Report on the pollution in Bandi river by textile industries

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CONTENTS

A. Background

Almost one and a half years have passed since the New Delhi based Centre for Science and Environment (CSE) released its first study in May 2006 on heavy metal contamination in the Bandi basin due to textile dyeing and printing industries in Pali city. This research was initiated in November 2005 on the request of *Sri Kisan Paryavaran Sangarsh Samiti*, a farmers group spearheading the fight against the surface and groundwater pollution by industries. The study found that pollution management system in Pali was in shambles with only 45 per cent of the effluents generated were tapped for treatment before disposal into the river. Even the effluent reaching the common effluent treatment plants (CETPs) was inadequately treated as they were badly designed and operated. The partially treated and untreated wastewater was mixed and discharged into the dry river and finally dammed 50 km downstream at Nehda leading to groundwater contamination severely impacting livelihood and public health. The study outlined the need for a rethink in pollution management strategies so that the health and livelihood of thousands of villagers downstream Pali could be saved. The administration and the industry agreed that there were problems and assured of action.

In May 2007, CSE revisited the area to assess the water quality in the Bandi river basin preceding a good monsoon in 2006 and in the wake of the initiatives of the industry. What we found is that the industry and the government have, no doubt, put in a lot of efforts and invested a lot of money in the name of pollution control. Even the pollution cess collected from individual industries has also been enhanced by twenty five rupees to Rs 90 per 100 kilogrammes[1] of raw cloth compared to 2005-2006, to fund for running of CETPs. Our water quality assessment detected that all these hardware investments have once again failed to clean up the river, which is a seasonal drain. And most importantly, there is no reprieve for the farmers. They still continue to fight the system that has dirtied its environs demanding clean water and to regain their right to cultivate.

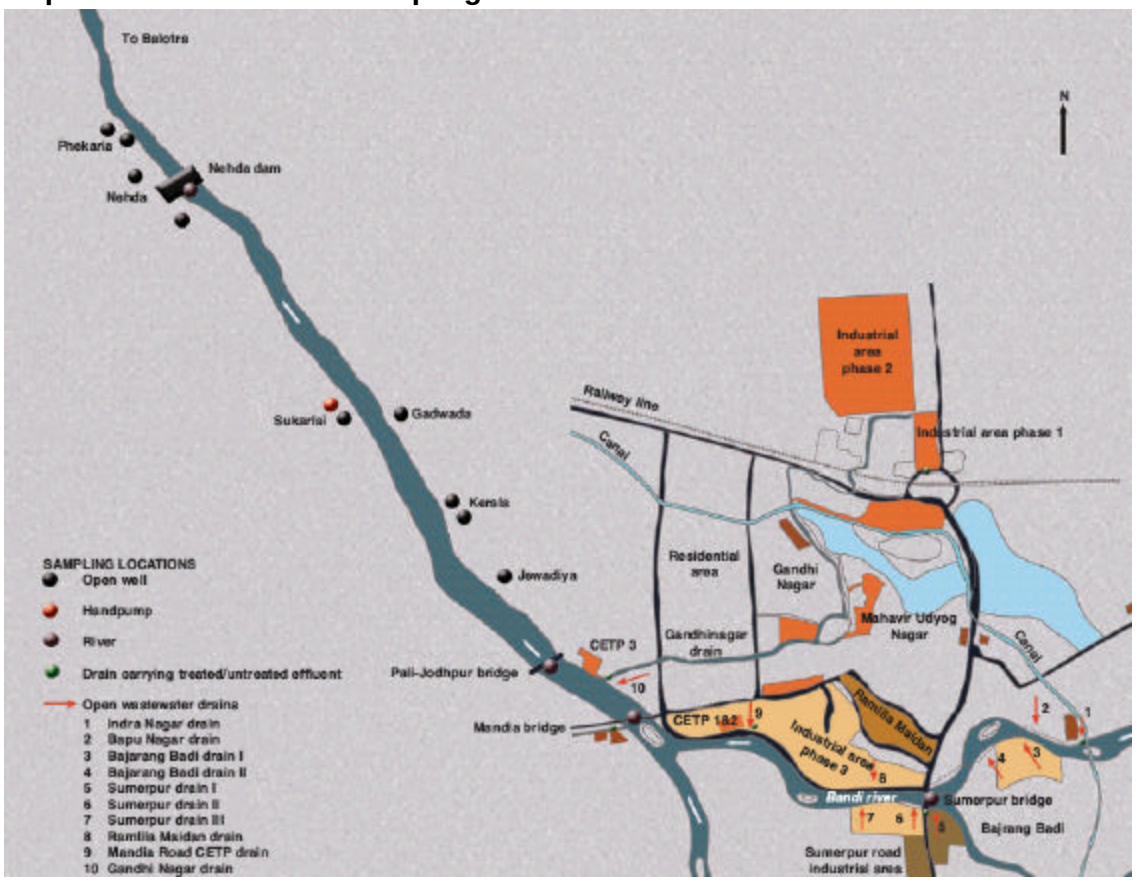
Pali's pollution, and the farmer's protest cannot be ignored forever. The situation needs to change, as it is a public health issue and most importantly an issue of the very survival of thousands of villagers. And we need to act very fast. We must remember that money is not the answer, we need out of the box solutions.

