BEFORE THE HON'BLE NATIONAL GREEN TRIBUNAL PRINCIPAL BENCH, NEW DELHI, ORIGINAL APPLICATION NO. 307/2022, WITH RESPECT TO: News item published in The Hindu dated 26.04.2022 titled "**Flow of industrial effluents into Phalguni results in fish kill"**

INDEX

REPORT OF JOINT COMMITTEE APPOINTED BY HON'BLE NATIONAL GREEN TRIBUNAL PRINCIPAL BENCH, NEW DELHI (NGT) IN MATTER OF O.A NO. 307/2022, ORDER, DATED 29.04.2022, WITH RESPECT TO NEWS ITEM PUBLISHED IN "THE HINDU" DATED 26.04.2022 TITLED "FLOW OF INDUSTRIAL EFFLUENTS INTO PHALGUNI RESULTS IN FISH KILL"

1.0 Preamble:

Hon'ble NGT, Principal Bench, New Delhi has registered a *suo-moto* complaint in OA No: 307 of 2022 dated: 29.04.2022, based on the **News item published in "The Hindu" dated 26.04.2022 titled, "Flow of industrial effluents into Phalguni results in fish kill".** The media had reported that hundreds of fishes were found dead and floating in Phalguni (Gurupura) river, downstream of Maravooru vented dam, following the flow of industrial and domestic effluents into the river and the colour of the river has turned black due to the effluents released by the industries in Baikampady industrial area in Mangalore, Dakshina Kannada, Karnataka.

Hon'ble NGT considered the matter and prima facie held that untreated effluents are being discharged in the river in question by the industries in the area, without any regulation by the concerned statutory authorities in violation of the Water (Prevention and Control of Pollution) Act, 1974.

Further, Hon'ble NGT, constituted a joint committee comprising of the Regional Officers of MoEF&CC and CPCB Bengaluru, State PCB, Director, Fisheries, Karnataka and District Magistrate, Dakshina Kannada District to look in to the cause of the incident and suggest remedial measures. The State PCB was made the nodal agency for Co-ordination and compliance. The Committee was directed to meet within two weeks and undertake visit to the site, interact with the stakeholders, ascertain the cause of the incident and suggest remedial measures. If polluters were identified, it was directed to issue them the notice so that they could also file their response, if any, before the tribunal. Copy of the Hon'ble NGT order is enclosed as **Annexure-1.**

In compliance to Hon'ble NGT order, the Member Secretary, Karnataka State Pollution Board (KSPCB) constituted a Committee vide Office Memorandum No. KSPCB/NEIA-

OB/06/NGT-285/22-2023/813, dated: 07-05-2022 consisting of the following members, the copy of the same is enclosed as **Annexure- 2.**

Table 1: Constitution of Committee as per Hon'ble NGT Order

Sl. No	Name & Designation	Details
1	The District Magistrate, Dakshina Kannada District	Chairman
2	Senior Officer/Scientist, Regional Office, Ministry of Environment, Forest & Climate Change, South Zone Office, E-3/240, Kendriya Sadan, 4th Floor, E & F Wings, 17th Main Road, 2nd Block, Koramangala, Bengaluru -560 034	Member
3	Regional Director, Central Pollution Control Board, Nisarga Bhavan, Basaveshwara Nagar, Bengaluru-560010	Member
4	The Director, Department of Fisheries, Karnataka	Member
5	The Zonal Senior Environmental Officer, Karnataka State Pollution Control Board, Mangaluru	Member
6	Environmental Officer, KSPCB, Mangaluru	Member Convenor

2. Fish Kill Details:

2.1 Fish kill at Storm Water Drain near Gurupura River: Visit by KSPCB

Based on the public complaint received on 25.04.2022, regarding fish kill at Kenjar Guttumane, Bajpe, Mangalore Taluk, Dakshina Kannada District, Regional Officer, KSPCB, Mangalore and his team inspected the location on 25.04.2022. During inspection, following observations were made:

i) Traces of small dead fishes were observed **in the stagnant pockets of storm water drain/creek, but no dead fishes were observed in the main Gurupura River.**

ii) There was no flow of water in the drain except two pools of stagnant water in the low lying area of the drain.

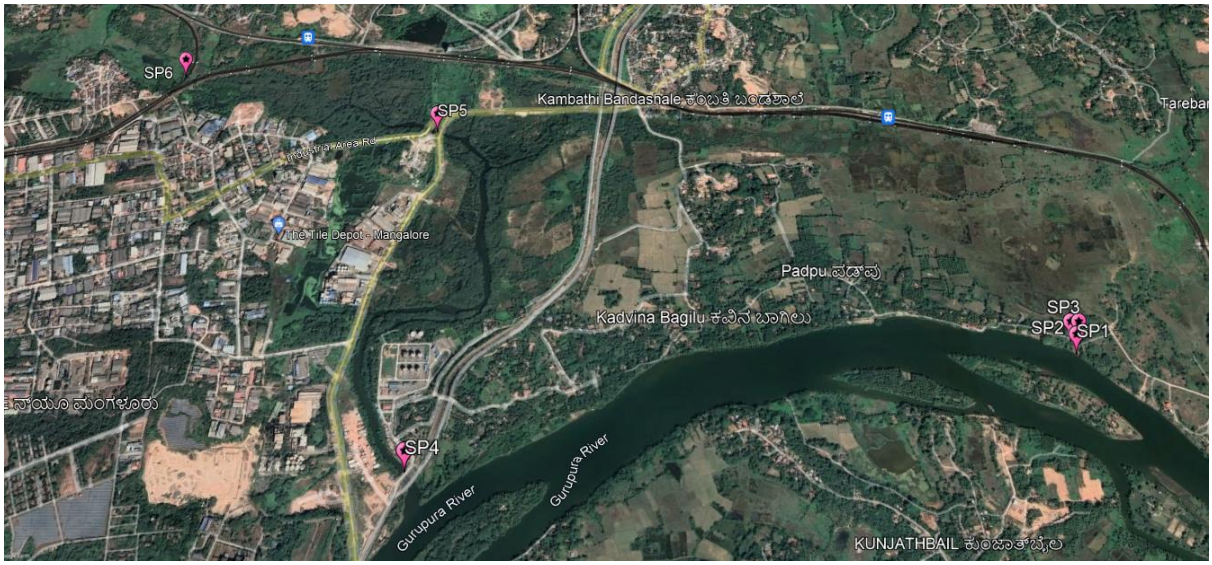
iii) At the outset, it appeared that lack of adequate water flow (lack of tidal flushing) and also high temperature of the summer might have resulted in depletion of oxygen causing the probable death of small fishes. The extent of impact was minimal, meaning fish kill was limited to those two stagnant pools within the Storm water drain.

Location Map of fish Kill spot:

Fish kill points at the stagnant pools in the storm water drain (creek). *As can be seen from the above, storm water drain/creek ultimately joins the river Gurupura.*

Photos of magnified view of stagnant pocket of Storm Water Drain where the small fishes were dead

iv) During inspection, the samples of water were collected for analysis is indicated in the Map-1 below: Please note that SP2 and SP3 are the actual fish kill location.



Map showing the sample collection points during the inspection on 25.04.2022 of magnified view of stagnant pocket of Storm Water Drain where the small fishes were dead

a) **SP1**- Water samples of Gurupura river at the junction where the storm water drain joined the river (Back water of Gurupura river collected near Kenjaru Guthu Mane, Kenjaru, Mangaluru)

b) **SP2 and SP3**- Stagnant water from two low lying pools of the storm water drain where fish kill was observed (Upstream and downstream of storm water drain which finally joins to Gurupura river back water near Kenjaru Guthu Mane Kenjaru

c) **SP-4**: Sample of water collected near ELF gas industry which joins the river Gurupura (Back water collected at ELF gas industry Up stream Centre of the Bridge which finally joins to Gurupura River Back Water)

d) **SP-5:**Back water collected near Thokur Bridge which finally joins to Gurupura River Back Water near ELF Gas Industry

e) **SP-6**:Storm water collected near Thokur railway bridge out let of Baggundi lake which finally joins to Gurupura River Back Water near ELF Gas Industry
(Note: SP-Sampling Point)

v) At the stretch from Back Water (creek) near ELF Gas Industry (SP4), the colour of water was light black by physical observation on 25.04.2022. But, while observing on 26.04.2022 & 27.04.2022, there was no appearance of black colour. But, again during inspection on 28.04.2022 colour of water was light black and on 29.04.2022 it was colourless again.

vi) During inspection, dissolved oxygen (DO) analysis were done and found that the DO values were 0.8 & 0.9 mg/L @ two stagnant pools of storm water drain (SP2 and SP3) where fish kill had occurred. The DO level of Gurupura River was 4 mg/L.(SP1) The results indicated that low DO concentrations could have caused oxygen stress which would have resulted in fish kill in the stagnant pools of storm water drain. Copy of Analysis report is enclosed as **Annexure-3.**

vii) DO level near ELF Gas industry (SP4) was observed to be 0.8 mg/l which could be again due to lack of tidal flushing in the storm water drain/creek near Baikampady Industrial Area which had caused the formation of stagnant water pockets in the low lying areas of the creek ultimately leading to temporary lowering of DO level.

viii) Further, it was observed that in and around Baikampady industrial area, surrounding the Baggundi Lake, there are residential pockets/villages like Kodikere, Kudumburu Colony, Angaragundi etc, with considerable human population. Since there is no UGD system in this area, sullage and sewage discharge from these villages and small establishments end up in the open drains ultimately joining the back water of the river. Apart from this, there is also no proper solid waste collection mechanism in the Baikampady industrial area, neither the Mangalore City Corporation (MCC), nor the Karnataka Industrial Area Development Board (KIADB) is taking lead in the matter.

ix) Industrial area has about 400 industries mostly of small scale sectors. Major sectors of industries are fish processing industries, Chicken rendering plants, vehicular service stations, Plywood industries, edible oil refineries, engineering and fabrication industries; plastic manufacturing industries, hazardous waste reprocessing industries, Cashew processing industries, labour sheds belonging to these sectors, Go downs, Commercial establishments (hotels) etc. Among these, some industries like fish processing and edible oil refineries are water based, but, most of them are small scale and water insignificant industries. Most of the Large and medium industries have provided in house Effluent Treatment Plants (ETP), some of them have ZLD system also.

x) Bacteriological analysis of *Faecal coliforms* and *Total coliforms* revealed that there is abundant microbial load in the sample of Backwater collected on 29.04.2022. Copy of the report is enclosed as **Annexure-4**.

2.2 Meeting called by the Deputy Commissioner, Mangaluru:

Based on the fish kill and blackening of river at Kenjar Guttumane, Bajpe, Mangalore Taluk due to alleged discharge of industrial effluent and sewage effluent which was reported in The Hindu Newspaper on 26.04.2022, Deputy Commissioner called the meeting of all the concerned officers on 16-05-2022.

