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Guidelines for Implementation of Sewage Collection, Diversion, Pumping, Treatment, and Reuse (Sewage CDPTR) Infrastructure in Class I Towns

GRB EMP : Ganga River Basin Environment Management Plan

by

Indian Institutes of Technology

IIT Bombay | IIT Delhi | IIT Guwahati | IIT Kanpur | IIT Kharagpur | IIT Madras | IIT Roorkee

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 has constituted 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 the river Ganga. One of the important functions of the NGRBA is to prepare and implement a Ganga River Basin: Environment Management Plan (GRB EMP).

A Consortium of 7 Indian Institute of Technology (IIT) has been given the responsibility of preparing Ganga River Basin: Environment Management Plan (GRB EMP) by the Ministry of Environment and Forests (MoEF), GOI, New Delhi. Memorandum of Agreement (MoA) has been signed between 7 IITs (Bombay, Delhi, Guwahati, Kanpur, Kharagpur, Madras and Roorkee) and MoEF for this purpose on July 6, 2010.

This report is one of the many reports prepared by IITs to describe the strategy, information, methodology, analysis and suggestions and recommendations in developing Ganga River Basin: Environment Management Plan (GRB EMP). The overall Frame Work for documentation of GRB EMP and Indexing of Reports is presented on the inside cover page.

There are two aspects to the development of GRB EMP. Dedicated people spent hours discussing concerns, issues and potential solutions to problems. This dedication leads to the preparation of reports that hope to articulate the outcome of the dialog in a way that is useful. Many people contributed to the preparation of this report directly or indirectly. This report is therefore truly a collective effort that reflects the cooperation of many, particularly those who are members of the IIT Team. Lists of persons who are members of the concerned thematic groups and those who have taken lead in preparing this report are given on the reverse side.

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Contents

1. Introduction

Two important objectives of Ganga River Basin Environment Management Plan (GRB EMP) are the restoration of, 1) 'Nirmal' dhara and 2) 'Aviral' dhara in all the rivers of the Ganga River Basin (GRB). This report specifically addresses the construction, operation and maintenance of the sewage collection, diversion, pumping, treatment and reuse (CDPTR) infrastructure in Class 1 towns of GRB to achieve the objectives of GRB EMP. The steps recommended in this report will lead to partial restoration of 'Nirmal' dhara in the rivers of the Ganga basin. The question of restoration of 'Aviral' dhara is largely outside the scope of this report, though it is thought that restoration of 'Nirmal' dhara will indirectly help in the restoration of 'Aviral' dhara also.

2. Sewage CDPTR Infrastructure Proposed Under URMPs

In future, sewage collection, diversion, pumping, treatment and reuse (CDPTR) infrastructure in Class 1 towns of Ganga River Basin (GRB) must be constructed strictly according to DPRs prepared based on 'work packages' specified under relevant 'actionable' items (see sections 4.4, 4.5 and 4.6 of Report No. 002_GBP_IIT_EQP_S&R_02) in the URMPs prepared for these towns.

The relevant 'actionable' items for this purpose (also specified in Report No. 002_GBP_IIT_EQP_S&R_02) are the following,

Item 4.4.1: Construction of main sewers, branch sewers, laterals and house connections for collection of sewage from individual households. In the long term, sewage from all households, including slum areas must be collected by the underground sewer system.

Item 4.4.2: Construction of trunk sewers in a phased manner for the conveyance of the sewage to the sewage treatment plant. In the long-term, all sewage generated in the town must be collected and conveyed to sewage treatment plants.

Item 4.4.3: Construction of intercepting sewers for diverting the flow of small 'nalas'/drains into the sewer system. All sewage flowing in small 'nalas'/drains must be diverted to the underground sewer system. This is a short-medium term solution, which will hopefully become redundant once a comprehensive sewage collection system is developed for the whole town.

Item 4.4.4: 'Nala'/drain tapping works for diverting discharges of large 'nalas'/drains to the sewer system. All sewage flowing in large 'nalas'/drains to be diverted from rivers and other surface water bodies and into sewers or directly to sewage treatment plants. This is a short-medium term

solution, which will hopefully become redundant once a comprehensive sewage collection system is developed for the whole town.

Item 4.5.1: Construction of sewage pumping stations for conveying sewage flowing in trunk sewers and large 'nalas' to sewage treatment plants. Capacity for pumping all sewage generated in the town to sewage treatment plants must be created.