B. What we have found?

The CSE research team, which visited Pali during May 8-10, 2007, collected forty-six water/effluent samples from CETPs, drains, river and groundwater. Effluent samples were collected from the three CETPs (inlet and outlet), from the three drains (Indira Colony drain, Subash Nagar drain and the Mandia road bridge drain), from the river at nine locations (3 within the city and 6 downstream) and groundwater samples from ten wells spread across six villages downstream of Pali city. (see annexure 1: CSE's water quality sampling locations). The team held discussions with the CETP officials, district administration including the groundwater department and the municipal corporation engineers and the farmers.

The results, needless to say, are rather depressing—the river and the groundwater still remain polluted. And it is very evident that the pollution debate has not moved forward. There are many issues that need urgent attention and action as listed below. A detailed description of the key issues is given below:

Map: Bandi river and the sampling locations



1. About sixty per cent of wastewater is discharged untreated

During the CSE's study it was found that though capacity exist to treat 66 per cent of wastewater generated, only about 40 per cent of the waste was treated. There is definitely a gap between the amount of waste generated and the treatment capacity available. Also, there is an issue of under utilisation. But before any one attempts to augment the treatment capacity, following issues need to be sorted out.

i. Suspect data: As reported in the May 2006 report, even today there are no authentic estimates on the amount of waste that is generated. The data that is frequently quoted by the RSPCB shows that the effluent generation was to the tune of 34 million litres per day (mld) as against the installed treatment capacity of 22.7 mld. This data dates back to 1993, when the Nagpur based National Environmental Engineering Research Institute (NEERI) mapped ten drains that criss-crossed the city and estimated its flow to be about 34 mld.[2] Though the RSPCB by its own submission accepts that the amount of wastewater generated is much higher than what is treated in the CETPs and that the quantity shoots up during the winter season when the demand in the domestic and international markets are high, there is no recent data available.

It was informed that the Pali regional office of the RSPCB has initiated a survey to assess the same. As per the initial findings as many as sixteen industries have increased their production capacity (to the tune of 2 to 18 times), where as about 35 industries switched from cotton to synthetics without any permission. Similarly it is reported that the domestic wastewater generation has also increased from the 4 mld reported earlier. According to the data provided by Pali Municipal Corporation the water supply is to the tune of 25 mld and proportionately the waste generated is about 20 mld, which flows into ponds and lakes and the river Bandi itself.

ii. Drainage system is inadequate and improper

Pali has not worked on its drainage system and still continues to be appalling. Some of the drains are lined and some of them lead to the CETPs, where as the rest empties the untreated effluents into the river. The drain at Sumerpur bridge and Mandia road bridge is just a case in point. Even the siphon arrangement made in the river to pump the effluents in the CETP was found to be leaking into the riverbed. Meanwhile, the Pali CETP managers have spend a little above Rs 1 crore in lining the Gandhi Nagar drain—carrying industrial and domestic waste. Ironically, even the flow in this drain is not fully tapped for treatment. As mentioned earlier, the data on the flow in the drains is almost fourteen years old. The RSPCB shockingly does not have any details regarding the quantity and quality of flow in these drains.

iii. CETPs under utilised: As per the existing conditions even if the CETPs are fully functional about 66 per cent of the waste can be treated. But the reality is that the CETPs are not run at full capacity all the time. At the time of CSE's study only CETP II was fully utilised. CETP III was operated at about 60 per cent efficiency and CETP I was under renovation. This essentially meant that about 18 mld or 56 per cent wastewater was flowing untreated into the river. (see annexure 2: Utilisation levels of CETPs during May 2007) This scenario continued from September 2006 till May 2007 in the name of repair and renovation of CETPs. No action what so ever was taken to operate the industries in a phased manner depending on the treatment capacity operational at a given time, so as to ensure treatment of entire waste. Instead, what was preferred was

to either shut down or run the CETP at a lower capacity adding to the pollution woes of the river.

iv. CETPs bypass effluents: Most importantly, effluent bypass arrangements exist at the inlet of all the three CETPs. Lack of monitoring gives a free hand to the CETP operators to let off untreated waste into the river as per their convenience. Though the earlier CSE report on Pali has pointed this out, no action whatsoever has been initiated.

