SUGGESTED REVISION IN STANDARDS OF TREATMENT OF DOMESTIC SEWAGE FOR PROMOTION OF WASTE-WATER RECYCLING IN INDIA**

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** *Paper presented at the "Blue Revolution – A Paradigm Shift: International Conference on Water, Sanitation and Recycling" organized by MACCIA at Mumbai in March, 2014.*

Summary:

The discharge of partially treated and/or untreated sewage into rivers and other water bodies is a fundamental cause of water pollution which, in turn, is responsible for most water-borne diseases and public ill-health. Implementation of existing effluent standards for domestic sewage has not yielded results of even minimum satisfaction level. As a result most of the water bodies in the country continue to be polluted. Taking a quick review of the historical actions and inactions in this context, the author has attempted a proposal for amelioration of the present situation by suggesting more stringent standards for treated domestic sewage by application of environmentally sound technologies (BATNEEC) irrespective of its disposal location.

1. Introduction

The vision of the Eleventh Plan included a clear commitment to pursue a development process that is environmentally sustainable. It is based on a strategy that not only preserves and maintains natural resources but also provides equitable access to those denied this currently. It recognizes that unless environment protection is at the core/center stage of all policy formulation, development if pursued may actually lead to deterioration in the quality of life. This will be discernible in the generally worsening quality of air in our cities and even our villages, in the increasingly polluted waters of our lakes and rivers, the loss of biodiversity, and the shrinking habitats of wildlife. Translating the vision of environmental sustainability will require that environment concerns are given a very high priority in development planning at all levels.

2. Why protection?

The Eleventh Plan laid great emphasis on achieving among other things, monitor-able socio-economic targets within the Environment and Forests sector to treat all urban waste water by 2011-12 thereby cleaning river waters. Cleaning of major polluted rivers by 2007 and stretches by 2012 was a Tenth Plan target. The Eleventh Plan set a target of treating all urban waste water by 2011-12 to clean river waters. As per Central Pollution Control Board's

(CPCB) survey, the estimated wastewater generation in 2008 from class I & II towns in the country was around 36,000 MLD (1, 67,400 MLD by 2025) against which treatment capacity of only 7,650 MLD exists at present. Sewage treatment capacity of about 3,939 MLD (about 52%) has been created under the Ganga Action Plan-I (GAP) and National River Conservation Programme (NRCP). The available treatment capacity is hopelessly inadequate.

3. The National Ganga River Basin Authority (NGRBA) has now been setup, a fast track project approval mechanism is being put in place, and a change in the funding pattern from existing 70:30 to 90:10 is being considered. Therefore a target of 11,000 MLD [5,500 MLD each under Jawaharlal Nehru National Urban Renewal Mission (JNNURM) and NRCP] in treatment capacity should be the target for the Eleventh Plan. The Ministry of Environment and Forests and the Ministry of Urban Development could apportion the capacity that could be established as suggested by the Planning Commission.

4. Sanctioning and monitoring of works under NRCP and National Lake Conservation Program (NLCP) for improving the water quality of rivers and lakes, respectively is the objective which also includes reducing pollution load in major rivers through pollution abatement works. 150 major polluted stretches on 37 rivers have been identified by CPCB. NRCP only covers 40 polluted stretches.

5. Adverse effects (surface water, ground water, soil)

The disposal of untreated or partially treated sewage and industrial waste water is the main cause of water pollution in India causing and/threatening the structure and function of the recipient ecosystem. Adverse effects of water pollution on environment and health are very well documented. There is no need to emphasize remedial actions that must to be taken by all concerned agencies systematically over a period of time so as to achieve the goals of the Water (Prevention and Control of Pollution) Act, 1974 and the Environment (Protection) Act, 1986.