Item 4.5.2: Construction of new STPs, clearly showing the area of the town from which sewage will be diverted to the STP. All sewage generated in the town to be diverted to new or existing STPs.

Item 4.6.1: Renovation of existing surface water bodies in the town/surrounding rural area for storage of treated sewage and groundwater recharge.

Item 4.6.2: Construction of surface water bodies in the town/surrounding area for storage and groundwater recharge of treated sewage.

Item 4.6.3: Construction of pipelines/open channels for conveyance of treated sewage, 1) to storage structures, 2) from storage structures to reuse points in the town and elsewhere.

Item 4.6.4: Production and use of sludge-derived products, i.e., manure, compost, etc. in the town or in other areas.

Further,

1. Sewage treatment plants sanctioned by NGRBA for Class I towns in the GRB shall provide tertiary level treatment broadly using the technological options (or their equivalent) specified in Report No. 003_GBP_IIT_EQP_S&R_02.
2. The required treated water quality should be as specified in Report No. 003_GBP_IIT_EQP_S&R_02, irrespective of standards specified elsewhere. This is essential for improving the bacteriological and other water quality parameters of the river water in various rivers of the Ganga Basin.

3. Long-Term Vision

As stated by the IIT consortium in various forums, it is strongly felt that the restoration of 'Nirmal' dhara in all rivers of the GRB will require, among other actions, the following steps in the medium to long term (within next 25 years) concerning sewage CDPTR infrastructure in Class 1 towns of GRB,

1. Complete stoppage of the discharge of sewage, either treated or un-treated, from Class 1 towns in GRB into all rivers of the GRB.
2. All sewage generated in Class I towns of GRB must be collected and treated up to tertiary level (treatment guidelines for tertiary treatment specified elsewhere (IIT Report 003_GBP_IIT_EQP_S&R_02); Effluent Standards: BOD < 10 mg/L; SS < 5 mg/L; fully nitrified effluent; P < 0.5 mg/L; FC < 10/100 mL)

3. The tertiary treated water should be reused for various purposes, i.e., industrial, irrigation, horticultural, non-contact/non-potable domestic uses, groundwater recharge through surface storages and subsequent infiltration into the ground water, etc.

   Note: However, in exceptional cases, discharge of tertiary treated sewage into the river may be allowed only on short-term basis, i.e., until the required water reuse/recycling infrastructure is put in place.

4. Sewage CDPTR Infrastructure: Current Status

Ideally, all sewage generated in Class 1 towns of GRB should be collected through the underground sewer network and conveyed to sewage treatment plants for treatment followed by proper disposal or reuse. This is a necessary (if not sufficient) condition for improvement in the overall river water quality in all rivers of GRB. The current status and deficiencies in the sewage CDPTR infrastructure in various Class 1 towns of the GRB is summarized as follows.

1. The sewer network is not present in many towns. In other towns, the sewer network is only present in certain areas, with many new localities, unauthorized colonies and slum clusters having no sewer network.
2. The sewage generated in areas with no sewer network is discharged in surface drains and 'nalas'. Even in areas with sewer network, many houses are not connected to the network for a variety of reasons. The sewage from these houses is also discharged in surface drains and 'nalas'.
3. Sewage collected by the sewer network is often not conveyed to the treatment plant due to a variety of reasons, i) lack of and/or malfunctioning of sewage pumping infrastructure, ii) choked or broken sewers, or iii) lack of capacity for sewage treatment. Under such circumstances, the sewage is diverted into 'nalas' or is discharged into surface water bodies.
4. The sewage flowing in 'nalas' mostly discharged into surface water bodies without any treatment.
5. In some cases, the sewage flowing in 'nalas' is diverted to sewage treatment plant for treatment. Such diversion is often ineffective due to, i) lack of/malfunctioning of sewage pumping infrastructure due the various reasons, and ii) insufficient sewage pumping capacity.
6. In some towns, sewage treatment capacity is often much less than the amount of sewage generated.
7. In other cases, the existing sewage treatment capacity is often under-utilized due to the lack of and/or malfunctioning of the pumping infrastructure and choking/blocking of sewers required for conveying the sewage to treatment plant.