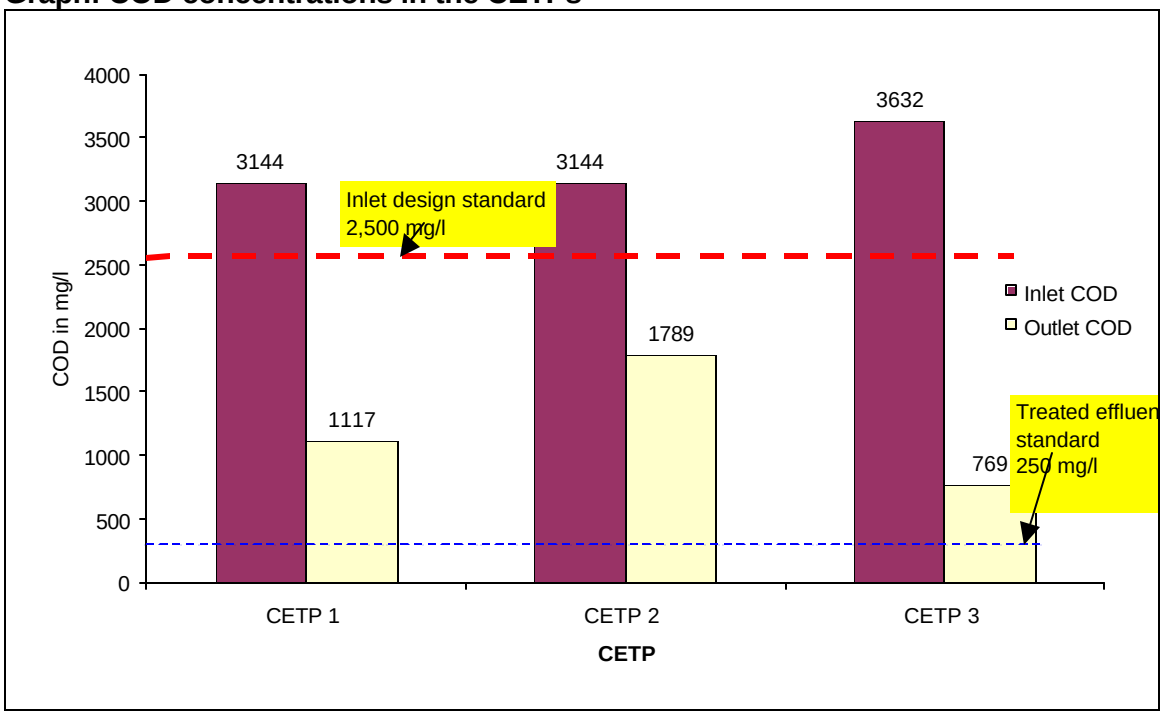
iv. 'Illegal' waste remains untouched: There is also the issue of 'illegal' waste—generated by the industries illegally operating in the Bajrang Badi, Sumerpur and Indira Nagar colony area. These industries, according to the RSPCB, generate about 6.9 mld wastewater which is neither tapped nor treated. The CETP Trust informed that a 1.5 kilometre long lined drain and a sump well was being made to tap the waste from these industries. These industries, says the government and RSPCB, is likely to be shifted to Punayata road industrial area and the Union ministry of textiles have already sanctioned Rs 5.99 crore for the construction of a 12 mld CETP. The RSPCB officials informed that there is a controversy over shifting of the illegal industries and the matter being sub-judice no action has been initiated. The issue of relocation had been lingering on for a long time and it is high time that an action is taken to stop the flow of untreated effluent from this area into the river. The regulators need to ensure that not a drop of untreated waste, whether legal or illegal, is discharged into the river. If industries are unwilling the same shall be closed down as it is in violation of the law of the land. Even the volume of 12 mld needs a thorough reassessment before the plans are drawn up.

2. Upgraded CETPs violate discharge norms

Along side the issue of optimal utilisation is the issue of effectiveness of treatment plants. One of the major works that happened during 2005-2007 was the upgradation of the CETPs. It was argued that the upgradation would equip the CETPs to deal with the changed characteristics of wastewater that resulted from the alterations in the textile production processes over the past few years. All the three CETPs were receiving effluents with pollution levels higher than what it could actually treat and hence the effluent discharge standards were violated. (see box: the CETP upgradation work)

a. CETPs do not meet the discharge norms: Despite spending huge sums of money the CETPs were not meeting the effluent disposal standards set by the Rajasthan State Pollution Control Board (RSPCB). Samples collected from the CETPs revealed that the COD norms were violated at the inlet as well as the outlet. At inlet the COD concentrations at the three CETPs ranged between 3,144 –3,632 mg/l—levels much higher than the revised inlet COD level of 2,500 mg/l. At the outlet COD values were in the range of 769 –1,789 mg/l, which again was 3 to 7 times higher than the effluent discharge standard of 250 mg/l. (See graph and annexure 3: COD concentrations in the CETPs)

Graph: COD concentrations in the CETPs



Source: Pollution Monitoring Lab, Centre for Science and Environment, New Delhi, May 2007; Sampling done on May 8, 2007 (4:30 - 4:40 pm at CETP I&II) and 5:30-5:45 pm at CETP III)

The CETP operators pointed out that partial treatment is due to the fact that only primary system in CETP I was operational and that the CETP III was under stabilisation. Even if those arguments were valid, what is rather shocking is the fact that the treated effluent from the CETP II, which was stabilised and fully functional at the time of inspection, was the worst with the COD values at outlet being seven times higher than the permissible limits. The treatment efficiency was also lowest in this CETP—a reduction of 43 per cent as compared to 78 per cent in CETP III. Despite not meeting the standards, the effluents are disposed off into the river Bandi. In its report of May 2006, CSE has raised some concerns over the upgradation process. One of the issues was that the revised inlet standards were fixed based on the observations of the CETP trust and not the outcome of any independent research or pre-feasibility studies. This essentially raises two issues: a. there is need for need for checks and balances on industries, which violate the CETP inlet standards and b. stricter monitoring of CETPs and enforcement of regulations by the RSPCB.