6. Legal Provisions

Standards: It is mandatory under Indian law that nobody will discharge sewage or trade effluent (e.g. industrial waste water) without complying with the notified environmental standards laid down for its treatment and disposal. Schedule VI (see Rule 3A) notified under the Environment (Protection) Act, 1986 provides general standards for environmental discharge waste water. Some of the standards for important parameters are presented below:

Sr. No.	Parameters, mg/lit except pH	Standards			
		Inland Surface Water	Public Sewers	Land for Irrigation	Marine Coastal Areas
1	pH	5.5 to 9.0	5.5 to 9.0	5.5 to 9.0	5.5 to 9.0
2	BOD	30	350	100	100
3	COD	250	---	---	250
4	Suspended Solids	100	600	200	a) 100: for process waste water b) 10% above influent for cooling waters
5	Oil & Grease	10	20	10	20

7. Primary Water Quality Criteria: In a water body or its part, water is subjected to several types of uses. Depending on the types of uses and activities, water quality criteria have been specified to determine its suitability for particular purposes. Among the various types of users there is one use that demands the highest level of water quality or purity and that is termed as "Designated Best Use" in that stretch of water body. Based on this, water quality requirements have been specified for the different uses in terms of primary water quality criteria. The Schedule I (see Rule 3) notified under the Environment (Protection) Act, 1986 at serial no. 93 in Table 1 provides stipulated primary water quality criteria for bathing water (water used for organized bathing). The table is reproduced as below:

CRITERIA		RATIONALE
Fecal Coliform, PN/100 mL:	500 (desirable) 2500 (Maximum permissible	To ensure low sewage contamination. Fecal coliform and fecal streptococci are considered as they reflect the bacterial pathogenicity.
2. Fecal Streptococci MPN/100 mL:	500 (desirable) 2500 (Maximum permissible)	The desirable and permissible limits are suggested to allow for fluctuation in environmental conditions such as seasonal change, changes in flow conditions etc.
3.. pH:	Between 6.5 – 8.5	The range provides protection to the skin and delicate organs like eyes, nose, and ears etc. which are directly exposed during outdoor bathing.
4. Dissolved Oxygen:	5mg/lit or more	The minimum dissolved oxygen concentration of 5mg/L ensures reasonable freedom from oxygen consuming organic pollution immediately upstream which is necessary for preventing production of anaerobic gases (obnoxious gases) from sediment.
5. Biochemical Oxygen Demand,	3mg/lit or less	The Biochemical Oxygen Demand of 3mg/L or less of the water ensures reasonable

CRITERIA		RATIONALE
3 day, 27^{o}C		freedom from oxygen demanding pollutants and prevent production of obnoxious gases.

8. In the coastal segment, marine water is subjected to several types of uses. Depending on the types of uses and activities, water quality criteria have been specified to determine its suitability for particular purposes. Among the various types of uses there is one use that demands highest level of water quality/purity and that is termed as "Designated Best Use" in that stretch of the coastal segment. Based on this, primary water quality criteria have been specified for the following five designated best uses:

Class	Designated best use
SW-I	Salt Pans, Shell fishing, Mariculture and Ecologically Sensitive Zones.
SW-II	Bathing, Contact Water Sports and Commercial fishing.
SW-III	Industrial Cooling, Recreation (non-contact) and Aesthetics.
SW-IV	Harbor.
SW-V	Navigation and Controlled Waste Disposal.

9. Existing Standard of BOD 30mg/lit: Why not ecologically effective?

The quantum of organic pollution load in each urban locality is relevant for assessing the water pollution hazard, but the actual manner of disposal of the load is of greater importance for control and management of pollution. In many towns, a substantial amount of the load is discharged directly into the water bodies, causing stream pollution.

10. On account of the large rural population, a significant amount of organic waste is generated in village environments. There are certain rural settlements where the density of the population is high enough to require a more organized treatment and disposal of the organic wastes generated within the community. In the urban and suburban situations, where there are large dairies, feed lots, slaughter houses or tanneries, the impact of the organic load on the environment as well as stream pollution is significantly higher.

11. The receiving water bodies, especially rivers and lakes, do not have adequate flow or quantity of water available to provide adequate dilution of at least ten times for treated water having final BOD of 30mg/lit. This is the most stringent national standard for the disposal of treated sewage or trade effluent into surface water streams. This standard does not include removal of nitrogen and phosphorous which are responsible for and cause eutrophication.