8. Sewage treatment plants often do not work properly due to erratic electricity supply and poor operation and maintenance and other associated causes. Thus untreated/partially treated sewage is often discharged from the treatment plants.
9. Sludge produced during sewage treatment is often not disposed in an acceptable manner. Sludge is often used as fertilizer in an unscientific manner with consequent occupational and other health hazards. Sludge/sludge derived products utilization infrastructure in not in place.
10. In most cases, there is no treated sewage reuse infrastructure. In some cases, treated and untreated sewage is used for irrigation purposes, mostly in an unscientific manner and with consequent occupational and other health hazards.

5. Sewage CDPTR Infrastructure: Current Initiatives

Construction, operation and maintenance of sewage CDPTR infrastructure in all Class 1 towns of the GRB is the responsibility of respective elected urban local bodies (ULBs). It is normally expected that the expenditure on above services will be recovered by the ULBs from the residents of the town through the levying of local taxes.

However, due to financial constraints, most ULBs in Class 1 towns of GRB are unable and/or unwilling to invest significant resources for construction, operation and maintenance of sewage CDPTR infrastructure. Nonetheless, over the years, the central and state governments have invested significant amounts of resources under GAP-I, GAP-II, other river action plans (RAPs) and other urban renewal projects for the creation of sewage CDPTR infrastructure in many towns of the GRB.

Funding was initially made available for projects included under 'actionable' items 4.4.2 (construction of trunk sewers), 4.4.3 (construction of intercepting sewers), 4.4.4 (construction of 'nala' tapping works), 4.5.1 (construction of sewage pumping stations) and 4.5.2 (construction of sewage treatment plants) in the proposed URMPs (see Report No. 002_GBP_IIT_EQP_S&R_02). However, sewage treatment plants ('actionable' item 4.5.2 in proposed URMPs) were funded to treat sewage only up to the secondary (and not tertiary) level.

Initially, no funding was sanctioned for development of sewer networks ('actionable' item 4.4.1 in proposed URMPs), as this was considered to have only indirect impact on river water quality. However, this restriction was somewhat relaxed in later stages of various RAPs. Central funding for development of sewer networks ('actionable' item 4.4.1 in proposed URMPs) was however always available from other sources, e.g., JNNURM and other related projects funded by MoUD and other agencies.

Almost no funding for projects included under 'actionable' items 4.6.1 (restoration of existing surface water bodies), 'actionable' items 4.6.2 (construction of new surface water bodies), 'actionable' items 4.6.3 (conveyance systems for treated sewage) and 'actionable' items 4.6.4 (production and use of sludge-derived products) under proposed

URMPs (see Report No. 002_GBP_IIT_EQP_S&R_02) was made available, since reuse of treated sewage and use of sludge-derived products was rarely emphasized in GAP-I, GAP-II and other RAPs.

The funding and implementation pattern for most projects involving sewage CDPTR supported by MoEF (through NRCD) was as follows.

1. The land for the project was provided by the ULBs/State Governments.
2. The capital cost of the project was provided (as per current practice) by the central and state governments in 70 : 30 ratio.
3. Project DPR was prepared and the project implemented by government agencies like UP Jal Nigam (UPJN).
4. After commissioning, operation and maintenance for a stipulated period, the infrastructure is handed over to ULB. Subsequent operation and maintenance of the infrastructure was the responsibility of the ULB.

Despite the above initiatives, the present scenario vis-à-vis sewage CDPTR in almost all towns of the Ganga river basin, even after implementation of works under GAP-I, GAP-II, other RAPs and other related urban renewal projects, still presents a discouraging picture. Large quantities of partially treated and untreated sewage continue to be discharged into the rivers of GRB. This gives the rivers an unwholesome appearance and the average citizen is unconvinced of positive impact, if any, of the considerable investment made over the years for cleaning the rivers.

Several assessments of GAP-I, GAP-II and other river action plans (RAPs) over the years have shown only marginal improvement, if any, in the river water quality in terms of BOD concentration. The DO values are also above the desired minimum in most stretches. However, total and fecal coliform concentrations in the river are above the desired values in most stretches.

5.1 Sewage CDPTR Infrastructure: Analysis of Current Scenario

The main deficiencies in the funding model adopted in GAP I, GAP II and other RAPs for the creation of sewage CDPTR infrastructure were the following,

1. ULBs were not closely involved in project planning and implementation. There was no public participation/involvement in project planning and implementation stages.
2. State governments were often late in releasing their share of the project cost resulting in delayed project implementation and cost overruns.
3. Despite written assurances at the project approval stage, ULBs were often unwilling to take over the operation and maintenance of the created infrastructure, citing their lack of expertise and lack of funds.
4. Uninterrupted electricity supply was not ensured for the pumping stations and sewage treatment plants, leading to constant disruptions and sub-optimal performance.