The heavy metals present in the effluents are also not monitored on a regular basis. Though found to be within the standards, CSE's analysis has detected the presence of all heavy metals including mercury. For instance, the levels of mercury at the outlet of CETP I & 2 ranged between 1.37 –5.5 ppb as compared to the discharge standard of 10 ppb. These standards are too lax given the fact that the river is dry and any amount of pollution present will neither be diluted nor assimilated by the river, but it will tend to accumulate. Besides initiating steps to revise the standards, a closer monitoring of the heavy metals on a regular basis is also required.

Box: CETP upgradation work

All CETPs—CETP I (4 mld) and CETP II (9.6 mld) at Mandia road and 9.08 mld CETP III at Punayata road— underwent a major facelift. Between November 2005 and May 2007, the Pali Water Pollution Control Research Foundation (PWPCRF) Trust who manages the CETPs mobilised Rs 18.86 crore from the Union ministry of textiles under the textile centre infrastructure development scheme (TCIDS) for various pollution control measures[1,2]. Of the approved amount about Rs 10 crore was earmarked for the upgrading the CETPs to deal with effluents having higher levels of total suspended solids (TSS), biochemical oxygen demand (BOD) and chemical oxygen demand (COD). (See annexure 4: inlet parameters at CETPs before and after upgradation). This is almost equivalent to the cost of Rs 8.13 crore spent since 1983 on the installation of the three CETPs with a treatment capacity of 22.7 mld.

The CETPs were operating on physico-chemical treatment followed by extended aeration and sedimentation but failed to meet the standards. The PWPCRF found that this was due to inefficient the chemical dosing and aeration systems. Under the upgradation programme facilities for modified chemical dosages were installed, better systems for mixing of effluents using diffused air jetting were installed. Equalisation tanks and aeration systems were also modified. Over and above these all the CETPs were provided with nutrient dosing for effective degradation of biological matter. The capacity of the CETP I was reduced by 1.2 mld and the same was augmented in CETP II. It was claimed and anticipated that the treated effluents from the upgraded CETPs would meet the discharge standards specified by the RSPCB.

As on May 2007, upgradation works of CETP II and CETP III were fully completed. CETP II and III Construction work in the clarifier was still ongoing and hence only the primary treatment system of the CETP I was operational. CETP II was operating at fully capacity whereas only 60 per cent capacity was utilised in CETP III. Arrangements for power back in CETP I, II and III were also being provided.

b. Effluent discharge standards for which the CETPs are designed are too lax and ineffective

The existing standards are fixed based on an assumption that the river is perennial and has freshwater to provide ten times dilution. However, the river being dry and lost its assimilative capacity, even if the CETPs operate efficiently, it will make no difference to the river and will continue to pollute the river, groundwater and land. While revising the standards, reuse of treated effluents for industrial applications shall be kept in mind.

[1] One of the main objectives of the TCID scheme is to provide the industry with world-class infrastructure facilities to meet international environmental and social standards

[2] Pali has three common effluent treatment plants (CETPs) established at the cost of Rs 8.13 crore. Of the three CETPs, two (CETP I and CETP II) receive waste from the Mandia road industrial area where it is located. Over hundred units located at industrial area Phase I and II, Mahaveer Udyog Nagar and Maharaja Shree Umaid mill are connected to CETP III situated at Punayata Road.[2] About 6.9 mld wastewater from the industries operating in the non-confirming areas like Bajrangbadi, Sumerpur road, Indira colony are not being treated and directly discharged into the river. Over and above this the city sewage of 4 mld also is taken into the Punayata road CETP