During the meeting, it was brought to the notice of the Deputy Commissioner that earlier also there was a similar fish kill incident happened in 2017 and at that time the then Deputy Commissioner had constituted a 17 membered monitoring committee involving technical experts from various institutions for monitoring of river water quality and to suggest appropriate actions to the district administration for maintaining good water quality in the river. Further, CMFRI, Mangaluru was given the task of conducting the study on the cause of the river pollution in question and CMFRI, after monitoring the entire stretch of Gurupura river have reported that there is increase in organic load resulting in reduced DO levels in the river and increased levels of Nitrate concentration leading to Eutrophication/algal bloom in the river. Concluding part of the 41-page report is enclosed as **Annexure-5.**

As the 17 membered committee was still in force, the Deputy Commissioner directed the committee members and technical experts to conduct a detailed survey of the river to identify non-point sources of waste water (sewage, sullage, industrial effluent any other waste water) joining the Gurupura river to help formulate concrete action plan to prevent the pollution of Gurupura river. Copy of signed proceedings enclosed as **Annexure-6.**

Accordingly, 17 member monitoring committee along with officials from other Departments took up the inspection of the Gurupura river stretch on 26-05-2022 through the Boat and by Road. During inspection, the committee identified different locations along the river stretch where storm water drains join the river and samples of water at these locations were collected and given for analysis. The analysis results of the samples collected at various points along the river on this date indicate BOD level of 5- 7 mg/l, DO of 4.4 mg/l to 5.4 mg/l, microbial load of >1600 MPN/100 ml and pH between 7.2 to 7.5 units. From the results, its observed that the river water meets the CPCB designated best use standard of **Class- C except for BOD values**. Copies of analysis report enclosed as **Annexure-7.**

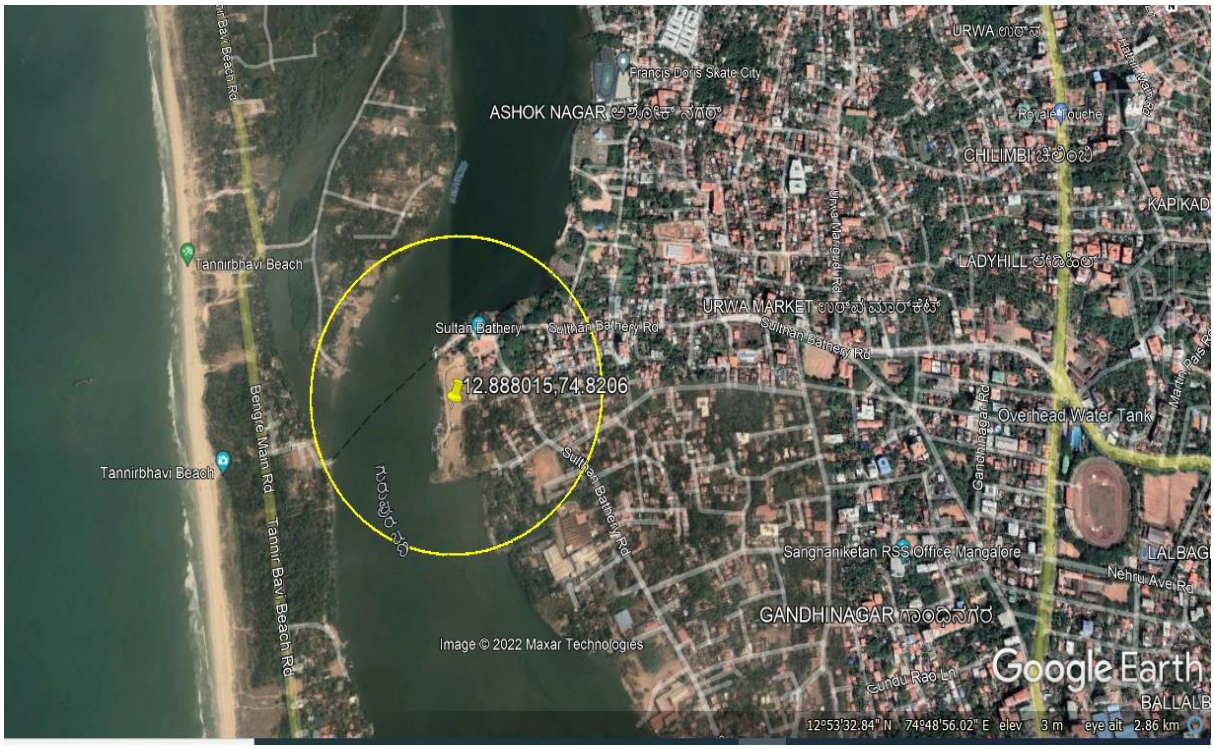
3.0 Meeting of the NGT constituted Committee:

The Joint committee constituted by Hon'ble NGT along with members of the 17 member monitoring committee met for the first time on 08-06-2022 under the chairmanship of Deputy Commissioner. During the meeting, the monitoring Committee members briefed the Deputy Commissioner about the river survey and their findings that there is sewage entry in to the river in question from unsewered areas along the catchment and they requested the Deputy Commissioner to schedule the spot inspection. Accordingly, site inspection was once again scheduled in the leadership of the Deputy Commissioner on 16-06-2022, meeting proceeding copy enclosed as **annexure-8.**

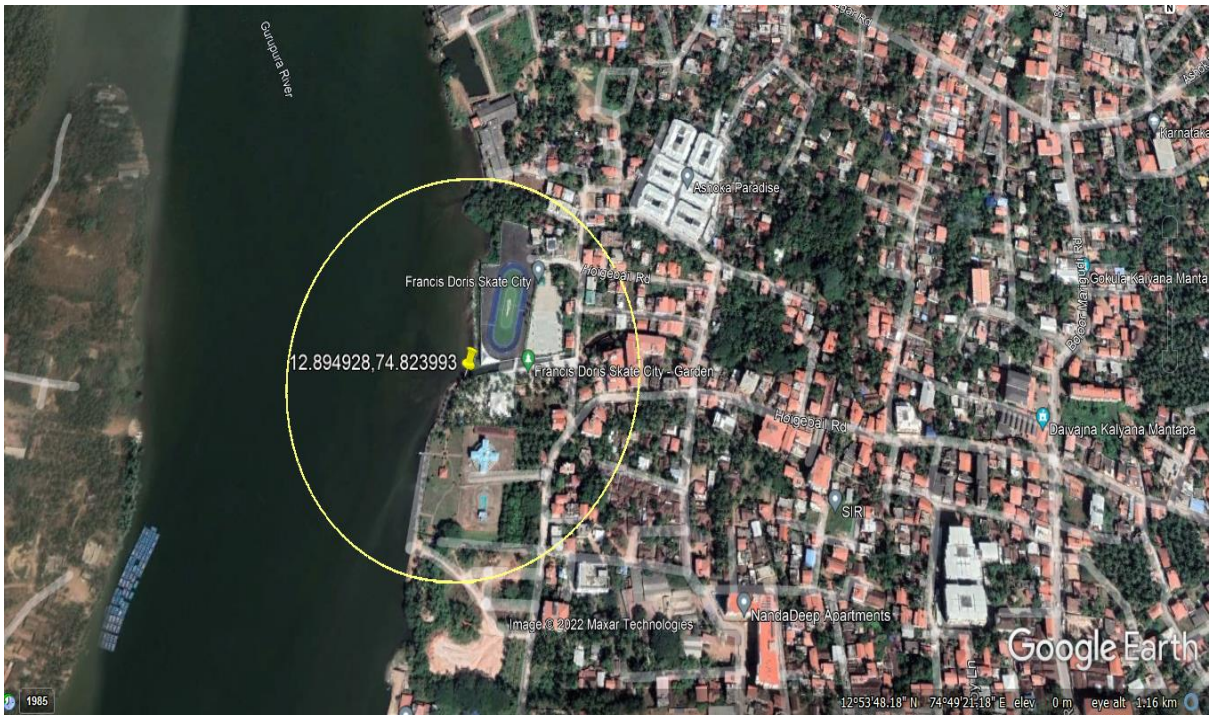
Joint Committee members along with the Deputy Commissioner and other technical experts conducted the spot inspection on 16-06-2022 and observed, proceeding of the inspection of Joint Committee is an enclosed as **Annexure-9.** It was observed that the following major Storm water drains carrying sewage/Sullage/other waste water ultimately joined the Gurupura river.

a. Storm Water drain (Major Drain Entering from Mangalore City) joining point at Backwater of Gurupura river near Kudroli (12.870525,74.829327)

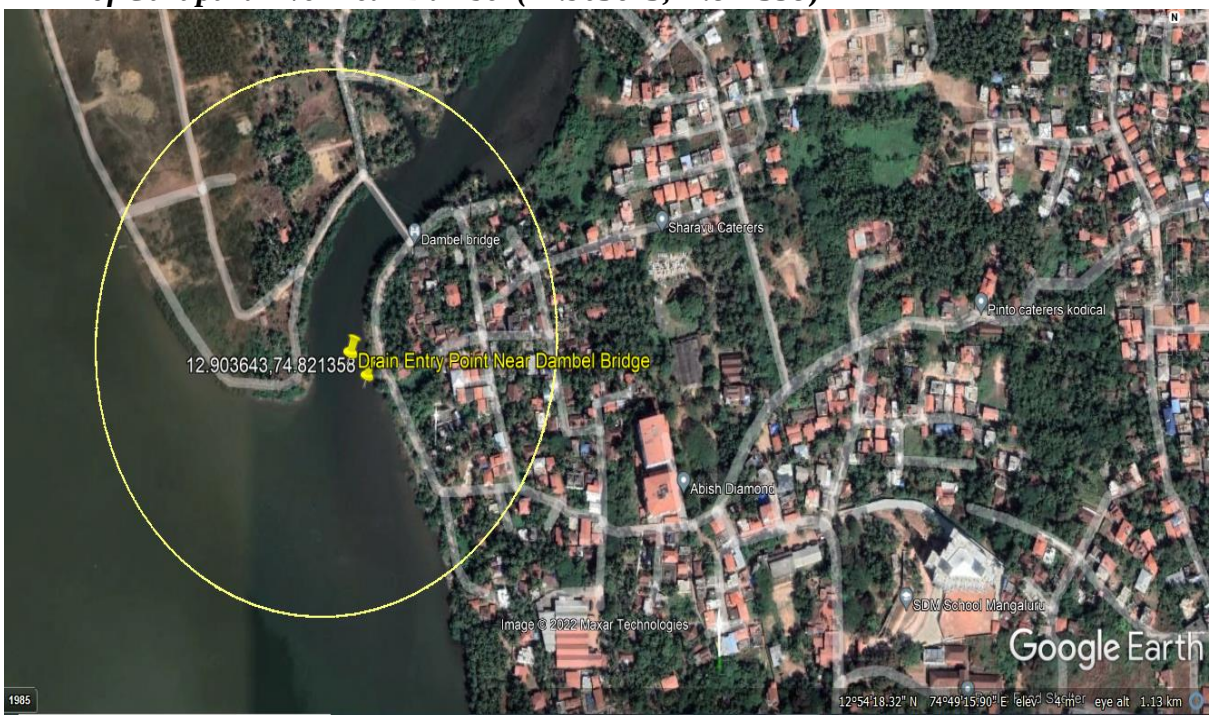
b. Storm Water drain (Drain Entering from Bolor, Thannirbhavi) joining point at Backwater of Gurupura river near Amruth Vidyalaya, Bolor (12.888015,74.8206)



c. Storm water drain -Skate City Garden Point, Near Bolar from the area of Ashoknagar (12.894928,74.823993)