12. In view of the facts mentioned above regarding organic load hazard from non-point sources (of untreated sewage and trade effluent) and discharges from organized point sources complying with the more stringent national standard of BOD of 30mg/lit, the rivers and lakes continue to remain polluted and their water does not generally meet the Water Quality Criteria for the Designated Best Use as prescribed and ought to be achieved by way of enforcement of the Water (Prevention and Control of Pollution) Act, 1974 and the Environment (Protection) Act, 1986. As a result, most of the water bodies are still polluted across the country.

13. Neglect of waste disposal has ended up in corroding the organic cycle and affecting human beings. For instance, discharge of partially treated and/or untreated sewage into rivers and other water bodies is a fundamental cause of water pollution which, in turn, is responsible for most water-borne diseases. People living on river banks have been found to suffer from several ailments caused by microorganisms penetrating the food chain through water sources.

14. The efforts of 36 years in the implementation of the Water (Prevention and Control of Pollution) Act, 1974 and 25 years of implementation of the Environment (Protection) Act, 1986 have not yielded results of minimum satisfaction level. The BOD standard of 30mg/lit was set up in early 1970s. In the last 40 years several technological developments have taken place. New technologies are more efficient and more cost effective. They can deliver 4 to 5 times better results as compared with those of conventional technologies based on the standards that were set up in the 1970s under the Water (P&CP) Act, 1974.

15. It is therefore important to take a serious review of all historical actions and inactions and prepare for amelioration as early as possible – as time is running out. One of the actions that is most logical and immediate is to make more stringent standards for disposal of treated sewage and trade effluent in water bodies and stopping the land disposal of even untreated/partially treated waste water. To achieve this, the most advanced environmentally sound technologies that are cost effective and robust in terms of operation and maintenance must be implemented and incentivized.

16. Experience of Maharashtra Pollution Control Board (MPCB)

The MPCB in the early 1990s was the first State Pollution Control Board in the country to come up with a River Policy for the prevention and control of water pollution due to direct discharge of treated, partially treated or untreated waste water. The Board prepared then a negative list of locations for new industries and even for the expansion of existing units that were highly polluting and

categorized as “red” by the CPCB. Concerted efforts were made by the Board and it was considerably successful in terms of controlling direct discharges of effluents into the rivers.

17. The MPCB came down heavily on polluters and enforced land disposal of waste water across the State by prescribing land disposal standards as notified by the CPCB (e.g., 100mg/lit BOD for land irrigation and 500mg/lit BOD with controlled irrigation on land. During this time, the Union Ministry of Environment and Forests (MoEF) and CPCB also intensified pressure on the SPCBs and on the 17 categories of Highly Polluting Industries (Red Category) to stop direct discharge of effluents into the rivers and water bodies.

18. Pursuing the policy of disposal of waste water on land for more than one decade was not without bad news. It was not feasible to verify compliance with regulatory standards for the treated effluent before or while it was disposed on land. There have been instances when the effluent discharged on land far exceeded the limits stipulated. A scientifically well planned program of ground water quality monitoring was not in place. The indiscriminate land disposal of treated, partially treated or untreated effluent caused contamination of ground water in many areas. Public complaints and agitations increased. The affected people started demanding compensation and supply of reticulated water from MIDC and State Government departments. The use of contaminated water caused adverse effects on environment and health. Concerns were raised in the legislature. The Board was under pressure to take actions against defaulters.

19. In the year 2005-06, MPCB commissioned NEERI to undertake a survey of two MIDC industrial clusters for assessment of the status of soil, plant and ground water following land disposal of industrial waste water. It was observed that the treated waste waters were disposed on land in an unplanned manner without considering the soil characteristics. This resulted in the contamination of ground water. Based on the environmental consideration and findings of NEERI’s report, the Board started stipulating a BOD standard of 30mg/lit irrespective of the receiving body. The land disposal standard for sewage and trade effluent was prescribed by the MPCB as 30mg/lit. It was within the powers of the State Pollution Control Board to further tighten the Minimal National Standard depending upon the local requirements.