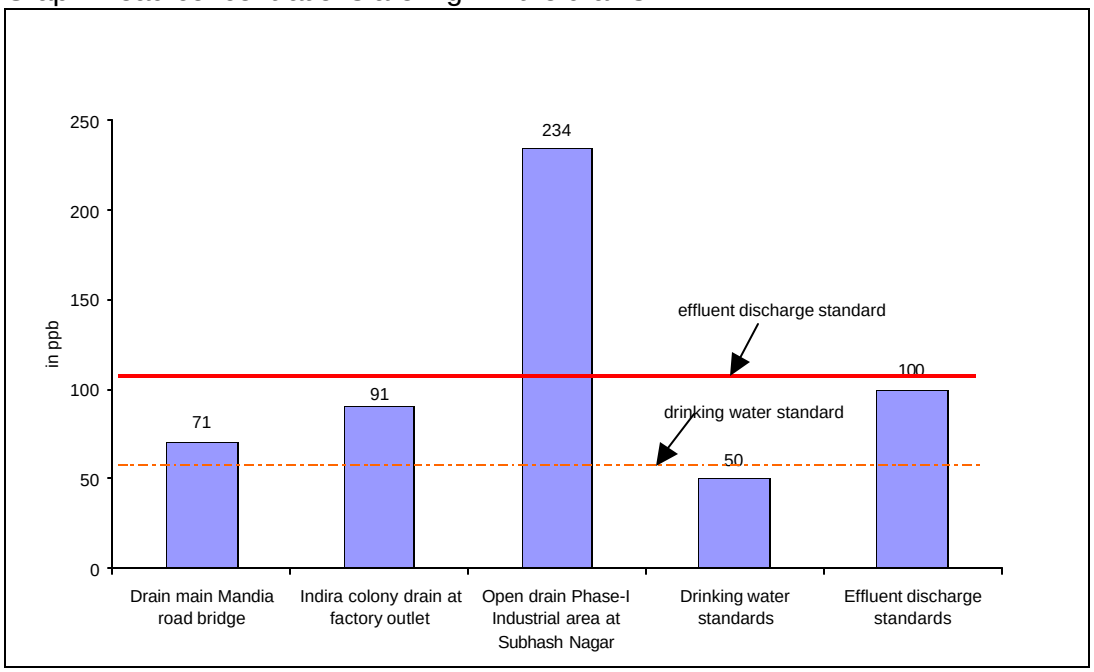
3. Extensive pollution in drains, river and groundwater

Pali city and its downstream villages are reeling under pollution caused by the industrial effluent on the drains, river and the groundwater.

i. Polluted drains: a threat to the city's groundwater: The samples collected and analysed from the three wastewater drains within the city— Indira Nagar Colony, drain at Mandia road bridge and open drain at Subhash Nagar in industrial area phase I— revealed the presence of heavy metals indicating presence of a cocktail of treated and untreated waste. Of the three, the first two drains discharge directly into the river without any treatment. What needs to be remembered is the fact that most of the drains being unlined leads to groundwater contamination within the city as well. Levels of copper, lead and arsenic levels were found to be higher than the drinking water standards set by the BIS (the level groundwater is expected to be) and hence there is a chance of groundwater contamination in the city. (See also annexure 5: Heavy metals in drains).

Even if we compare the observed values with effluent discharge standards which are more lenient than, drinking water standards, some of the parameters like lead were found to be higher. The levels of lead in the Subash Nagar drain were 2.34 times the limits set for effluent discharge (100 ppb) and almost 5 times higher than the drinking water standard. The concentrations in the Indira Nagar drain and the drain at Mandia road bridge were almost equal to the discharge standard. On the other hand if we compare the flow in the drains with what is expected to flow in the river (i.e, no heavy metals as there are no standards prescribed by the Central Pollution Control Board) then all parameters except cadmium and mercury are violated. (See graph: Lead concentrations are high in the drains)

Graph: Lead concentrations are high in the drains



Source: Pollution Monitoring Lab, Centre for Science and Environment, New Delhi, May 2007;

ii. River pays for ineffective pollution control mechanisms

For years, the river Bandi has continued to be an effluent drain due to inadequate pollution control strategies. The fact that there is no freshwater flow, except during monsoons to dilute and wash away all the chemicals discharged by the industries and the city population has only aggravated the pollution woes.

For water quality analysis, samples were lifted from nine locations in the river—three within the city and six downstream till about 50 kilometers. (see map). The CSE study detected eight heavy metals including mercury in different locations of the river within the city and downstream. Now comes the question of standards to which the observed values are to be compared. The Central Pollution Control Board have not specified any standard for heavy metals in river water, except for boron, for various uses. This, therefore means that the standard should be zero for heavy metals in river water and thus, any amount of heavy metal found in the river water is a violation of the standard. On a conservative side, we could compare the values with effluent discharge standards or the Bureau of Indian Standards (BIS) drinking water standards (IS 10500:1991). Such a comparison also revealed alarmingly high levels of heavy metal contamination.

a. River within the city: The analysis shows that maximum concentration of heavy metals in the river is observed in the three locations within the city. Peaks were observed at river at Mandia road (midstream) and the river after the Gandhinagar drain at Pali-Jodhpur bridge (downstream). To be more precise, the concentrations of copper, zinc, chromium and nickel are the highest at the downstream location within the city i.e, river after the Gandhinagar drain whereas lead, and arsenic concentrations peaked at the Mandia road bridge. (Annexure 6: Heavy metal concentration in river water within Pali city)