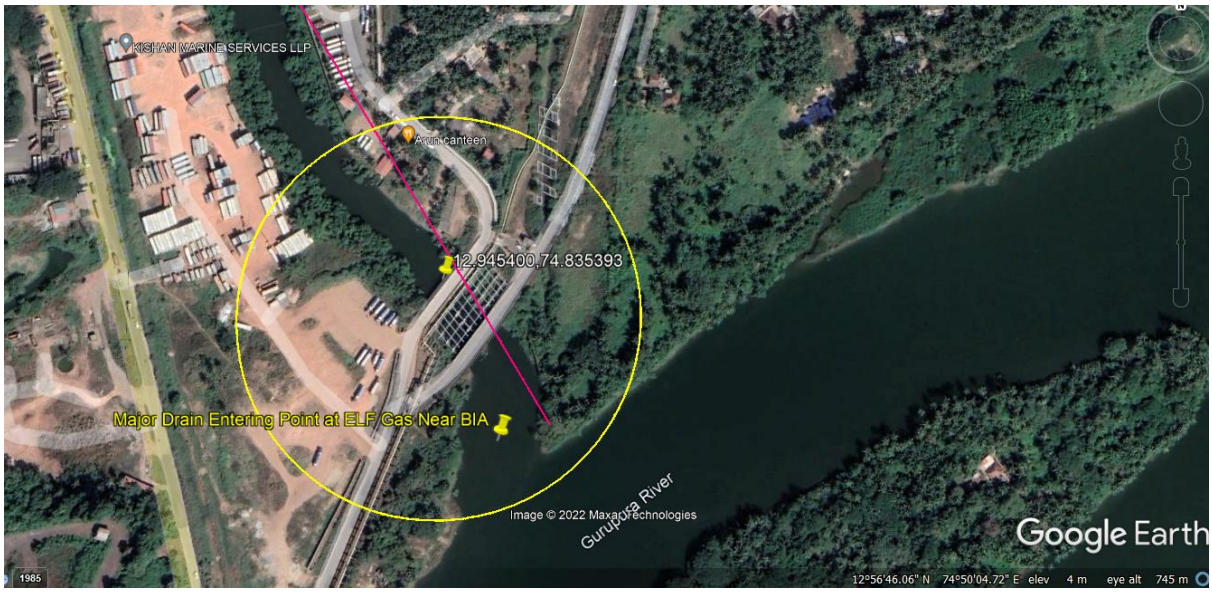


d. ***Storm Water drain (Major Drain Entering from Dambel) joining point at Backwater of Gurupura river near Dambel (12.903643,74.821358*)**

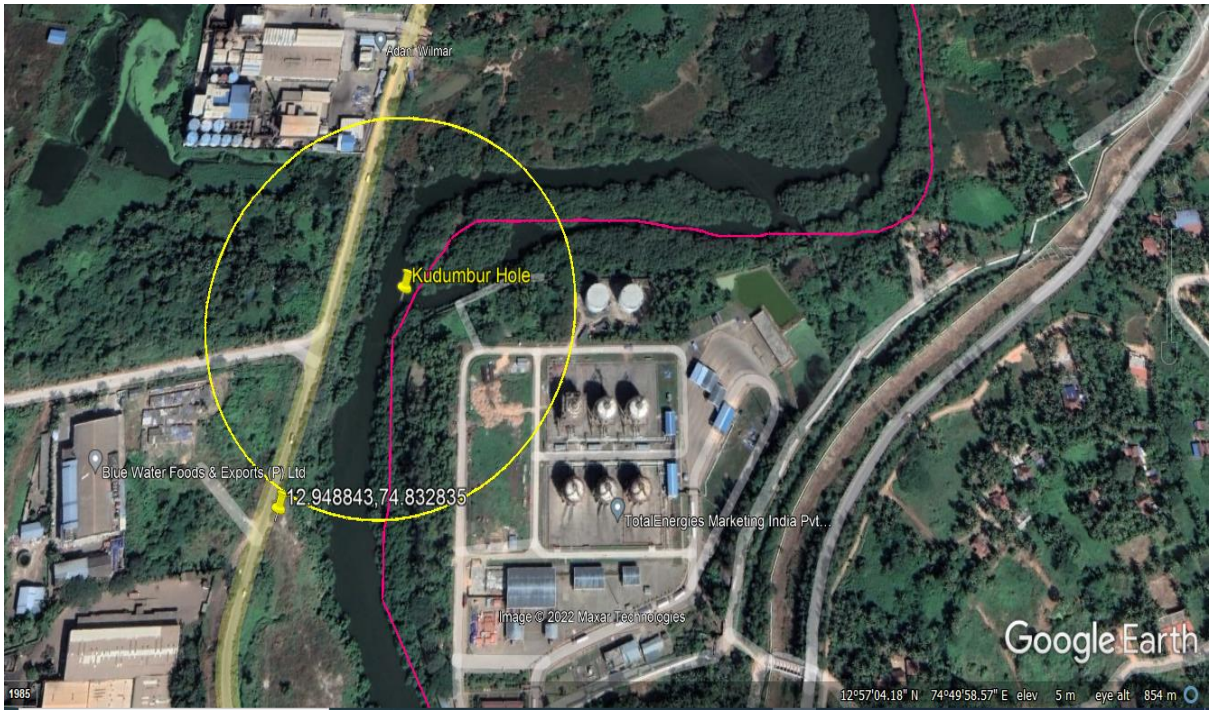


e. Storm Water drain (Drain Entering from Padukodi, Near Kulur Church) joining point at Backwater of Gurupura river near Kulur (12.927644,74.829748)

f. Kudumbur hole (rivulet) Backwater of Gurupura river at ELF Gas (Drain Entering from Baikampady Industrial Area, Jokatte, MSEZ RR Colony, MRPL Marshy land, Baggundi lake outflow, Angaragundi, Kudumburu village) (12.945400,74.835393)



g. Kudumburu Bridge Backwater of Gurupura river (Drain Entering from Jokatte village, MSEZ RR Colony, MRPL Marshy land, Baggundi lake outflow, Angaragundi, Kudumburu village) joining point at Backwater of Gurupura river (12.948843,74.832835)



During inspection, once again, water samples at the same locations as of previous inspection along the river stretch were collected and sent for analysis**.** The analysis results of the samples collected at various points along the river on this date indicate BOD level of 4 to 18mg/l, DO of 3.3 mg/l to 6.7 mg/l except at one place where it was 0.3 mg/l and microbial load of >1600 MPN/100 ml and pH between 6.7 to 7.4 units. From the results, it's observed that the river water meets the CPCB designated best use standard of **Class- C except for BOD values**. Copies of Analysis reports is enclosed as **Annexure-10.**

3.1 : Observations of the Committee:

3.1.1: General Observations:

- Residential/commercial developments on either side of the river and, no UGD in certain areas. Even in sewered areas, there is missing links/gaps.

- Major and minor storm water drains were observed to be joining the river and plenty of Organic load was observed at Kudroli, Sulthan Batteri, Dambel, Kulur Church and ELF Gas. Map showing storm water drains joining Gurupura river at different locations is enclosed as **Annexure-11**.

- Solid waste was found floating in the storm water drains which joined the river.

- Dumping/disposal of sewage collected from Hotels and selected industries and from other residential areas through Cess Pool at selected places along the banks of river back water, **which needs a proper investigation.**

- Upstream of the Gurupura river about 6 K.M. from Baikampady industrial area is built a vented dam which is the drinking water source for Maravooru Grama Panchayath limit. The dam was built in the year 2016-17. Since the construction of the dam, the river doesn't get minimum flow and during summer seasons fish kill incidents are happening in the river during summer seasons due to build-up of organic load as a result of inadequate flushing. It's only during the rainy season that the dam overflow reaches the river.

3.1.2: Observations near Baikampady Industrial Area

:Major water intensive industries in the Baikampady industrial area have provided in house ETP and some of them have Zero liquid discharge (ZLD).

- Few small industries generating less waste water are yet to install ETP and STP.

- Sullage/sewage is being discharged to Storm water drain from many Godowns, commercial establishments, hotels and some small industries, Labour quarter's/shed. etc.
- No proper collection mechanism for Municipal and other Solid Waste in Baikampady industrial area. Solid waste heaps dumped along road sides were observed. Photos enclosed as **Annexure-12.**
- Construction debris and solid waste is being disposed at ODC Road to Jokatte at the bank of the back water of Gurupura River.
- The Back water /Creek at the Baikampady Industrial area is blocked and the water is stagnated, there is no easy flushing.
- During random inspection of industries in the Baikampady industrial area by KSPCB officials, it is observed that the following industries are discharging untreated effluents to the storm water drain, some of them in spite of having ETP facilities.

Table 2: Details of Industries in Baikampady Industrial Area discharging untreated effluents along with action taken:

Sl No.	Name and address of the industries	Activity	Action initiated by the KSPCB
1	M/s Ocean Proteins, Plot No. 281/282, Baikampady Industrial Area, Mangaluru, D K District-575 011.	Fish processing (Surimi)	Personal hearing held and action being initiated to close down the industry and to file criminal case
2	M/s R.K. Industries, Plot No.191-A Baikampady Industrial Area, Mangalore, D K District-575 011.	Vehicular Service station	Notice of proposed directions to close down the industry is issued.
3.	M/s Shree Gurudev Service Station, Plot No. 102, Near Canara Steel Industry, Industrial Area, Baikampady, Mangaluru, Dakshina Kannada District - 575011	Tanker washing /vehicular Service station	

4	M/s Stems and Leaves International, Plot No.162-C, Baikampady Industrial Area, Mangalore, D.K District-575011	Granite cutting and polishing	Notice of proposed directions (NPD) to close down the industry is issued
5	M/s Viceroy Exports India Pvt. Ltd., Plot No.55, Baikampady Industrial Area, Mangalore, D.K District-575011.	Fish Processing (Freezing and Export)	
6	M/s Sunrise Mats, Plot No. 6-16, Baikampady Industrial Estate Area, Mangalore, D.K., District-575011	Plastic waste reprocessing and mat making	Restraining order and NPD issued
7	M/s Marine Food Packers, Industrial Area, Baikampady, Mangaluru, Karnataka 575011	Fish Processing (Freezing and Export)	Show cause notice is issued
8	M/s A. K. Veneers Pvt. Ltd., Plot No. 449, Industrial Area, Baikampady, Mangaluru, D. K. District	Plywood and Veneers manufacturing	Show cause notice is issued

Subsequent to the issue of show cause notices/ Notice of proposed directions/restraining orders, some industries have rectified the problems and initiated action for providing STP/ETP. Industries who have continued the violations even after issue of Notice of proposed directions, KSPCB is in the process of initiating further course of action as per Law.