5. DG sets provided for operation of pumping stations during power cuts were mostly non-operational.
6. Performance monitoring of the completed projects was not done in an objective and systematic basis, and effective action was not taken to improve the performance of the created infrastructure based on such monitoring. Public participation/ involvement in project monitoring was minimal.
7. In many cases, due to the lack of regular maintenance, and lack of allocated funds, the created infrastructure deteriorated at a rapid rate and became non-operational very quickly.
8. The sewage treatment plant capacity was often underutilized, since sewage conveyance and pumping infrastructure was either non-existent or was not functioning properly.
9. Adopted sludge management practices were insufficient for safe and secure management of solid residues arising from sewage treatment operations.

The net effect of the above factors was that in most cases, the benefits of the creation of sewage CDPTR infrastructure, as envisaged during project planning was never realized.

Based on the analysis of the current funding and implementation scenario for sewage CDPTR infrastructure as presented above, the main issues that appear to have prevented proper functioning of sewage CDPTR infrastructure have been listed as follows.

1. Deficiencies in the operation and maintenance of the created infrastructure, often due to lack of resources.
2. Lack of involvement of ULBs and general public in project planning and implementation.
3. Lack of assured electricity supply for the operation of pumping stations and sewage treatment plants.
4. Deficiencies in the monitoring of the performance of the created infrastructure and lack of action to improve performance based on performance monitoring reports.

In addition there has been a general lack of strategic approach, i.e., examination of a spectrum of solutions such as decentralized sewage treatment, regional sewage treatment plants shared by various ULBs, reuse potential of treated sewage, etc.

The responsibility of operation and maintenance of sewage diversion and treatment infrastructure constructed through central and state funds lies with the ULBs. However, ULBs have time and again expressed reluctance in taking up the operation and maintenance of the sewage CDPTR infrastructure citing, i) lack of funds, and ii) lack of expertise. It is contended that in addition to the above reasons, another important reason for this reluctance of ULBs is the lack of motivation. Following points are made to support this contention.

- Operation and maintenance of sewage diversion, pumping and treatment infrastructure is a very low priority item for ULBs.
- Most ULBs would like to have an efficient underground sewage collection infrastructure, such that sewage is removed from the city efficiently. However, most ULBs will have no qualms in discharging this sewage to rivers, even without treatment. Sewage diversion, pumping and treatment does not provide any direct benefits to the residents of a town.
- Sewage treatment before disposal of the treated sewage into the river does result in the improvement of river water quality, but only downstream of the town. Hence it is not of direct benefit to the town.
- It is thus not unreasonable to assume that ULBs would prefer to spend their scarce resources for other development works which directly and immediately benefit the residents of the town, e.g., improvement of roads and other traffic infrastructure, water supply, drainage and sewer system, solid waste collection, etc.
- Indeed, over the last two decades, though the income of some ULBs have gone up, but almost no funds have been invested by these ULBs for creation or up-gradation of sewage diversion, pumping or treatments works, while local investment on other infrastructure services, like roads, water supply, sewers, drainage, solid waste collection, etc., have increased.
- Repeated interventions by MoEF (through NRCD) and even the courts (including the apex court) have been largely unsuccessful in compelling the ULBs to invest adequate funds and show motivation for the creation, operation and maintenance of sewage diversion, pumping and treatment infrastructure.

Considering the above points, it is impractical to envisage a scenario where the operation and maintenance of sewage CDPTR infrastructure can be done in an efficient manner, if the sole responsibility for these activities lies with the ULBs.

6. Sewage CDPTR Infrastructure: Proposed Changes

Funding is required for both construction and operation and maintenance of the required sewage CDPTR infrastructure in all Class 1 towns of GRB. Implementation of the required projects should be as per proposed URMPs to be prepared for each Class 1 town of the GRB. In other words, implementation of 'work packages' under 'actionable' items 4.4.1 – 4.4.4, 4.5.1 - 4.5.2 and 4.6.1 – 4.6.4 of the URMPs is required for creation of the required sewage CDPTR infrastructure.

Funding is required for both construction and operation and maintenance phases of various projects. At present, the construction costs of various projects are largely paid by the central and state governments, while operation and maintenance is largely being done by ULBs. It is now proposed that the above funding model be changed, primarily through the involvement of independent private/public sector agencies, through Design-Build-Finance-Operate Model (DBFO Model) or Public-Private-Partnership (PPP Model).