- ***Mandia road bridge:*** Lead is 1.77 times the effluent standards and 3.54 times drinking water standards; Arsenic levels are 18 times and chromium 7.86 times the drinking water standards
- ***Bandhi river after the Gandhinagar drain:*** Concentration of copper is 5.46 times the effluent discharge standards and 327 times the drinking water standards; Zinc is 1.6 times the drinking water standards. Mercury is 36 times drinking water discharge standard

b. River downstream Pali city: In the river downstream of Pali all heavy metals except mercury were detected. Even on comparison with drinking water standards, at most of the locations the heavy metal concentrations are alarmingly high. Hotspots where concentrations were higher than drinking water standards are listed below:

- Copper and Arsenic are higher at all locations—highest concentration of copper was observed at Sukarlai and Arsenic at Phekaria;
- Lead: Sukarlai and Jewadiya. Jewadiya recorded the highest level
- Chromium: Jewadiya, Kerala, Sukarlai. Highest level observed at Sukarlai

(see table: Heavy metal concentration in river water downstream of Pali city)

Table: Heavy metal concentration in Bandi river downstream of Pali city

S No	Location	Heavy metal concentrations in ppb					
		Copper	Lead	Chromium	Cadmium	Nickel	Arsenic
1	Bandi river at Jewadiya	171	99	56	ND	23	16
2	Bandi river at Kerala	176	20	70	ND	26	36
3	Bandi river at Gadwada	152	35	20	ND	24	34
4	Bandi river at Sukarlai	176	69	88	0.36	32	32
5	Bandi river at Nehda Dam	131	47	24	ND	21	27
6	Bandi river at Phekaria	140	24	30	ND	22	41
7	Drinking water standards	50	50	50	10	-	10
8	River water quality criteria of CPCB	**Zero (as standards are not specified)**					

Note: Shaded blocks indicate concentrations higher than drinking water standards
Source: Pollution Monitoring Lab, Centre for Science and Environment, New Delhi, May 2007

This contaminated water is stored at Nehda 50 kilometers downstream of Pali and is used for irrigation after the monsoon. In 2006, the dam over flew for about 6 days and the stored water was used for irrigation. The command area of the dam is about 1110 hectares. According to the villagers the first irrigation water was given during October 2006 and the second one during November and December 2006.

Thus the heavy metals in all likelihood would enter the food chain through the crops. Many villagers have complained that the land has turned infertile because of using the river water for irrigation due to the formation of thick layer of salts.

iii. Groundwater unfit for human use

Despite receiving bountiful rains[3] during the year 2006, the levels of pollution in the groundwater in Bandi river basin remains grim. Groundwater samples were collected for the study from six villages Jewadiya, Kerala, Gadwada, Sukarlai, Nehda and Phekaria along the banks of the river Bandi (Nine open wells and one hand pump (in Sukarlai near a village pond)). When compared with the drinking water standards (IS 10500:1991), these samples were found to be unfit for human consumption. Though villagers are not using the wells for drinking water purposes, most of them are still used for irrigation, indicating the possibility of these contaminants entering the food chain and human beings. The tests revealed that:

- ♣ Concentration of copper is higher than drinking water standards in five out of ten wells. Hand pump at Sukarlai recorded the highest concentration with 100 ppb.
- ♣ Lead is higher than the standards in five wells; Awad Danji Charan open well in Gadwada the level is 202.5 ppb (4.04 times the standard).

[3] with upstream locations (Deshuri) receiving almost three times (1180 mm) the average rainfall (396 mm)

- ♣ Arsenic is above drinking water standards in six wells out of the ten. Highest observed value is 262.07 (26.20 times the standard) found in Pukhraj Suthar well at Kerala village;
- ♣ Nickel concentration varies from 10.75 ppb lowest in Jewadiya to 68.26 ppb highest in Dhimdi well at Phekaria. However there is no limit set by BIS for nickel in drinking water. (see table: groundwater contamination profile of six villages)

Table: groundwater contamination profile of six villages

S No	Name of village	Contaminants in groundwater (no of times higher than drinking water standards)
1	Jewadiya	Copper (1.1 times) and Arsenic (4.2 times)
2	Kerala	Arsenic (1.8 to 26 times)
3	Gadwada	Lead (4 times)
4	Sukarlai	Copper (2 times), zinc (4.2 times), Lead (1.5 times) and Arsenic (1.4 times)
5	Nehda (u/s of dam)	Lead (3 times) and Arsenic (10.5 times)
6	Nehda (d/s of dam)	Copper (1.5 times), Lead 1.9 times),
7	Phekaria	Copper (1.6 times), Arsenic (1.4 times)

Source: Pollution Monitoring Lab, Centre for Science and Environment, New Delhi, May 2007;

C. Re-engineer the plans for pollution control and mitigation

It is clear that the pollution challenge is huge and business as usual is not going to help. A comprehensive plan for pollution control will require the involvement of RSPCB, Pali Municipal Corporation, CETP Trust, the industries and residents of Pali city. Besides these stakeholders active participation of the groundwater department and farmers would be required for embarking on a programme to dilute groundwater contamination.