4.0 Based on Literature: Literature review from various researchers reveals that the incidence of river blackening and fish kill at times is not a very uncommon phenomenon and this bio-geochemical phenomenon has been most of the times co-related to presence of high organic load and inadequate tidal flushing especially in summers. High organic load quickly depletes the dissolved oxygen leading to anaerobic conditions. The anaerobic microbes degrade the dissolved organics which may further react with minerals in water and sediment forming black precipitates. A copy of one of the research review paper published by Zhiwei Leiang *et.al.,* 2018 on subject matter is enclosed for kind reference as **Annexure-13.**

5.0 Conclusions and Recommendations:

1. The Committee from the Monitoring results and from other available data is of the opinion that the present fish kill is an isolated, very small one possibly by the Organic/Sewage load dumped in this particular location leading to oxygen stress during summer season.

2. There was no fish kill in the main Gurupura river, fish kill has happened in the stagnant pockets of the storm water drain leading to the river. Measured Dissolved oxygen levels at locations of fish death (along the two stagnant pockets of storm water drain) were 0.8mg/l and 0.9 mg/l, whereas, at the point where storm water joined the river, DO level was 4 mg/l, which shows that the fish death must have occurred due to inadequate tidal flushing in the creek/storm water drain resulting in low D.O levels.

3. The Committee has also observed that there is no traces of any discharge of industrial effluent in that Storm Water Drain in which fish kill has occurred.

4. Committee has observed entry of domestic sewage all along the river through Storm Water Drains; this needs an urgent attention by Mangaluru City Corporation (MCC).

5. There is no Underground drainage (UGD) facility with terminal Sewage Treatment Plant (STP) in Baikampady industrial area to take care of sewage/sullage discharge from Godown, commercial establishments, hotels and some small industries, Labour quarter's/sheds. etc. Responsible organisations like KIADB and Mangaluru City Corporation (MCC) are required to initiate action to construct a proper UGD system with terminal sewage treatment plant.

6. Mangaluru City Corporation also has to initiate action for treatment and disposal of sewage generated from the area around the Baggundi lake such as, MSEZ RR colony, Angaragundi, Kudumbur Villages so as to prevent joining of untreated sewage into Baggundi lake thereby to Gurupura river.

7. Action plan for Sl No.4,5 and 6 along with cost estimate and timelines shall be prepared by MCC and KIADB and necessary funds have to be released by Urban Development Department, Government of Karnataka and CEO, KIADB respectively for undertaking the above work.

8. Town Panchayath, Bajpe and Grama Panchayath, Jokatte are unsewered area along the catchment of the river Gurupura. Chief Officer, Bajpe has to take action for treatment and disposal of sewage generated in the area near airport and Bajpe village to avoid entering of sewage into the storm water drain ultimately joining the Gurupura river and PDO, Grama Panchayat, Jokatte has to take action for treatment and disposal of Sewage generated from Jokatte areas. Directions have to be issued to DMA and CEO, ZP to release necessary funds required for undertaking the STP work.

9. There is no proper Solid waste collection mechanism in the Baikampady industrial Area. Construction debris (C and D waste) and solid waste including plastic waste are being dumped everywhere across the industrial area including the bank of the back water of Gurupura River. KIADB and Mangaluru City Corporation (MCC) being responsible agencies are required to initiate action to bring in a proper collection mechanism of Municipal solid waste/C and D /plastic and other types of waste and create awareness too in co-ordination with Industrial Associations.

10. There were lot of complaints in Media and by Industries Association that cess pool operators are discharging sewage through tankers and dumping/discharging indirectly in to rivers. Committee suggests that KIADB, MCC, ZP, PRED, Industrial Association and Police shall have to install CCTV Camera at Strategic locations in their respective jurisdiction to prevent any unauthorized/illegal dumping of waste water/sewage/solid waste in to the river.

11. The Committee suggests that the Minor Irrigation department who is in charge of protecting the river boundaries shall initiate steps to conduct a comprehensive survey on river encroachment along with other line departments such as, Revenue, CRZ, MCC and corresponding Town/Grama Panchayats and take appropriate action on the encroachers.

12. Upstream of the Gurupura river a vented dam is built, which is the drinking water source for Maravooru Grama Panchayath and 14 other villages. Since the construction of the dam, the river doesn't get minimum flow and during summer seasons fish kill incidents are happening in the river during summer seasons due to

build-up of organic load as a result of inadequate flushing. Zilla Panchayat, PRED, Mangalore Officials will have to submit compliance to conditions imposed during clearance of vented dam.

13. KSPCB to ensure Zero Liquid Discharge in all industries and establishment of ETP in all small scale industries irrespective of effluent quantity.

14. KSPCB has listed out few non-complying industries which are habituated to discharge into storm water drains in spite of some of them having the ETP units. Continuous monitoring of such non-complying industries followed by action as per law shall be initiated by KSPCB on priority.

15. KSPCB to take up strengthening of its laboratory at Mangaluru, adequate manpower to be deployed and upgrade the laboratory with advanced equipments.

Dr. Rajendra K.V., IAS
Deputy Commissioner,
Dakshina Kannada District
Chairman of the Joint Committee

Dr. Prabhu S., Scientist D
Representative nominated by
Regional Office, MOEF&CC, Bangalore
Member

Smt. Sowmya D., Scientist D.,
Representative nominated by
Regional Director,
Central Pollution Control Board, Bangalore
Member

Dr. Harish Kumar, Deputy Director
Representative nominated by The Director,
Department of Fisheries, Bangalore
Member

Smt. Vijaya Hegde
Senior Environmental Officer,
Zonal Office, KSPCB, Mangaluru
Member

Sri Ramesh K.M.
Environmental Officer,
KSPCB, Mangaluru
Member Convenor

ANNEXURE-1

Item No. 16 (Court No. 1)

BEFORE THE NATIONAL GREEN TRIBUNAL
PRINCIPAL BENCH, NEW DELHI

(By Video Conferencing)

Original Application No. 307/2022

In re : News item published in The Hindu dated 26.04.2022 titled **"Flow of industrial effluents into Phalguni results in fish kill"**

Date of hearing: 29.04.2022

CORAM: HON'BLE MR. JUSTICE ADARSH KUMAR GOEL, CHAIRPERSON
HON'BLE MR. JUSTICE SUDHIR AGARWAL, JUDICIAL MEMBER
HON'BLE PROF. A. SENTHIL VEL, EXPERT MEMBER

ORDER

1. The matter has been put up in the light of captioned media report to the effect that hundreds of fishes were found dead and floating in Phalguni (Gurupura) river, downstream the Malavoor vented dam, following the flow of industrial and domestic effluent into the river. The administration has remained mute to the happening. The photographs in the media report suggest that color of the River has turned black due to the effluents released by the industries in Baikampady industrial area in Mangalore, Dakshina Kannada, Karnataka.

2. We have considered the matter. *Prima facie,* it appears that untreated effluents are being discharged in the river in question by the industries in the area, without any regulation by the concerned statutory authorities in violation of the Water (Prevention and Control of Pollution) Act, 1974.

3. Accordingly, it appears to be necessary to ascertain facts and ensure remedial action for enforcement of Rule of Law, protection of environment and bio-diversity. The stretch of Phalguni river may be treated as polluted river stretch for formulation and execution of restoration plan, defining timelines and budgetary backup. Field survey be conducted to identify sewage and industrial effluent entering into the said river. Target for restoration of water quality is required to be at level of Class B of Primary Water Quality Criteria.

4. We constitute a five-member joint Committee comprising of the Regional Officers of MoEF&CC and CPCB Bengaluru, State PCB, Director, Fisheries, Karnataka and District Magistrate, Dakshina Kannada District. The State PCB will be the nodal agency for coordination and compliance. The Committee may meet within two weeks and undertake visit to the site. It will be open to members of the Committee to participate online except for site visit. The Committee may interact with the stakeholders, ascertain the cause of the incident and suggest remedial measures. If polluters are identified, they may be put to notice so that they can file their response, if any, before this Tribunal. Based on the observations during the proceedings of the Committee, the statutory regulators may take remedial action, following due process of law. A factual and action taken report may be filed within two months by e-mail at judicial-ngt@gov.in preferably in the form of searchable PDF/ OCR Support PDF and not in the form of Image PDF with a copy to the identified polluters for their response.

List for further consideration on 01.08.2022.

A copy of this order be forwarded to the Regional Officers of MoEF&CC and CPCB Bengaluru, State PCB, Director, Fisheries,

Karnataka and District Magistrate, Dakshina Kannada District by email for compliance.

Adarsh Kumar Goel, CP

Sudhir Agarwal, JM

Prof. A. Senthil Vel, EM

April 29, 2022
Original Application No. 307/2022
AB

ANNEXURE-2

ಫ್ಯಾಕ್ಸ್/Fax : 080-25586321
ಈಮೇಲ್/E-mail : ho@kspcb.gov.in
ವೆಬ್‌ಸೈಟ್/Website : http://kspcb.gov.in

25581383, 25589112
25588151, 25588270
25588142, 25586520

ಕರ್ನಾಟಕ ರಾಜ್ಯ ಮಾಲಿನ್ಯ ನಿಯಂತ್ರಣ ಮಂಡಳಿ
Karnataka State Pollution Control Board
"ಪರಿಸರ ಭವನ", 1 ರಿಂದ 5ನೇ ಮಹಡಿಗಳು, ನಂ. 49, ಚರ್ಚ್ ಸ್ಟ್ರೀಟ್, ಬೆಂಗಳೂರು - 560 001, ಕರ್ನಾಟಕ, ಭಾರತ
"Parisara Bhavana", 1st to 5th Floor, # 49, Church Street, Bengaluru - 560 001, Karnataka, INDIA

No. KSPCB/NEIA-OB/06/NGT-285/22-2023/ 813 Date: 07 MAY 2022

ರವಾನಿಸಲಾಗಿದೆ

OFFICE MEMORANDUM

Sub: Constitution of Joint Committee in the matter of OA No. 307/2022 pertaining to the Flow of Industrial Effluent into Phalguni river resulting in Fish kill-reg.