20. These measures coupled with rain water harvesting and dilution over a period of time could improve the quality of ground water and help maintain river/lake water quality. In the meanwhile, the MPC Board encouraged a local body at Navi Mumbai to adopt advanced technology for sewage treatment which was cheaper and more effective than the conventional method of treatment and

robust in terms of operation and maintenance. During the year 2006, the MPC Board issued Consent to Establish under Water (P&CP) Act, 1974 to four sewage treatment plants, for the first time in India, based on modern, optimized and automated technologies with stipulation of BOD at 5mg/lit and recycling of treated water for non-potable purposes. The four STPs were completed in the year 2008 and 2009 and are running successfully.

21. Experience of Municipalities

Sewage treatment and disposal is essentially managed by the municipal authorities (Local Self Governments). As on date about 300 sewage treatment and disposal projects are under different stages of implementation. The sewage effluent treatment standard applicable is, BOD <30mg/lit. Out of these, however, there are at least 70 sewage treatment plants based on Best Available Technology Not Entailing Excessive Costs (BATNEEC) advanced technology of Sewage Treatment. They will achieve an average of BOD 5mg/L for treated sewage with maximum being <10 mg/lit. Treated sewage will be suited for recycling/reusing for non-potable purposes.

22. When 70 odd local bodies have already adopted modern (new generation) technology for sewage treatment and can achieve BOD 5mg/lit, average and maximum being 10 mg/lit makes a fit case for making more stringent standards and doing best possible as of today.

23. Economical effectiveness of technology

Economics of each technology is identified in two parts: 1. Capital investment of the plant and 2. Operation and Maintenance (O&M) cost. The capital investment for a project is based on the type of technology being used. It is essential to use Best Available Technology Not Entailing Excessive Costs (BATNEEC). It has been observed with the experience of various local bodies that vendors are interested in in establishing of plants rather than operation and maintenance of sewage treatment plants.

24. O&M of these plants requires technical personnel with good experience and knowledge of legal provisions of environment. Also the revenues from O&M business are not as lucrative as those from construction of plant. Hence the local bodies either employ services of contractors who are willing to do the work at very low cost or these corporations are conducting O&M of these plants on their own; however they do not have the technical personnel to undertake the O&M.

25. The new generation of technology provides the balance between capital cost and O&M cost. As stated earlier, O&M component is essential for any

technology. Use of better and new technologies for producing BOD < 5mg/lit at outlet has the following advantages:

- Process automation reduces dependence on personnel for making technical judgments.

- Reduced carbon footprint has been a requirement for all STPs as conventional methods of sewage treatment have been criticized for excessive use of power. There has been reduction in power consumption due to automation and used of PLC's in sewage treatment operations as the system is optimized to achieve the precise value of dissolved oxygen for best appropriate operation.

- In the current scenario where land resources are under tremendous pressure leading to escalated land costs, minimum use of land for such projects is desirable. Modern technologies such as SBR, MBR, MBBR, RO etc. require less area for construction.

- Due to the use of new technologies, the O&M costs are lower per cubic meter of sewage treated. In case of a new technology there are opportunities for local bodies to reuse the water for non-potable purposes; the Navi Mumbai Municipal Corporation, for example, has invited bids for commercial use of this treated waste water for non-potable use. The revenue generated from sale of such water is 10-12 times more than the O&M costs; similarly Koradi Thermal Power Station is using treated sewage of Nagpur city for its process water requirements. Use of this quality of water for construction activities is also permissible, hence reducing pressure on existing water resources. Table below shows cost comparative between different sewage treatment technologies (O&M)

26. Efficient O&M of STPs is important to sustain the treatment of waste water. It is essential to consistently discharge treated waste water with minimum BOD. To achieve this, technology evaluation should be done in such a way that the technology in use should be more efficient, automated and require minimum manpower. Moreover the cost entailed during O&M should be low as much as possible so as to attract more private participation.

27. It is important here to note that many local bodies and corporations have already adopted these standards on their own following the success story of Navi Mumbai. Navi Mumbai Municipal Corporation and CIDCO for the first time in India adopted norms of treating domestic sewage to < 5 mg/lit of BOD and <10 mg/lit of TSS and also Nitrogen and Phosphorous removal standards

of TN < 10 mg/lit and TP < 1 mg/lit. This was primarily done to protect and safeguard the ecology of the Thane creek. Other predominant reason was a major techno economic benefit. The plants were built at a capital cost which matched the existing conventional processes and a much lower operating cost.