Action 1. Tap and treat all waste from the drains

Currently, the CETPs treat 40-60 per cent of the wastewater generated and about 34 per cent of installed capacity is unused. Three-pronged strategy is required for ensuring that all waste is treated

1. Ensure that the installed CETP is run at full capacity 24 x 7. The RSPCB need to be proactive in its monitoring and shall strictly monitor the operations and enforce applicable rules as per the water pollution prevention act if there is any violation of norms.
2. Need to ensure that all wastewater generated whether domestic or industrial, legal or illegal (non confirming areas) is tapped for treatment. First utilise the existing capacity and then augment
3. Permanently seal and remove any arrangements for bypass of untreated effluents. Redesign the inlet in such a way that not a drop of wastewater is bypassed without treatment.

Action 2. Enhance the treatment capacity

There is a need to augment the treatment capacity for industrial and domestic wastewater. For this there are two pre-requisites:

- ♣ Assess the amount of wastewater generated by the industrial and domestic users and its quality. And map all wastewater drains. RSPCB has to coordinate this study.
- ♣ RSPCB need to make the effluent discharge norms stringent for the CETPs based on the assimilative capacity of the river.

    - Based on these revised standards select appropriate, cost effective, affordable technologies for wastewater treatment, which would not only remove pollutants but also make the effluents fit for reuse.
    - Regulators shall also draw up and implement a road map for treated effluent reuse in industries in Pali.
- *Domestic sewage:* The Pali Municipal Corporation need to urgently draw up a plan to treat and reuse the domestic sewage generated from the city.
    - Cost effective approaches including modified septic tank approach could be used for decentralised treatment of sewage.
    - Plan for sewage treatment at colony level and make wastewater recycling mandatory in the building byelaws for new and large developments.

Action 3: Polluted water should not be allowed to accumulate at the Nehda dam

Way back in 1985, a report submitted to the Department of Environment by the Centre for Management Studies, of the HCM Rajasthan State Institute of Public Administration recommended that the Nehda dam should not be built, as it would aggravate groundwater pollution.[3] However, the dam has been built and it recharges deadly cocktail of toxins into the groundwater. This is having a big impact on groundwater as well as the health of the human beings and their livelihood. The administration shall:

- Take immediate action to drain the polluted water from the Nehda dam in such a way that it does not transfer problem to areas downstream.
- Ensure that no polluted water is accumulated in the dam.
- Initiate a survey to assess the impact on agriculture and health due to accumulation of water in the Nehda dam and its use for irrigation.

Action 4: Initiate a massive community based programme for groundwater recharge in the basin

Concerted effort needs to be taken to revive the groundwater sources. All efforts shall be made to harvest rain, revive tanks and ponds for recharging and diluting the contaminants in groundwater within the city and in villages. For this:

- The district administration shall draw up a plan for well recharging in the Bandi basin.
- Map the ponds and tanks in the Bandi basin (including Pali city), assess its functional status and draw up a plan for revival.

Action 5: Involve local community in monitoring of the CETPs and rework the management structure of the CETP

CSE's May 2006 report suggested that the Pali Water Pollution Control, Treatment & Research Foundation Trust's management structure need to be reorganised. With the district Collector as the Chairman of the Trust, it is found that the regulator (the RSPCB) is unable to play an effective and independent role in monitoring and regulating the CETPs. Under such circumstances, the CETP society should be restructured so that it could be independently monitored and regulated. Besides monitoring by RSPCB, yet another tier of monitoring by a group of independent experts and members of the local community shall be initiated and reviewed on a regular basis.

Annexure

Annexure 1: Water quality sampling protocol

In its water quality assessment conducted in the year 2005, CSE collected samples from the Bandi river at five different locations. These included one from within the city (at Mandia road) and four others from downstream locations (Jewadiya, Kerala, Sukarlai and Nehda dam). With the aim of firming up the trends in terms of contamination, it was decided to include more monitoring locations. As a results two stations were included (upstream and downstream of the Pali city) and then two more was added on station in between Kerala and Sukarlai and another at Phekaria (downstream of Nehda dam). Besides this samples were collected from three CETPs (inlet and outlet). List of sampling stations is given below:

Table: List of sampling stations

S No	Location	Description	Date of collection	Details of samples
1	Sumerpur road bridge	U/s Pali city	May 8, 2007	♣ River
2	Mandia road bridge	Mid-stream Pali city		♣ River ♣ Drain main Mandia road bridge
3	Downstream Gandhinagar drain at Pali – Jodhpur Bridge	D/s Pali city		♣ River
4	Jewadiya	10 km from Pali	May 9, 2007	♣ River ♣ Malaramji's son's open well
5	Kerala	15 km from Pali	May 9, 2007	♣ River ♣ Kutarwa open well ♣ Pukhraj suthar open well
6	Gadwada	20 km from Pali	May 9, 2007	♣ River ♣ Awad danji Charan open well
7	Sukarlai	25 km from Pali; U/s Nehda dam	May 9, 2007	♣ River ♣ Hand pump near Pond ♣ Open well on the banks of the river