Ref: The Hon'ble National Green Tribunal, Principal Bench, New Delhi order dated: 26.04.2022 in respect of OA No. **307/2022**

******

Preamble:

The Hon'ble National Green Tribunal, Principal Bench, New Delhi has passed an order Dated: 29.04.2022 in the light of the captioned media report to the effect that hundreds of fishes were found dead and floating in Phalguni (Gurupura) River, downstream the Malavoor vented dam, following the flow of industrial & domestic effluent into the river. The administration has remained mute to the happenings. The photographs in the media report suggest that colour of the River has turned black due to effluents released by the industries in Baikampady Industrial Area in Mangalore, Dakshina Kannada, Karnataka. Prima facia, it appears that untreated effluents are being discharged in the river in question by the industries in the area, without any regulation by the concerned statutory authorities in violation of the Water (Prevention & Control of Pollution) Act 1974.

In view of the above and its order cited under reference, the Hon'ble National Green Tribunal has constituted a five-member Joint Committee comprising of the following Officers of respective Departments with the State PCB will be the Nodal agency for co-ordination and compliance.

Sl. No.	Name & Designation	Details
1.	The District Magistrate, Dakshina Kannada District	**Chairman**
2.	Senior Officer/Scientist, Regional Office, Ministry of Environment, Forest & Climate Change, South Zone Office, E-3/240, Kendriya Sadan, Fourth Floor, E&F wings, 17th Main Road, 2nd Block, Koromangala, Bengaluru-560034.	**Member**
3.	Regional Director, Central Pollution Control Board, Nisarga Bhavan, BasaveshwaraNagar, Bengaluru-560010.	**Member**
4.	The Director, Department of Fisheries, Karnataka	**Member**
5.	The Zonal Senior Environmental Officer- KSPCB, Mangaluru.	**Member**
6.	The Environmental Officer, Regional Office –KSPCB, Mangaluru.	**Member Convener**

The stretch of Phalguni River may be treated as polluted river stretch for formulation & execution of restoration plan, defining timelines & budgetary backups. Field survey be conducted to identify sewage and industrial effluents entering into the said river. Target for restoration of water quality is required to be at level of Class B of Primary Water Quality Criteria.

The Committee shall inspect the area to ascertain as per the directions of NGT as mentioned below:

- The Committee may meet within two weeks, undertake visit to the site. It will be open to members of the Committee to participate online except for site visit.
- The committee may interact with the stakeholders, ascertain the cause of the incident and suggest remedial measures.
- If polluters are identified, they may be put to notice so that they can file their response, if any, before the Tribunal.
- Based on the observations during the proceedings of the Committee, the statutory regulators may take remedial actions, following due process of law.
- A factual & action taken report may be filled within two months by e-mail at judicial-ngt@gov.in preferably in the form of searchable PDF/OCR support PDF and not in the form of Image PDF with a copy to the identified polluters for their response.

It is requested to nominate the Officers from your department to conduct inspection. The matter may be treated as '**Most Urgent**'. It is required to submit the **Joint Inspection report within the time stipulated by the Hon'ble Tribunal.**

Encl.: NGT order dated: 29.04.2022 **in respect of OA No. 307/2022 (PB).**

Draft Approved by Chairman

Sd/-
MEMBER SECRETARY

To,

1. The Deputy Commissioner,
   Dakshina Kannada District

2. Senior Officer/Scientist, Regional Office,
   Ministry of Environment, Forest & Climate Change,
   South Zone Office, E-3/240, Kendriya Sadan,
   Fourth Floor, E&F wings, 17th Main Road, 2nd Block,
   Koramangala, Bengaluru-560034.

3. The Secretary,
   Department of Fisheries, GOK ,
   IIIrd Floor Podium Block,
   Vishweshwaraiah Tower,
   Dr, Ambedkar Veedhi,
   Bengaluru- 560001, Mangalore.

4. Regional Director, Central Pollution Control Board,
   Nisarga Bhavan, BasaveshwaraNagar, B
   Bengaluru-560010.

5. The Zonal Senior Environmental Officer,
   Karnataka State Pollution Control Board, **Zonal Office, Mangalore**

6. The Environmental Officer, Regional Office -KSPCB, Mangaluru.

Copy to:

1. Deputy Director, Zilla Panchayat, Mangaluru for kind information and needful action.
2. Case File

SENIOR ENVIRONMENTAL OFFICER

KARNATAKA STATE POLLUTION CONTROL BOARD

ANNEXURE 03

No 10 B,Industrial Area Baikampady Mangalore 575011 Ph No: 0824-2408420

PCB/RO(MNG)/RW-64-69/2022-23/R No : 01

Date: 29/4/22

ANALYSIS REPORT OF WATER QUALITY
REGIONAL LABORATORY

NAME OF THE LOCATION :	M/s Gurupura water samples
SAMPLE COLLECTED BY :	EO, Mangaluru.
DATE OF COLLECTION :	25.04.2022
DATE OF RECEIPT :	25.04.2022
SAMPLE NO & PARTICULARS OF SAMPLE COLLECTED:	1.Back water of Gurupura collected near Kenjaru Guthu mane Kenjaru Mangalore(Back water of Gurupura river)(64) 2.Upstream of storm water drain which bfinally joins to Gurupura river back water near Kenjaru Guthu mane Kenjaru (Storm water drain)(65) 3.Downstream of storm water drain which finally joins to Gurupura river Back water near Kenjaru Guthu mane Kenjaru (Back water of river water)(66) 4.Back water collected at ELF gas industry Upstram centre of the bridge which finally joiuns to Gurupura river (Back water of Gurupura river) (67) 5.Back water collected near Thokur bridge which finally joins to Gurupura river back water near ELF gas industry(Back water of Gurupura river)(68) 6.Storm water collected nera Thokur railway bridge outlet of Bagundi lake which is finally joins to Gurupura river Back water near ELF gas industry (Back water of Gurupura river)(69)

Sl No.	Parameters Analysed	Unit	Standard *	Standard **	Results					
					Sample No.64	Sample No.65	Sample No.66	Sample No.67	Sample No.68	Sample No.69
1	pH	pH unit	6.5-8.5	5.5 - 9.0	**9.8**	7	**11**	7	7.4	6.7
2	Suspended Solids	mg/L	10	100	**336**	**112**	**134**	**34**	**20**	**16**
3	BOD (3 days @ 27 ^{0} C)	mg/L	10	30	**180**	**102**	**510**	**330**	**72**	**13**
4	COD	mg/L	50	250	**3954**	**4858**	**3608**	**3229**	**1052**	**104**
5	Ammoniacal Nitrogen	mg/L	5	50	**11**	**6**	**17**	**12**	**15**	**16**
6	TKN	mg/L	10	100	**16**	**12**	**20**	**15**	**19**	**20**
7	Free Ammonia	mg/L	_	5	**9.355**	0.0339	**16.706**	0.0679	0.2649	0.0906
8	Sulphide	mg/L	_	2	BDL	BDL	BDL	BDL	BDL	BDL
9	Dissolved Phosphate	mg/L	_	5	0.0729	BDL	0.1648	BDL	0.1424	BDL
10	Total Residual Chlorine	mg/L	_	1	BDL	BDL	BDL	BDL	BDL	BDL
11	Oil and Grease	mg/L	_	10	10	**12**	**22**	6	BDL	BDL
12	Total Dissolved Solids	mg/L	_	2100	**17480**	**17890**	**18204**	**12484**	**5840**	748

13	Sulphate	mg/L		1000	945	970	915	805	293	
14	Copper	mg/L		3	**5.94**	0.206	0.187	0.453	0.121	0.032
15	Total Choromium	mg/L		2	BDL	BDL	BDL	BDL	BDL	BDL
16	Cadmium	mg/L		2	BDL	BDL	BDL	BDL	BDL	BDL
17	Nickel	mg/L		3	0.321	0.311	0.482	0.145	0.111	0.054
18	Lead	mg/L		0.1	**0.366**	**0.897**	**1.245**	**0.477**	**0.356**	0.127
19	Zinc	mg/L		5	0.141	0.115	0.135	0.256	0.341	0.054
20	Iron	mg/L		3	0.958	1.055	0.477	0.746	1.029	0.868
21	Dissolved Oxygen	mg/L			**4**	**0.8**	**0.9**	**0.8**	**3.5**	**2.5**
INFERENCE										

Note: * Treated Sewage Standard ** Inland Surface Water

1. The above results pertain only to the sample tested.
2. The method of analysis is as per the Standard Method for the examination of Water and Waste Water, and Indian Standard Publication.
3. ND: Not detected.
4. BDL: Below detection limit

Scientific Assistant
ANALYSED BY

Scientific Assistant
VERIFIED BY

Scientific Officer
LAB HEAD

OneEarth Enviro Labs

1st Floor, KSIA Building, Industrial Area Road, Baikampady,
Mangaluru - 575 011. Ph: 0824-240 9011 Mob: +91 87625 39077
Email: oneearthenviro@gmail.com Website: oneearthenvirolabs.com

OEL/MC/15/100
Certificate No. TC-7847
NABL ISO/IEC 17025:2017

ISO 9001:2015 | ISO 45001:2018 Certified | MOEF & CC RECOGNISED

Report No: W/2021/AP2903
Report Date 03-05-2022

WATER QUALITY ANALYSIS REPORT

Name of the Industry	M/s. Karnataka State Pollution Control Board		
Address	Parisara Bhavana ,10B Baikampady Industrial Area Mangalore-11		
Sample Collected By	Given By the User	Method	--
Sampling Location	River Water of Gurupura collected near old sand extraction area up stream of Kuloor bridge Mangaluru		
Sample Appearance	Clear		
Date of Sampling	29-04-2022	Analysis Start Date	29-04-2022
Date of Sample Receipt	29-04-2022	Analysis End Date	03-05-2022
Sampling Details	River Water Sample for Micro Biological Analysis		

Parameter	Unit	IS 10500-2012 STD PL (MAX)	Results Code:AP2903	Protocol APHA 2017 23rd Edition
Fecal Coliforms MPN	MPN/100ml	A	920	9221E
Fecal Streptococcus MFT	CFU/50ml	NS	60	9230C
Total Coliforms MPN	MPN/100ml	A	920	9221-B

PL-Permissible Limit Std-Standard P-Present A-Absent < 1.8: Shall be treated as – ve

Opinion	Microbial load is abondant.

*** End of the Report ***

One Earth Enviro Labs PHONE 2409011 Mangaluru - 575 011

For OneEarth Enviro Labs

Authorised Signatory
(Dr. Sandesh K, Technical Manager)

Note: 1.The report shall not be reproduced wholly or in part, cannot be used as evidence in court of law. 2. The above result pertains only to the samples collected/received. 3. Samples will be destroyed after fifteen days from the date of issue of test reports unless otherwise specified. Perishable samples are not retained. 4. Any dispute arising out of this test report is subjected to Mangalore Jurisdiction only. 5. Total liability of our lab is limited to the invoice amount only. 6. Conformity statement might be affected due to measurement uncertainty.