The private/public sector agencies will participate in project financing and in project conception, design, construction and operation and maintenance phases of some types of projects.

The suggested funding sources for various 'actionable items' concerning sewage CDPTR infrastructure is summarized below,

Item	Brief Description	Funding	
		Construction	Operation and Maintenance
4.4.1:	Sewer network	NGRBA (through MoEF, MoUD), State and Local resources	Mostly using local resources, with occasional funding from State government and NGRBA (MoUD)
4.4.2:	Trunk sewers	NGRBA (through MoEF, MoUD), State resources	Mostly using local resources, with occasional funding from State government, NGRBA (MoEF, MoUD)
4.4.3:	Intercepting sewers	NGRBA (through MoEF, MoUD), State resources	Mostly using local resources, with occasional funding from State government, NGRBA (MoEF, MoUD)
4.4.4:	'Nala' tapping works	NGRBA (through MoEF, MoUD), State resources	Mostly using local resources, with occasional funding from State government, NGRBA (MoEF, MoUD)
4.5.1:	Sewage pumping stations	NGRBA (through MoEF, MoUD) and State resources, using DBFO model of funding	Initially by NGRBA (MoEF, MoUD) through DBFO model, later using local resources (preferably through DBFO model)
4.5.2:	Sewage treatment plants		
4.6.1:	Renovation of surface water storage structures	NGRBA (through MoEF, MoUD, MoWR) and State resources	Mostly through local resources, with occasional funding from state government and NGRBA (MoEF, MoWR)
4.6.2:	New surface water storage structures	NGRBA (through MoEF, MoUD, MoRD) and State resources	Mostly through local resources, with occasional funding from state government and NGRBA (MoEF, MoWR)
4.6.3:	Treated water conveyance	NGRBA (through MoEF, MoWR, MoRD), State resources, Local resources, Private funds through PPP model	NGRBA (through MoEF, MoWR, MoRD), State resources, Local resources, Private funds through PPP model
4.6.4:	Sludge management and sludge-derived products	NGRBA (through MoEF, MoRD), State resources, Local resources, Private funds through PPP model	NGRBA (through MoEF, MoRD), State resources, Local resources, Private funds through PPP model

6.1 Sewage Pumping and Treatment: Proposed Changes

One of the major proposed changes is the introduction of the DBFO model for encouraging the participation of independent private /government agencies in providing sewage pumping and treatment services ('actionable' items 4.5.1 and 4.5.2 in proposed URPs) in Class I towns of GRB.

For this purpose it is necessary that for the sake of river Ganga, which has been declared a 'National River', the central and state governments not only fund the entire construction, but also the operation and maintenance costs for the sewage pumping and treatment infrastructure ('actionable' items 4.5.1 and 4.5.2 in proposed URMPs) for a certain period of time after commissioning of the infrastructure. The time period as defined above should ideally be 15 years, though a lower period of time (at least 5 years) may also be considered. This proposal is based on the following points.

1. Creation and efficient operation of sewage pumping and treatment infrastructure ('actionable' items 4.5.1 and 4.5.2 in proposed URMPs), will, in the medium to long term, result in the prevention of the discharge of treated and untreated sewage into the rivers of the GRB from Class 1 towns. This is a necessary condition for improvement of the river water quality in all rivers of the GRB. In addition, visible defilement of rivers of the GRB through the discharge of millions of liters of untreated and treated sewage per day will stop. Such developments are highly desirable and hence may be considered as a 'public good'. 'Public goods' are often funded by central and state governments in various sectors, (e.g., National Parks, NREGA, mid day meal scheme in primary schools, etc.) without considering the monetary returns/revenue generated from such actions.

2. Central and state governments are already funding the entire capital cost of sewage pumping and treatment infrastructure. In new projects, operation and maintenance costs are also being paid for 5 years. As per the present proposal, the central and state governments will continue to make payments for operation and maintenance of the created infrastructure for a period of at least 5 years after commissioning. It is further suggested that the duration of payments for operation and maintenance of the sewage pumping and treatment infrastructure by central and state governments be extended beyond five years. Ideally, such payments should continue for 15 years after commissioning of the infrastructure, though any lesser period of extension beyond 5 years is also welcome.