8	Nehda Dam	50 km from Pali	May 9, 2007	♣ River; ♣ Shiv Sagar open well upstream of the dam; ♣ Lumbaram open well downstream Nehda Dam
9	Phekaria	5 km; D/s Nehda dam	May 9, 2007	♣ Dhimdi open well ♣ Bhuraram open well

Annexure 2: Utilisation levels of CETPs during May 2007

S No	Name of CETP	Treatment capacity (mld)	Utilisation May 8,9, 2007 (mld)
1	CETP I (Mandia road)	4	0
2	CETP II (Mandia road)	9.6	9.6
3	CETP III (Punayata road)	9.1	5.5
	Total	22.7	14.9

Source: Information provided by Tarun Solanki, Engineer, CETP on May 8, 2007

Annexure 3:

COD at inlet and outlet of the three CETPs

Sno	**Location**	**Date of collection**	**Time of collection**	**COD value**	**% COD reduction**
1	CETP 1 & 2 inlet	8.5.07	4:30 pm	3144.0	
2	CETP 1 outlet	8.5.07	4:40 pm	1117.0	64.47
3	CETP 2 outlet	8.5.07	4:40 pm	1788.76	43.10
4	CETP 1 & 2 inlet	9.5.07	7:30 am	3436.92	
5	CETP 1 outlet	9.5.07	7:25 am	1054.61	69.31
6	CETP 2 outlet	9.5.07	7:35 am	785.02	77.15
7	CETP 3 inlet	8.5.07	5:30 pm	3632.20	
8	CETP 3 outlet	8.5.07	5:35 pm	769.40	78.81
9	CETP 3 inlet	9.5.07	7:50 am	749.87	
10	CETP 3 outlet	9.5.07	7:50 am	1780.95	-137.50

Source: Pollution Monitoring Lab, Centre for Science and Environment, New Delhi, May 2007;

Annexure 4: Upgradation: What parameters have been modified?

Parameters	Old			Upgraded	
	CETP I	CETP II	CETP III	CETP I &II	CETP III
pH	9-11	5.5-10	5.5-10	5.5-11	5.5-11
TSS	200-500	810-950	840-900	1000-1800	800-1400
BOD	500-900	380-420	280	750	750
COD		980-1590	1160	2500	2500
Oil & grease	---	---	---	200	200

Note: all values in mg/l and refer to value at inlet

Source: Anon 2007, Note on upgradation and other related details prepared by the Pali Water Pollution Control Research Foundation (PWPCRF) Trust, PWPCRF, May, *mimeo*

Annexure 5: Heavy metals concentration in drains

Sno	Name of drain	Heavy metal concentrations in ppb							
		Copper	Zinc	Lead	Chromium	Cadmium	Nickel	Arsenic	Mercury
1	Indira colony drain at factory outlet	7.39	59.2	90.88	1.07	ND	14.76	40	ND
2	Drain main Mandia road bridge	875.16	190.8	71.17	12.93	ND	16.9	7.31	ND
3	Open drain Phase-I Industrial area at Subhash Nagar	459.23	574.9	234.1	601.29	ND	28.8	56.3	ND
4	Drinking water standards	50	5000	50	50	10	-	10	1
5	Effluent discharge standards	3000	5000	100	2000	2000	3000	200	10

Source: Pollution Monitoring Lab, Centre for Science and Environment, New Delhi, May 2007;

Annexure 6: Heavy metal concentration in river water within Pali city

SNo	Location	Heavy Metals Concentrations in ppb							
		Copper	Zinc	Lead	Chromium	Cadmium	Nickel	Arsenic	Mercury
1	Bandi river at Sumerpur road bridge (upstream)	140.34	116.5	51.12	8.12	ND	28.82	45.78	ND
2	Bandi river at Mandia road bridge (mid stream)	864.29	860.9	177.11	393.09	ND	58.21	181.19	ND
3	Bandi river after Gandhi Nagar drain at Pali-Jodhpur bridge (downstream)	16396.3	7904	146.71	8261.7	15.75	932.74	38.16	36.56
4	River water quality criteria of CPCB	Zero (as standards are not specified)							
5	Drinking water standards	50	5000	50	50	10	-	10	1

Note: Shaded blocks indicate concentrations higher than drinking water standards
Source: Pollution Monitoring Lab, Centre for Science and Environment, New Delhi, May 2007;

Reference:

[1] Anon 2007, Report of the proceedings of the technical workshop on operation and management of CETPs, jointly organised by Bhopal Zonal office of the Central Pollution Control Board and the Rajasthan State Pollution Control Board, Jodhpur, January 18-19, *mimeo*

[2] Anon 1993, *Basic Engineering package for common effluent treatment plant at Pali, Rajasthan, National Environmental Engineering Research Institute*, Nagpur, August

[3] VN Bahadur and M Hasan, 1985*, State of Environment in the Pali Area, Rajasthan-report submitted to Department of Environment, Rajasthan*, Centre for Management Studies, HCM Rajasthan State Institute of Public Administration, Jaipur