OneEarth Enviro Labs

1st Floor, KSIA Building, Industrial Area Road, Baikampady,
Mangaluru - 575 011. Ph: 0824-240 9011 Mob: +91 87625 39077
Email: oneearthenviro@gmail.com Website: oneearthenvirolabs.com

Certificate No. CC-1943/00
NABL ISO/IEC 17025:2017

ISO 9001:2015 | ISO 45001:2018 Certified | MOEF & CC RECOGNISED

Report No: W/2021/AP2904
Report Date 03-05-2022

WATER QUALITY ANALYSIS REPORT

Name of the Industry	M/s. Karnataka State Pollution Control Board		
Address	Parisara Bhavana ,10B Baikampady Industrial Area Mangalore-11		
Sample Collected By	Given By the User	Method	--
Sampling Location	River Water of Gurupura collected near Boating pint downstream of Kuloor bridge Mangaluru		
Sample Appearance	Clear		
Date of Sampling	29-04-2022	Analysis Start Date	29-04-2022
Date of Sample Receipt	29-04-2022	Analysis End Date	03-05-2022
Sampling Details	River Water Sample for Micro Biological Analysis		

Parameter	Unit	IS 10500-2012 STD PL (MAX)	Results Code:AP2904	Protocol APHA 2017 23rd Edition
Fecal Coliforms MPN	MPN/100ml	A	350	9221E
Fecal Streptococcus MFT	CFU/50ml	NS	70	9230C
Total Coliforms MPN	MPN/100ml	A	350	9221-B

PL-Permissible Limit Std-Standard P-Present A-Absent < 1.8: Shall be treated as – ve

Opinion	Microbial load is moderate.

*** End of the Report ***

For OneEarth Enviro Labs

Authorised Signatory
(Dr. Sandesh K, Technical Manager)

OneEarth Enviro Labs

1st Floor, KSIA Building, Industrial Area Road, Baikampady,
Mangaluru - 575 011. Ph: 0824-240 9011 Mob: +91 87625 39077
Email: oneearthenviro@gmail.com Website: oneearthenvirolabs.com

OEL/W/F/13/00
Certificate No. TC-7847
NABL ISO/IEC 17025:2017

ISO 9001:2015 | ISO 45001:2018 Certified | MOEF & CC RECOGNISED

Report No: W/2022/AP2902
Report Date 03-05-2022

WATER QUALITY ANALYSIS REPORT

Name of the Industry	M/s. Karnataka State Pollution Control Board		
Address	Parisara Bhavana ,10B Baikampady Industrial Area Mangalore-11		
Sample Collected By	Given By the User	Method	--
Sampling Location	**Back Water collected at ELF gas industry Up stream centre of the bridge which finally joins to Gurupura River Back Water**		
Sample Appearance	Clear		
Date of Sampling	29-04-2022	Analysis Start Date	29-04-2022
Date of Sample Receipt	29-04-2022	Analysis End Date	03-05-2022
Sampling Details	River Water Sample for Micro Biological Analysis		

Parameter	Unit	IS 10500-2012 STD PL (MAX)	Results Code:AP2902	Protocol APHA 2017 23rd Edition
Fecal Coliforms MPN	MPN/100ml	A	>1600	9221E
Fecal Streptococcus MFT	CFU/50ml	NS	40	9230C
Total Coliforms MPN	MPN/100ml	A	>1600	9221-B

PL-Permissible Limit Std-Standard P-Present A-Absent < 1.8: Shall be treated as – ve

Opinion	Microbial load is abondant.

*** End of the Report ***

11 MAY 2022

One Earth Enviro Labs PHONE 2409011 Mangaluru - 575 011

For OneEarth Enviro Labs

Authorised Signatory
(Dr. Sandesh K, Technical Manager)

ANNEXURE 05

केन्द्रीय समुद्री मात्स्यिकी अनुसंधान संस्थान
(भारतीय कृषि अनुसंधान परिषद)

CENTRAL MARINE FISHERIES RESEARCH INSTITUTE
(Indian Council of Agricultural Research)

मंगलूर अनुसंधान केन्द्र, पो.बॉ.सं. 244, होइगे बजार,
मंगलूर - 575 001, कर्नाटक, भारत

Mangalore Research Centre, Post Box No. 244, Hoige Bazar,
Mangalore - 575 001, Karnataka State, India

No. /2-14/461/2018(M)

Dr. Prathibha Rohit
Principal Scientist and Scientist-in-Charge

No.

Date: 31 May 2018

To,

The Deputy Commissioner,
Dakshina Kannada District
Mangaluru-576001

Dear Sir,

Sub. Pollution of Gurupur estuary at downstream portion of Marvoor Dam reg.

Ref. i. CMFRI letter no,. 12-14/399/18 (M) date 9 May 2018

With reference to the above mentioned subject and letter, a detailed report of the analysis carried out is attached herewith for your information.

Yours Sincerely,

Prathibha

Scientist-in-Charge
प्रभारी वैज्ञानिक
SCIENTIST - IN - CHARGE

cc. i. Karnataka State Pollution Control Board
ii. The Deputy Director, Department of Fisheries, Mangaluru

EO. FCS / CRZ Gist
To discuss the contents of the report

4. Conclusion

Large-scale hydrological alterations on land, such as river damming could cause reductions in river water inputs to downstream and to the sea.

The results of the analysis of this study indicated the following:

- The depth of water at the sampling stations ranged from ranged from 0.6 to 5.63 m
- The bottom water salinity was significantly higher than salinity in surface waters. The relatively lower salinity in the surface waters may be attributed to the rainfall. However, the pronounced stratification near the dam (stn.1-3) may also indicate minimal mixing.
- There was significant variation between the dissolved oxygen levels in the surface and bottom waters. Low DO values were recorded in bottom waters near the dam site (stn.1). The oxidation reduction potential in all stations were <200 mV during the sampling time, corroborating the reduced DO levels.
- The silicate content in the upstream water was higher than the levels recorded in the downstream stations. This may be due to damming of the river, which could cause reductions in river water inputs to downstream. All nutrients (nitrogen, phosphorus, and silicon) may get trapped in reservoirs behind dams.
- Nitrate is a common contaminant in water sources and in excess can contribute to the eutrophication of water. The higher levels of total suspended solids content; chlorophyll concentration and phytoplankton diversity in stn.4 indicates higher primary production or algal blooms in the Baikampady Industrial area. The reduction in nitrate and bottom water phosphate levels and the increase in organic carbon content, benthic biomass and biochemical oxygen demand in this station further corroborates these findings.
- The presence of relatively higher numbers of dead gastropod shells near the dam (stn.1); reduced organic carbon content in sediment; reduced chlorophyll content and TSS; reduced bottom water DO and pH may also indicate the reduced inflow from the river as well as reduced flushing of this area with the estuarine waters during the high tide.

- Higher bacterial loads were recorded in case of bottom water in stn.1 and stn.2, which are located in close proximity to the Malavoor Dam. The presence of *E. coli* all along the sampling area (except in stn.2) indicates the possibility of sewage pollution in the estuary.
- The present one-time water quality investigation of the Malavoor (Maravoor) Dam in Gurupura River undertaken by ICAR-CMFRI, Mangalore Research Centre indicated that all parameters monitored were well within the acceptable limits and therefore conducive for fish survival. However, at stns.4 and 5 the BOD and chlorophyll *a* levels were higher. A higher density of phytoplankton was also observed in these two stations indicating eutrophication.
- Further conclusions on the reasons that could have led to fish kill during May 2017 can be suggested only through regular monitoring of the Malavoor downstream area and on receipt of information on the bathymetry of the area as well as the Environmental Impact Assessment reports from the concerned departments.

ANNEXURE-6

Proceedings of the Meeting held with Committee Members of Gurupura River water Quality Monitoring Committee and invitees on 16 .05.2022 at 3.30 PM, 3rd floor DC office Court hall

****

Presiding Officer/ Chairman to the Meeting		**Dr. Rajendra K.V., IAS** Deputy Commissioner, Dakshina Kannada District
INVITEES PRESENT IN THE MEETING		
1	Akshy Shridhar	Commissioner
2	Dr. B.N Dodamani	Professor, Water Resource and Ocean Engineering, Department, NITK
3	Dr. Bindu Sulochan	Principal Scientist, CMFRI
4	Dr. Lakshmipathi	Professor, College of Fisheries, Mangalore
MEMBERS OF THE COMMITTEE PRESENT IN THE MEETING		
1	Prof: G. Srinikethan,	Director Research, Nitte
2	Dr. Shivakumar	Dean College of Fisheries,Mangalore
3	Sri Harish Kumar	Joint Director, Department of Fisheries, Mangalore
4	Sri Gokuldas Nayak	Joint Director, DIC Mangaluru
5	Sri G. Narendra Babu	Executive Engineer, RAWS Division
6	Sri K. Keerthi Kumar	Environmental Officer, KSPCB, RO-Mangalore
7	Sri Dayanand Anil Poojari	Environmental Engineer, Mangaluru City Corporation
8	Sri Vishnu Kamath	AEE, Minor Irrigation Sub-division, Mangalore
9	Sri Isaac Vas	President, Karnataka Small Scale Industries Association, Baikampady
10	Sri Ashok	Secretary, Grama Panchayath-Gurupura
OTHER OFFICERS/INVITEES PRESENT		
1	Sri Mahesh Kumar	Deputy Director- Fisheries present on behalf of RD-CRZ
2	Sri Chandrashekhar	Executive Engineer, KUWS & DB
3	Sri Prasanna Kumar A	AEE, KUWS & DB
4	Dr. Maheshwari Singh	Deputy Environmental Officer, KSPCB,RO-Mangalore
5	Sri Janardhan Naik	AE, KIADB
6	Smt. Poornakala YK	Chief Officer, Bajpe
7	Sri Ajith	KIA, Past President, KIA

8	Sri Robin Joes	Joint Secretary, KIA
9	Sri Guruprasad K.	Member, KIA
10	Sri Jithendra Bathala	Senior Manager, (HSE), MRPL
	MEMBERS ABSENT FOR THE MEETING	
1	Tahsildar, Mangaluru	
2	President Grama Panchayath Maravooru	
3	Panchayath Development Officer-Gurupura Village	

Preamble: Based on public compliant alleging contamination in Maravooru vented dam downstream committee was formed in 2017 for monitoring of river water quality under the Chairmanship of Deputy Commissioner, Dakshina Kannada. Recently, there was fish kill and blackening of river fish kill at Kenjar Guttumane, Bajpe, Mangalore Taluk, Dakshina Kannada District due to alleged discharge of industrial effluent and sewage effluent which was also reported in The Hindu Newspaper on 26.04.2022.