3. It may be argued that payment by central and state governments for both capital and operation and maintenance costs of sewage diversion, pumping and treatment infrastructure in towns of the Ganga river basin violates the 'polluter pays' principle. It lets the 'polluter' i.e., the ULBs completely avoid paying for cleaning the pollution it causes. However, it may also be argued that while the 'polluter pays' principle should be strictly applied to profit-making industrial units, application of this

principle to ULBs, which are not profit-making and often under great financial stress can be considered in a more sympathetic manner. Even under the present proposal, ULBs will be making various 'in kind' contributions to facilitate the creation, operation and maintenance of sewage diversion, pumping and treatment infrastructure and will take over the responsibility for the operation and maintenance of the created infrastructure after the initial period of payments by the central and state governments for operation and maintenance is over.

4. As envisaged in this report, sewage is to be treated to the tertiary (treatment guidelines for tertiary treatment specified elsewhere (IIT Report 003_GBP_IIT_EQP_S&R_02); effluent standards: BOD < 10 mg/L; SS < 5 mg/L; fully nitrified; P < 0.5 mg/L; FC < 10/100 mL) level. The treated effluent must be (in the medium to long term) reused for various non-potable purposes, irrigation or ground water recharge (see 'actionable' items 4.6.1 – 4.6.3 in proposed URMPs). This reuse will reduce the consumption of fresh water, which would otherwise be obtained by exploiting ground water or from the existing surface water resources. Hence in effect, the investment in the creation and operation of sewage diversion, pumping and treatment infrastructure will actually augment the water resources in the Ganga river basin, ensuring which is an important component of the GRB EMP.

It is proposed that sewage pumping and treatment infrastructure ('actionable' items 4.5.1 and 4.5.2 in proposed URMPs) be constructed through the participation of independent private/public agencies using the DBFO Model. The ULB will appoint a service provider (private or public company) from a list of companies empanelled for this purpose for the project planning, design, construction, and operation and maintenance of the created infrastructure over a pre-defined (i.e., 5 – 15 years after commissioning) contact period. The DPR prepared by the service provider (as per relevant 'work packages' specified in URMPs) will be vetted by the ULB and State Government and submitted to NGRBA for approval. Once approved by the NGRBA, the project implementation will be done by the service provider under the supervision of the ULB. Initial investment for creation of the infrastructure will be made by the service provider through equity infusion or debt. No payments will be made to the service provider during the construction period of the infrastructure. After commissioning, the service provider will be paid by the ULB in annuities over the contact period. Payments to the service provider will be made by the ULB after ensuring compliance of the service provider with contract conditions. Funds for payment to the service provider will be made available to the ULB by the central and state governments throughout the contract period.

7. Design-Build-Finance-Operate (DBFO) Model

Funding for sewage pumping and treatment infrastructure ('actionable' items 4.5.1 and 4.5.2 in proposed URMPs) should be done by the DBFO model. The essential components of the proposed DBFO model are the following,

- Scope of the sewage pumping and treatment infrastructure to be constructed in a town is finalized through consultation of the associated 'work packages' specified in the relevant URMP (see Report 002_GBP_IIT_EQP_S&R_01) and subsequent discussions amongst ULB, state government and NGRBA.
- The period of the operation and maintenance contract (5 – 15 years post-commissioning) to be offered to the service provider to be decided through mutual consultations.
- The entire land for building the facility is identified by the ULB. Obtaining the associated clearances required for construction of the facility on this land is also the responsibility of the ULB. No project will be sanctioned by the NGRBA if this clearance is not in place. The actual construction of the facility must however, occur in phases as the quantity of sewage available for treatment increases.
- Bids to be invited from empanelled service providers using the two bid system. The agency submitting the lowest financial bid is selected amongst the bids that are technically sound as per prescribed criteria.
- Detailed DPR prepared by the service provider and submitted to ULB. After vetting by ULB and concerned State Government, the DPR is submitted for the approval of NGRBA.
- Once the DPR is approved, the identified land is leased to the service provider at a nominal rate by the ULB for the duration of the contract period (i.e., construction period followed by 5 - 15 years duration after commissioning).
- The service provider builds, and then maintains and operates the facility for the contact period (i.e., 5 - 15 years) after commissioning.
- Responsibility for the arrangement of uninterrupted power supply for the facility is with the service provider.
- The service provider and ULB will have joint rights (as stipulated in the contract) for the commercial exploitation of the products, i.e., treated water, sludge and sludge-derived products generated through sewage treatment. A special purpose vehicle (SPV) may be set up for this purpose by the service provider and ULB using the PPP model (see 'actionable' items 4.6.1 – 4.6.4 in the URMPs).
- Any treated sewage, sludge, etc. discharged from the sewage treatment facility during the contract period to be disposed of by the service provider in a safe manner and as per provisions of the contract.
- The facility reverts back to the ULB after the end of the contract period (construction period followed by 5 - 15 years duration after commissioning) unless the contract duration is extended.