28. These corporations saved huge amounts in land requirements. Both these corporations have now pioneered treated sewage water recycling and intend to reuse existing treated sewage to save water and generate revenue. Thus, for the first time in the country they are converting Sewage Treatment Plants from a cost center to a revenue and water generation source. This model was fully backed and supported by MPCB. This model has now been well received and many states and corporations have now adopted on their own < 5 mg/lit and N&P removal standards. Most notably are Uttaranchal Peya Jal Nigam, Punjab Water Supply and Sewerage Board, Noida Development Authority, Ghaziabad Development Authority, Pune Municipal Corporation, Pimpri Chinchwad Municipal Corporation etc.

30. Where policy interventions are required and why?

The initiative for river conservation has gathered momentum not only at the government level but also in public forums. The time to prevent the pollution of rivers has come and gone: major rivers in the country are already highly polluted. Pune city, for example, is still discharging 325 MLD of untreated sewage into the Mula-Mutha Rivers. Further steps to prevent this discharge will require stringent conditions of disposal into these rivers.

31. NRCD is considering funding the increase in capacity of sewage treatment in various cities including Pune; however the guidelines for the Detailed Project Report require that the discharge standard to rivers for BOD should be less than 30mg/L. Any of the above mentioned technologies are adequate to achieve these results; however, discharging treated waste water at the current standard is not at all adequate. Moreover, the water availability for dilution of this discharged waste water is not sufficient hence the standards for discharge should be made stricter i.e. BOD of 5mg/lit (average) with maximum permissible limit of <10 mg/lit for which the treated sewage water is also then suited for recycle/reuse for non-potable purposes.

32. Funds available under JNNURM and NRCD/GAP for sewage collection, treatment and disposal are unprecedented allocations since India's Independence in 1947. It is most important for the success of these programs that environmentally sound technologies (BATNEEC) are adopted for achieving most stringent standards of BOD of 5mg/lit (average) with maximum

permissible limit of <10 mg/L and the treated sewage water is then also suited for recycle/reuse for non-potable purposes.

33. Issuance of suitable directions in this regard under Section 5 of the Environment (Protection) Act, 1986 to the concerned authorities and to the local bodies must be considered the Government and Pollution Control Board. Disposal of treated water having BOD of 5mg/lit (average) with maximum permissible limit of <10 mg/lit in to the river will also augment structure and function of riverine ecosystem.

34. It is imperative that the MoEF and NRCD consider making the discharge standards more stringent in their guidelines for the preparation of the Detailed Project Report. Over the years millions of rupees have been spent by various government authorities for construction of sewage treatment plants at current BOD discharge concentrations; still these investments have not resulted in reduction of pollution of rivers due to inadequate capacities and inefficient O&M of existing plants.

35. Need for stringent standards

State Governments, JNNURM, National River Conservation Directorate (NRCD) and other agencies have recognized the value of modern technologies and it is being considered, among other things, for installation for sewage treatment plants in big cities and small and medium towns in the country. Table summary of results of treated sewage standards achieved at Navi Mumbai are given below for illustration.

36. The technology options in this paper are illustrated only to establish the fact that it is practically feasible in India to improvise the level of sewage treatment so as to significantly reduce the BOD standard of 30mg/lit. Even removal of Nitrogen and Phosphorous is possible. The standards to this effect are therefore required to be stipulated in terms of following parameters, as far as sewage treatment is concerned:

BOD, 3day, $27^{o}C$	**5 mg/lit,** average of 50 readings in a month (8-hourly, flow-based composite sampling) with maximum permissible limit of 10 mg/lit for any five readings.
Total Nitrogen (TN)	**$\underline{<}$ 10mg/lit**
Ammoniacal Nitrogen (NH_3N)	**$\underline{<}$ 2mg/lit**
Total Phosphorus	**$\underline{<}$ 1mg/lit**
Chemical Oxygen Demand	**$\underline{<}$ 25 mg/lit**

Total Suspended Solids	**≤ 10 mg/lit**
pH	**7.0 to 9.0**
Dissolved Oxygen	**≤ 2 mg/lit**

37. Conclusions

The discharge of partially treated and/or untreated sewage into rivers and other water bodies is a fundamental cause of water pollution which, in turn, is responsible for most water-borne diseases and public ill-health. People living on river banks have been found to suffer from several ailments caused by microorganisms penetrating the food chain through contaminated water sources.