Further, The Hon'ble National Green Tribunal, Principal Bench, New Delhi has passed Orders vide OA No.307/2022 dated:29.04.2022 where in five-member joint Committee consisting of RO MoEF & CC Bengaluru, CPCB, State PCB, District Magistrate and Secretary, Fisheries, Karnataka was formed to investigate and submit the report on this incident.

In view of recurrence of fish kill and blackening part of river and Suo-moto NGT case, the meeting of committee constituted by Deputy Commissioner, Dakshina Kannada vide No.Edis/MSC (2) CR 771/E-22679/2017/D6 dt: 18.12.2017 along with other concerned departments and technical experts was called on 16 .05.2022 at 3.30 PM, 3rd floor DC office Court hall.

During the meeting, Deputy Commissioner first sought the background of Committee formation of Gurupura river. Prof G. Srinikethan, member of the committee briefed about the background of committee formation and previous similar incidence of Gurupura (Phalguni) river blackening and fish kill incidence. After detailed discussion with the technical experts and concerned department officials, Deputy Commissioner gave the following directions:

1. The technical experts of the committee along with the other officials have to visit and identify non-point sources of waste water (sewage, sullage, industrial effluent any other waste water) joining the Gurupura river to take the solid action plan prevent the pollution of Gurupura river.
2. Deputy Commissioner informed that he would again visit the major identified non-point sources which are joining the Gurupura river along with the committee members.
3. KSPCB to identify the industries who are discharging Sewage, sullage, effluent outside the industry premises **(Action: KSPCB)**
4. To submit the present sewage and solid waste management status by Jokatte Grama Panchayath, Gurupura Gram Panchayath, Bajpe TP **(Action: PDO-Jokatte Grama Panchayath, Gurupura Gram Panchayath, Chief Officer-Bajpe TP)**
5. To submit the action taken/proposal of installation of Common STP to Baikampady Industrial Area and Solid waste Management by MCC and KIADB **(Action: Development Officer KIADB & Commissioner MCC)**
6. Not to allow any industries to discharge the untreated/treated effluent to the Backwater **(Action: KSPCB)**
7. To identify and submit the report on list of godowns, hotels, commercial establishments, hostel, labour sheds those who are discharging sewage/sullage outside the premises **(Action: Development Officer KIADB).**
8. To identify and submit the encroachment details of Backwater of Gurupura river due to which natural flushing is hampered **(Action: RD, CRZ, Revenue Department)**
9. To finalize the points to install the CCTV cameras at vulnerable points non-point source pollution **(Action: KIADB, KASIA & KSPCB)**

COMMITTEE CHAIRMAN &
DEPUTY COMMISSIONER
DAKSHINA KANNADA DISTRICT

KARNATAKA STATE POLLUTION CONTROL BOARD

No 10 B,Industrial Area Baikampady Mangalore 575011 Ph No: 0824-2408420

PCB/RO(MNG)/SW-155-157/2022-23/R No : 70

Date: 15/06/2022

ANALYSIS REPORT OF WATER QUALITY
REGIONAL LABORATORY

NAME OF THE LOCATION :	Storm water drain samples, joining at Back water of Gurupura River, Mangaluru
SAMPLE COLLECTED BY :	EO, Mangaluru.
DATE OF COLLECTION :	26.05.2022
DATE OF RECEIPT :	26.05.2022
SAMPLE NO & PARTICULARS OF SAMPLE COLLECTED:	1.Storm water drain joining at Back water of Gurupur River at Kulur Bridge, Mangaluru (155) 2.Storm water drain joining at Back water of Gurupur River at Padukodi Church, Mangaluru (156) 3.Storm water drain joining at Back water of Gurupur River at Total Gas Indy Bridge, Mangaluru (157)

Sl No.	Parameters Analysed	Unit	Results		
			Sample No.155	Sample No.156	Sample No.157
1	pH	pH unit	7.3	7.2	7.5
2	Suspended Solids	mg/L	54	14	10
3	BOD (3 days @ 27 ^{0} C)	mg/L	7	7	5
4	Ammoniacal Nitrogen	mg/L	2	BDL	BDL
5	TKN	mg/L	4	BDL	BDL
6	Free Ammonia	mg/L	0.0353	BDL	BDL
7	Sulphide	mg/L	BDL	BDL	BDL
8	Dissolved Phosphate	mg/L	BDL	BDL	BDL
9	Total Residual Chlorine	mg/L	BDL	BDL	BDL
10	Oil and Grease	mg/L	BDL	BDL	BDL
11	Total Dissolved Solids	mg/L	4330	3784	1186
12	Sulphate	mg/L	639	565	168
13	Copper	mg/L	BDL	BDL	BDL
14	Total Choromium	mg/L	BDL	BDL	BDL
15	Cadmium	mg/L	BDL	BDL	BDL
16	Nickel	mg/L	BDL	BDL	BDL
17	Lead	mg/L	BDL	BDL	BDL
18	Zinc	mg/L	0.106	0.044	0.119
19	Iron	mg/L	0.192	0.112	0.1192
20	Dissolved Oxygen	mg/L	4.4	4.8	5.4
INFERENCE					

Note:

1. The above results pertain only to the sample tested.
2. The method of analysis is as per the Standard Method for the examination of Water and Waste Water, and Indian Standard Publication.
3. ND: Not detected.
4. BDL: Below detection limit
5. COD was not carried out due to high interference from Chloride

Scientific Assistant
ANALYSED BY

Scientific Assistant
VERIFIED BY

Scientific Officer
LAB HEAD

KARNATAKA STATE POLLUTION CONTROL BOARD

No 10 B,Industrial Area Baikampady Mangalore 575011 Ph No: 0824-2408420

PCB/RO(MNG)/RW-152-154/2022-23/R No : 69

Date: 15/06/2022

ANALYSIS REPORT OF WATER QUALITY
REGIONAL LABORATORY

NAME OF THE LOCATION :	Storm water drain samples, joining at Back water of Gurupura River, Mangaluru
SAMPLE COLLECTED BY :	EO, Mangaluru.
DATE OF COLLECTION :	26.05.2022
DATE OF RECEIPT :	26.05.2022
SAMPLE NO & PARTICULARS OF SAMPLE COLLECTED:	1.Storm water drain joining at Back water of Gurupur River at Bunder, Kudroli Mangaluru (152) 2.Storm water drain joining at Back water of Gurupur River at Skate City Point, Boloor, Mangaluru (153) 3.Storm water drain joining at Back water of Gurupur River at Dambel, Mangaluru (154)

Sl No.	Parameters Analysed	Unit	Results		
			Sample No.152	Sample No.153	Sample No.154
1	pH	pH unit	7.5	7.1	7.4
2	Suspended Solids	mg/L	20	12	10
3	BOD (3 days @ 27 ^{0} C)	mg/L	12	15	13
4	Ammoniacal Nitrogen	mg/L	2	3	2
5	TKN	mg/L	4	6	5
6	Free Ammonia	mg/L	0.0353	0.053	0.0353
7	Sulphide	mg/L	BDL	BDL	BDL
8	Dissolved Phosphate	mg/L	0.0513	BDL	BDL
9	Total Residual Chlorine	mg/L	BDL	BDL	BDL
10	Oil and Grease	mg/L	BDL	BDL	BDL
11	Total Dissolved Solids	mg/L	16106	10794	9618
12	Sulphate	mg/L	1700	1264	1012
13	Copper	mg/L	0.068	0.023	BDL
14	Total Choromium	mg/L	BDL	BDL	BDL
15	Cadmium	mg/L	BDL	BDL	BDL
16	Nickel	mg/L	0.038	0.027	0.019
17	Lead	mg/L	BDL	BDL	BDL
18	Zinc	mg/L	0.616	0.163	0.095
19	Iron	mg/L	0.439	0.29	0.257
20	Dissolved Oxygen	mg/L	3.2	2.1	3.2
INFERENCE					

Note:

1. The above results pertain only to the sample tested.
2. The method of analysis is as per the Standard Method for the examination of Water and Waste Water, and Indian Standard Publication.
3. ND: Not detected.
4. BDL: Below detection limit
5. COD was not carried out due to high interference from Chloride

Scientific Assistant
ANALYSED BY

Scientific Assistant
VERIFIED BY

Scientific Officer
LAB HEAD

OneEarth Enviro Labs

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Certificate No. TC-7847
NABL ISO/IEC 17025:2017
OEL/W/F/13/00

ISO 9001:2015 | ISO 45001:2018 Certified | MOEF & CC RECOGNISED

Report No: W/2022/MY2604B
Report Date 28-05-2022

WATER QUALITY ANALYSIS REPORT

Name of the Industry	M/s. Karnataka State Pollution Control Board		
Address	Parisara Bhavana ,10B Baikampady Industrial Area Mangalore-11		
Sample Collected By	Given By the User	Method	--
Sampling Location	Storm water drain joining point at Backwater of Gurupur River at Bunder,Kudroli,Mangaluru		
Sample Appearance	Clear		
Date of Sampling	26-05-2022		
Date of Sample Receipt	26-05-2022	Analysis Start Date	26-05-2022
Sampling Details	River Back Water Sample for Micro Biological Analysis	Analysis End Date	28-05-2022

Parameter	Unit	IS 10500-2012 STD PL (MAX)	Results Code:MY2604	Protocol APHA 2017 23rd Edition
Fecal Coliforms MPN	MPN/100ml	A	>1600	9221E
Fecal Streptococcus MFT	CFU/100ml	NS	80	9230C
Total Coliforms MPN	MPN/100ml	A	>1600	9221-B

PL-Permissible Limit Std-Standard P-Present A-Absent < 1.8: Shall be treated as – ve

Opinion	Microbial load is abundant.

*** End of the Report ***

One Earth Enviro Labs PHONE 2409011 Mangaluru - 575 011

For OneEarth Enviro Labs

Authorised Signatory
(Dr. Sandesh K, Technical Manager)

Note: 1.The report shall not be reproduced wholly or in part, cannot be used as evidence in court of law. 2. The above result pertains only to the samples collected/received. 3. Samples will be destroyed after fifteen days from the date of issue of test reports unless otherwise specified. Perishable samples are not retained. 4. Any dispute arising out of this test report is subjected to Mangalore Jurisdiction only. 5. Total liability of our lab is limited to the invoice amount only. 6. Conformity statement might be affected due to measurement uncertainty.

