewage Treatment in Class I Towns: Recommendation and Guidelines”, 003_GBP_IIT_EQP_S&R_02_Ver 1_Dec 2010.
3. IITC [2011a], “Review of Wastewater Reuse Projects Worldwide: Collation of Selected International Case Studies and Experiences”, 012_GBP_IIT_EQP_SOA_01_Ver 1_Dec 2011.
4. IITC [2011b], “Emerging Contaminants in Ganga River Basin with Special Emphasis on Pesticides”, 013_GBP_IIT_EQP_SOA_02_Ver 1_Dec 2011.
5. IITC [2011c], “Pulp and Paper Industries in Ganga River Basin: Achieving Zero Liquid Discharge”, 014_GBP_IIT_EQP_S&R_04_Ver 1_Dec 2011.
6. IITC [2012], “Water Quality in the Ganga River and Efficacy of Sewage Treatment Processes in Coliform Removal: A Case for Adopting Tertiary Treatment”, 023_GBP_IIT_EQP_ANL_01_Ver 1_Jun 2012.
7. IITC[2013], “Assessment of Some Aspects of Provisioning Sewerage Systems”, 039_GBP_IIT_EQP_S&R_02_Ver 1_Dec 2013.
8. IITC [2014a], “Assessment of Domestic Pollution Load from Urban Agglomerations in Ganga River Basin: Uttarakhand”, 058_GBP_IIT_EQP_DAT_02_Ver 1_Dec 2014.
9. IITC [2014b], “Assessment of Domestic Pollution Load from Urban Agglomerations in Ganga River Basin: Haryana”, 059_GBP_IIT_EQP_DAT_03_Ver 1_Dec 2014.
10. IITC [2014c], “Assessment of Domestic Pollution Load from Urban Agglomerations in Ganga River Basin: Uttar Pradesh”, 060_GBP_IIT_EQP_DAT_04_Ver 1_Dec 2014.
11. IITC [2014d], “Assessment of Domestic Pollution Load from Urban Agglomerations in Ganga River Basin: Rajasthan”, 061_GBP_IIT_EQP_DAT_05_Ver 1_Dec 2014.
12. IITC [2014e], “Assessment of Domestic Pollution Load from Urban Agglomerations in Ganga River Basin: Bihar”, 062_GBP_IIT_EQP_DAT_06_Ver 1_Dec 2014.
13. IITC [2014f], “Assessment of Domestic Pollution Load from Urban Agglomerations in Ganga River Basin: Madhya Pradesh”, 063_GBP_IIT_EQP_DAT_07_Ver 1_Dec 2014.

14. IITC [2014g], "Assessment of Domestic Pollution Load from Urban Agglomerations in Ganga River Basin: West Bengal", 064_GBP_IIT_EQP_DAT_08_Ver 1_Dec 2014.
15. IITC [2014h], "Assessment of Domestic Pollution Load from Urban Agglomerations in Ganga River Basin: Yamuna Sub-Basin", 065_GBP_IIT_EQP_DAT_09_Ver 1_Dec 2014.
16. IITC [2014i], "Assessment of Domestic Pollution Load from Urban Agglomerations in Ganga River Basin: Ramganga, Kali and Gomti Sub-Basins", 066_GBP_IIT_EQP_ DAT_10_Ver 1_Dec 2014.
17. IITC [2014j] "Assessment of Domestic Pollution Load from Urban Agglomerations in Ganga River Basin: Gandak and Kosi Sub-Basins", 067_GBP_IIT_EQP_DAT_11_Ver 1_Dec 2014.
18. IITC [2014k], "Assessment of Domestic Pollution Load from Urban Agglomerations in Ganga River Basin: Hooghly Sub-Basin", 068_GBP_IIT_EQP_DAT_12_Ver 1_Dec 2014.
19. IITC [2014l], "Assessment of Provisioning an Appropriate Solid Waste Management Approach in Urban Agglomerations in Ganga River Basin", M Tech Thesis of Smriti Gupta Submitted to Environmental Engineering and Management Programme, IIT Kanpur; Adopted as IIT Consortium Report on GRBMP; 071_GBP_IIT_EQP_S&R_05_Ver 1_Dec 2014.
20. IITC [2014m], "Assessment of Approaches for Eliminating Use of Fresh Water in Tanneries at Jajmau, Kanpur", M Tech Thesis of RajatVerma Submitted to Environmental Engineering and Management Programme, IIT Kanpur; Adopted as IIT Consortium Report on GRBMP; 072_GBP_IIT_EQP_S&R_06_Ver 1_Dec 2014.
21. Jenny, H. [1994], "*Factors of soil formation: a system of quantitative pedology*", Dover Publication. [*Accessed May 28, 2014 from:*

    http://www.soilandhealth.org/01aglibrary/010159.Jenny.pdf.].
22. MoWR(Min. of Water Resources, Govt. of India) [2014], "*Ganga Basin – Version 2.0*".
23. Pahl-Wostl, C. [2007], "*The implications of complexity for integrated resources management*", Environmental Modelling & Software, Vol. 22, pp 561–569.
24. Wikipedia [2014], "*Soils*". [*Accessed May 28, 2014 from:*

    http://en.wikipedia.org/wiki/Soil.].