38. The implementation of standard of BOD, 30mg/lit for sewage treatment and its stream disposal has not succeeded environmentally in India mainly due to lack of availability of dilution water in the recipient water bodies (e.g., rivers and lakes) and inadequate capacity for sewage treatment.

39. The conventional sewage treatment plants are not cost-effective and land requirement for such plants is greater when compared to available advanced technologies. They are also labor and energy-intensive. Operation and maintenance is also not robust. Thousands of crores of rupees have been spent in the last two decades for installing sewage treatment plants designed to give outlet BOD of 30mg/lit but this has not improved the stream water quality to meet the best designated use.

40. It has therefore become necessary to set more stringent standards for disposal of treated sewage and trade effluent in water bodies and to stop the land disposal of untreated/partially treated water. The most advanced environmentally sound technologies that are cost-effective and robust in terms of operation & maintenance must be implemented and incentivized.

41. Advanced technology options are now available and are being used in India. Their successful implementation in the last five years has improved the level of sewage treatment far beyond regulatory compliance with the BOD standard of 30mg/L historically required in India. With achievement of BOD of 5mg/L, it has become possible to recycle treated sewage effluent for non-potable purposes or grey use in water-scarce towns.

42. The availability of funds for development of infrastructure for environment protection has been phenomenal in post-independent India. The utilization of these must yield environmentally sustainable gains over a period of time.

43. Since it is techno-economically feasible in Indian conditions to achieve standards of BOD 5mg/lit for domestic sewage and this should be irrespective

of the receiving water body (e.g. rivers, lakes, coast and land application too), there is a need to revise the existing standards accordingly. MoEF might consider stipulation of effluent treatment standards exclusively for domestic sewage as existing standards of BOD 30mg/lit for disposal into streams are applicable for both sewage and trade effluent.

44. For effective utilization of funds and to achieve the goals of sustainable development it is imperative that BOD of treated sewage must be brought down as low as possible by application of environmentally sound technologies (BATNEEC) as suggested in earlier paragraph at serial no. 38. Suitable directions under Section 5 of the Environment (Protection) Act, 1986 should also be issued to the concerned authorities and to the local bodies for achieving limits for treated sewage as under:

BOD, 3day, $27^{o}C$	**5 mg/lit,** average of 50 readings in a month (8-hourly, flow-based composite sampling) with maximum permissible limit of 10 mg/lit for any five readings.
Total Nitrogen (TN)	**≤10mg/lit**
Ammoniacal Nitrogen (NH_3N)	**≤ 2mg/lit**
Total Phosphorus	**≤ 1mg/lit**
Chemical Oxygen Demand	**≤ 25 mg/lit**
Total Suspended Solids	**≤ 10 mg/lit**
pH	**7.0 to 9.0**
Dissolved Oxygen	**≤ 2 mg/lit**

45. When the technology available in the country can yield treated sewage of BOD <5mg/lit, it would be prudent to revise the standard based on techno-economic feasibility. The stipulation of a standard for BOD of <5mg/lit along with the removal of nitrogen and phosphorous should be considered for sewage treatment with immediate effect. Enforcement of environmentally sound technology applications for sewage treatment would also encourage innovations for newer technologies.

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PS: *The author is also Ex Member Secretary of Maharashtra Pollution Control Board and was Expert Member of Consultative Group for Environment, Forests and Wildlife Sector for the 11th Five Year Plan Mid Term Appraisal constituted vide Office Memorandum No. M-13033/2/2009-E&F, by the Government of India, Planning Commission (Environment and Forests Division) dated 29.09.2009. The information and data used in this paper from Planning Commission is gratefully acknowledged.*