- Any liabilities arising out of site contamination during the construction period and contract period for operation of the facilities by the service provider lie with the service provider, even after conclusion of the contract period.

In the above model, the income to the service provider will be from two sources,

- Payment made to the service provider in the form of annuities. The expected amount of annual payments (for each year of operation after commissioning) will be clearly specified in the contract. However, the actual annual payments shall be linked to the quantity of treated sewage (of specified quality) produced by the service provider in that year.
- Profit (if any), from commercial exploitation of resources generated through sewage treatment, i.e., sale of treated water, sludge and sludge-derived products, as per provisions specified in the contract.

In return, the service provider is expected to invest the entire funds required for initial creation of the sewage pumping and treatment infrastructure as per the approved DPR and also take care of operation and maintenance of the facility through the operation and maintenance contract period (i.e., 5 - 15 years after commissioning).

Funds will be made available by the state and central governments for annual payment to the service provider throughout the contract period. The contract between the ULB and service provider will be guaranteed by the state government and counter guaranteed by the central government. Alternatively, some other mechanism can be put in place such that the service provider is assured of payment as per the contract. This kind of guarantee is necessary for the private operator for raising funds from the market (loan component) of the initial capital investment.

Payments will however be released each year to the service provider only after verification that the essential contract terms regarding both quantity and quality of sewage treated and disposal of treatment residues is satisfied. Suitable penalty clauses will be included in the contract in case of non-compliance by the service provider.

The DBFO model for construction, operation and maintenance of sewage pumping and treatment infrastructure, as proposed above, has been designed to overcome the drawbacks of the current project funding and implementation practices discussed earlier. The advantages of this model are as follows.

- Proper operation and maintenance of the created infrastructure after commissioning is assured over the contract period (i.e., 5 – 15 years after commissioning) with the service provider.
- The service provider will be interested in maintaining and operating the facilities throughout the contract period, because that is how the equity invested in the project by the service provider may be recouped and profits made.

- Depending on the mutually agreed contract terms, the annuity payments made to the service provider may be sufficient to ensure profits. However, even under these circumstances, the service provider will still be interested in creating a market for treated water, sludge and sludge-derived products obtained through treatment of sewage, since additional profits could be made through this option.
- If the contract terms do not ensure sufficient profits to the service provider only through the annuity payments, the service provider will be compelled to create a market for treated water, sludge and sludge-derived products obtained through treatment of sewage, since income through this option are then essential to ensure sufficient returns on the investment made by the service provider.
- ULBs are likely to help the service provider in creating a market for the treated sewage, sludge and sludge-derived products, since part of the profit from sale of such product will accrue to ULBs. Also, operation and maintenance of the created infrastructure beyond the contract period with the service provider will partially/wholly be sustained through income generated by ULB through this route.
- ULBs will be closely involved in the supervision of project planning and implementation and also will be responsible for project monitoring. This will inculcate a sense of ownership in ULBs for the developed infrastructure. ULBs will be indirectly answerable for operation and maintenance of project facilities since annual payments will be made to the operator by the ULBs.
- Since the payments to be made by the central and state governments for a particular project are spread over the contract in this model, the yearly outgo for a particular project will be lower. This will allow allocation of the yearly NGRBA budget simultaneously for many projects. A concerted effort for river cleaning will be possible and the results of such efforts will be plainly visible in a few years.

8. Compliance, legal implications and regulatory issues

ULBs are ultimately responsible for compliance with the effluent quality standards, though the sewage treatment plants will be operated by the service provider. As is the case now, ULBs can be taken to the court for non-compliance with the prevailing standards for effluent discharge. However, with the proposed model, ULBs also have the power to ensure compliance, since monitoring of the treatment plant performance and also the payment to the service provider will be made on the recommendations of ULB. The model proposed above envisages the following scenario,

i. ULBs will make certain quantities of sewage available at certain pre-determined points, i.e., terminal manholes, sump-wells or 'nala' tapping works. The quantity of sewage available may increase with time and will be specified in the contract.

ii. The service provider is responsible for construction, operation and maintenance of pump houses for conveyance of the sewage through pumping in a continuous, reliable and fail-safe manner (see 'actionable' item 4.5.1 in proposed URMPs).

Penalty clauses will be incorporated in the contact to ensure that the service provider diverts the contracted amount of sewage consistently and with high reliability.

iii. Prevailing sewage characteristics will be determined through composite sampling at the pre-determined sewage uptake points as described above. Maximum expected variation in sewage characteristics expected over the contract period will be specified in the contract.

iv. The diverted sewage will be taken to sewage treatment plant for tertiary level treatment. Treatment guidelines are specified elsewhere (Report No. 003_GBP_IIT_EQP_S&R_02). Effluent standards will be the following: BOD < 10 mg/L; SS < 5 mg/L; fully nitrified effluent; P < 0.5 mg/L; FC < 10/100 mL; bioassay test. These standards will be specified in the contact and will not change during the contract period.

v. Previously specified and guaranteed annual payments will be made to the service provider based on the amount of treated water of the specified quality delivered at certain pre-determined points specified in the contract.

vi. It is expected that a robust market for the treated water, and sludge-derived products will be developed through the joint efforts of the service provider and ULB during the initial contract period (i.e., initial 5 – 15 years after commissioning, when the central and state governments reimburse the ULB for operation and maintenance costs). Income generated from such activities will enable the ULBs to operate and maintain the created infrastructure in the period beyond the initial contact period with the service provider.

Recommendations and Actions Required:

1. *Henceforth, all new sewage treatment plants and associated sewage pumping stations ('actionable' items 4.5.1 and 4.5.2 in proposed URMPs) should be constructed and managed together, i.e., by the same agency using the DBFO model.*
2. *The sewage pumping and treatment infrastructure should be built in a modular fashion such that the pumping and treatment capacity is approximately the same as the actual sewage collected/available.*
3. *All new sewage treatment plants sanctioned by the NGRBA should require treatment up to tertiary level (as specified in Report 003_GBP_IIT_EQP_S&R 02) and should be funded by the DBFO model as specified in this report.*
4. *As per the proposed DBFO Model, payments will be made to the service provider in annuities spread over the contract period during the operation and maintenance phase of the project. The payments will be linked to the actual amount of treated sewage (of specified quality) produced by the service provider.*
5. *All necessary clearances, permissions, etc. required by NGRBA for funding of sewage pumping stations and treatment plants using the DBFO model should be obtained.*
6. *The process of empanelment of reputed service providers interested in participating in construction, operation and maintenance of sewage treatment plants through the DBFO route should be started.*

9. DBFO Model: Public Monitoring

In order for the DBFO model as proposed above to work and give the desired results, monitoring of the project by the members of general public, NGOs and other Civil Society Organizations (CSOs) is also necessary. These organizations can be used for project monitoring in the following ways.

- One of the major objectives for the creation of sewage diversion and treatment infrastructure is to ensure that ultimately no sewage either treated or untreated flows into the river. NGOs/CSOs can be given the task of monitoring that this is indeed the case.
- Another objective for the creation of sewage diversion and treatment infrastructure is to ensure that all sewage is treated to the tertiary level (treatment guidelines for tertiary treatment specified elsewhere (IIT Report 003_GBP_IIT_EQP_S&R_02); effluent standards: BOD < 10 mg/L; SS < 5 mg/L; fully nitrified; P < 0.5 mg/L; FC < 10/100 mL) and hence is suitable for reuse. The treated sewage may be diverted to a reservoir which may in turn be developed as a picnic spot open to the general public. The monitoring is to be done through public participation (e.g. committee of eminent citizens and communication through mass media on daily basis). This will put pressure on the ULB and service provider to ensure efficient sewage treatment.
- Multi-media social awareness campaigns can be carried out by various CSOs to inform the general public about the initiatives taken for cleaning the river etc. in their town. This will raise the general awareness and put pressure on the authorities to operate and maintain the facilities in an efficient manner.

The proposals for public monitoring of the sewage diversion, pumping and treatment infrastructure given in this section are preliminary in nature. A detailed plan for public monitoring will be developed in accordance with the relevant sections of the Water (Prevention and Control) Act after extensive discussions with NGOs and other CSOs and submitted to NGRBA in due course of time.