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Report No: W/2022/MY2605B
Report Date 28-05-2022

WATER QUALITY ANALYSIS REPORT

Name of the Industry	M/s. Karnataka State Pollution Control Board
Address	Parisara Bhavana ,10B Baikampady Industrial Area Mangalore-11
Sample Collected By	Given By the User
Sampling Location	Storm water drain joining at Backwater of Gurupur river at Skate City Point,Boloor,Ashoknagar
Method	--
Sample Appearance	Clear
Date of Sampling	26-05-2022
Date of Sample Receipt	26-05-2022
Analysis Start Date	26-05-2022
Analysis End Date	28-05-2022
Sampling Details	River Back Water Sample for Micro Biological Analysis

Parameter	Unit	IS 10500-2012 STD PL (MAX)	Results Code:MY2605	Protocol APHA 2017 23rd Edition
Fecal Coliforms MPN	MPN/100ml	A	>1600	9221E
Fecal Streptococcus MFT	CFU/100ml	NS	62	9230C
Total Coliforms MPN	MPN/100ml	A	>1600	9221-B

PL-Permissible Limit Std-Standard P-Present A-Absent < 1.8: Shall be treated as – ve

Opinion	Microbial load is abundant.

*** End of the Report ***

For OneEarth Enviro Labs

One Earth Enviro Labs PHONE 2409011 Mangaluru - 575 011

Authorised Signatory
(Dr. Sandesh K, Technical Manager)

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Report No: W/2022/MY2606B
Report Date 28-05-2022

WATER QUALITY ANALYSIS REPORT

Name of the Industry	M/s. Karnataka State Pollution Control Board		
Address	Parisara Bhavana ,10B Baikampady Industrial Area Mangalore-11		
Sample Collected By	Given By the User	Method	--
Sampling Location	Storm water drain joining point at Backwater of Gurupur River at Dambel,Mangaluru		
Sample Appearance	Clear		
Date of Sampling	26-05-2022	Analysis Start Date	26-05-2022
Date of Sample Receipt	26-05-2022	Analysis End Date	28-05-2022
Sampling Details	River Back Water Sample for Micro Biological Analysis		

Parameter	Unit	IS 10500-2012 STD DL (MAX)	Results Code:MY2606	Protocol APHA 2017 23rd Edition
Fecal Coliforms MPN	MPN/100ml	A	>1600	9221E
Fecal Streptococcus MFT	CFU/100ml	NS	65	9230C
Total Coliforms MPN	MPN/100ml	A	>1600	9221-B

PL-Permissible Limit Std-Standard P-Present A-Absent < 1.8: Shall be treated as – ve

Opinion	Microbial load is abundant.

*** End of the Report ***

For OneEarth Enviro Labs

OneEarth Enviro Labs PHONE 2409011 Mangaluru - 575 011

Authorised Signatory
Dr. Sandesh K, Technical Manager

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Report No: W/2022/MY2607B
Report Date 28-05-2022

WATER QUALITY ANALYSIS REPORT

Name of the Industry	M/s. Karnataka State Pollution Control Board		
Address	Parisara Bhavana ,10B Baikampady Industrial Area Mangalore-11		
Sample Collected By	Given By the User	Method	--
Sampling Location	Storm water drain joining at Backwater of Gurupur River at Kulur Bridge		
Sample Appearance	Clear		
Date of Sampling	26-05-2022		
Date of Sample Receipt	26-05-2022	Analysis Start Date	26-05-2022
Sampling Details	River Back Water Sample for Micro Biological Analysis	Analysis End Date	28-05-2022

Parameter	Unit	IS 10500-2012 STD DL (MAX)	Results Code:MY2607	Protocol APHA 2017 23rd Edition
Fecal Coliforms MPN	MPN/100ml	A	>1600	9221E
Fecal Streptococcus MFT	CFU/100ml	NS	74	9230C
Total Coliforms MPN	MPN/100ml	A	>1600	9221-B

PL-Permissible Limit Std-Standard P-Present A-Absent < 1.8: Shall be treated as – ve

Opinion	Microbial load is abundant.

*** End of the Report ***

One Earth Enviro Labs PHONE 2409011 Mangaluru - 575 011

For OneEarth Enviro Labs

Authorised Signatory
(Dr. Sandesh K, Technical Manager)

Note: 1.The report shall not be reproduced wholly or in part, cannot be used as evidence in court of law. 2. The above result pertains only to the samples collected/received. 3. Samples will be destroyed after fifteen days from the date of issue of test reports unless otherwise specified. Perishable samples are not retained. 4. Any dispute arising out of this test report is subjected to Mangalore Jurisdiction only. 5. Total liability of our lab is limited to the invoice amount only. 6. Conformity statement might be affected due to measurement uncertainty.

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Report No: W/2022/MY2608B
Report Date 28-05-2022

WATER QUALITY ANALYSIS REPORT

Name of the Industry	M/s. Karnataka State Pollution Control Board		
Address	Parisara Bhavana ,10B Baikampady Industrial Area Mangalore-11		
Sample Collected By	Given By the User	Method	--
Sampling Location	Storm water drain joining at Backwater of Gurupur River at Padukodi Church,Mangaluru		
Sample Appearance	Clear		
Date of Sampling	26-05-2022	Analysis Start Date	26-05-2022
Date of Sample Receipt	26-05-2022	Analysis End Date	28-05-2022
Sampling Details	River Back Water Sample for Micro Biological Analysis		

Parameter	Unit	IS 10500-2012 STD PL (MAX)	Results Code:MY2608	Protocol APHA 2017 23rd Edition
Fecal Coliforms MPN	MPN/100ml	A	>1600	9221E
Fecal Streptococcus MFT	CFU/100ml	NS	63	9230C
Total Coliforms MPN	MPN/100ml	A	>1600	9221-B

PL-Permissible Limit Std-Standard P-Present A-Absent < 1.8: Shall be treated as – ve

Opinion	Microbial load is abundant.

*** End of the Report ***

For OneEarth Enviro Labs

OneEarth Enviro Labs PHONE 2409011 Mangaluru - 575 011

Authorised Signatory
(Dr. Sandesh K, Technical Manager)

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F/13/00

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Report No: W/2022/MY2609B

Report Date 28-05-2022

WATER QUALITY ANALYSIS REPORT

Name of the Industry	M/s. Karnataka State Pollution Control Board		
Address	Parisara Bhavana ,10B Baikampady Industrial Area Mangalore-11		
Sample Collected By	Given By the User	Method	--
Sampling Location	Storm water drain joining at Backwater of Gurupur River at Total Gas Industry Bridge.		
Sample Appearance	Clear		
Date of Sampling	26-05-2022	Analysis Start Date	26-05-2022
Date of Sample Receipt	26-05-2022	Analysis End Date	28-05-2022
Sampling Details	River Back Water Sample for Micro Biological Analysis		

Parameter	Unit	IS 10500-2012 STD PL (MAX)	Results Code:MY2609	Protocol APHA 2017 23rd Edition
Fecal Coliforms MPN	MPN/100ml	A	>1600	9221E
Fecal Streptococcus MFT	CFU/100ml	NS	88	9230C
Total Coliforms MPN	MPN/100ml	A	>1600	9221-B

PL-Permissible Limit Std-Standard P-Present A-Absent < 1.8: Shall be treated as – ve

Opinion	Microbial load is abundant.

*** End of the Report ***

For OneEarth Enviro Labs

One Earth Enviro Labs PHONE 2409011

Authorised Signatory
(Dr. Sandesh K, Technical Manager)

ANNEXURE-8

Proceedings of the Meeting of the Joint Committee along with members of Gurupura River Monitoring Committee and other officials/Invitees in the matter of NGT OA No. 307/2022 pertaining to the flow of industrial/sewage effluent into Phalguni River resulting in fish kill on 08 .06.2022 at 12.30 PM, NIC Hall, ZP Office.

****

Presiding Officer/ Chairman to the Committee		**Dr. Rajendra K.V., IAS** Deputy Commissioner, Dakshina Kannada District
Members of Joint Committee appointed by NGT in the matter of OA 307/2022		
1. Dr. S. Prabhu, Scientist D., **(Joined through VC)**		Scientist D., Ministry of Environment, Forest & Climate Change, Integrated Regional Office, Bengaluru.
2. Smt. Sowmya D., Scientist 'D',		Regional Directorate, Central Pollution Control Board,1st Floor, "Nisarga Bhawan",7 C Main, Thimmaiah Road, Shivanagar, Bengaluru-560 010
3. Smt. Vijaya Hegde, Senior Environmental Officer **(Joined through VC)**		Zonal Senior Environmental Officer, Karnataka State Pollution Control Board, Mangaluru, D.K
4. Sri K. Keerthi Kumar Environmental Officer, KSPCB, RO-Mangalore		Member Convenor
INVITEES PRESENT IN THE MEETING		
1	Dr. Prathibha Rohith	Principal Scientist and Head, CMFRI
2	Dr. B.N Doddamani	Professor, Water Resource and Ocean Engineering, Department, NITK
3	Dr. Bindu Sulochan	Principal Scientist, CMFRI
MEMBERS OF THE GURUPURA RIVER MONITORING COMMITTEE PRESENT IN THE MEETING		
1	Prof: G. Srinikethan,	Director Research, Nitte
2	Sri Gokuldas Nayak	Joint Director, DIC Mangaluru
3	Sri G. Narendra Babu	Executive Engineer, RAWS Division
4	Sri Gokuldas	EE, Minor Irrigation Sub-division, Mangalore
5	Smt. Deepthi	Assistant Executive Engineer (Env), Mangaluru City Corporation
6	Sri Isaac Vas	President, Karnataka Small Scale Industries Association, Baikampady
OTHER OFFICERS/INVITEES PRESENT		
1	Sri Ganeshan R.	Deputy Commissioner- Development, MCC
2	Sri Shivalingappa M.N	AEE, MCC

3	Sri Mahesh Kumar	Deputy Director- Fisheries present on behalf of RD-CRZ
4	Smt. Manjulashree	Assistant Director, Dept. of Fisheries, Mangalore
5	Dr. Maheshwari Singh	Deputy Environmental Officer, KSPCB,RO-Mangalore
6	Smt. Poornakala Y.K.	Chief Officer, Bajpe
	MEMBERS/INVITEES ABSENT FOR THE MEETING	
1	**The Director of fisheries is yet to depute concerned member from Joint Committee**	
2	Dean Fisheries, Mangalore	
3	Tahsildar, Mangaluru	
4	President Grama Panchayath Maravooru	
5	Panchayath Development Officer-Gurupura Village	

Preamble:

Hon'ble NGT, Principal Bench, New Delhi has passed an order OA No:307 of 2022 dated: 29.04.2022 based on the **"News item published in The Hindu dated 26.04.2022 titled "Flow of industrial effluents into Phalguni results in fish kill"** which ***reported as "hundreds of fishes were found dead and floating in Phalguni (Gurupura) river, downstream the Maravooru vented dam, following the flow of industrial and domestic effluent into the river. The administration has remained mute to the happening. The photographs in the media report suggest that colour of the river has turned black due to the effluents released by the industries in Baikampady industrial area in Mangalore, Dakshina Kannada, Karnataka".***

Hon'ble NGT considered the matter. Prima facie, it appears that untreated effluents are being discharged in the river in question by the industries in the area, without any regulation by the concerned statutory authorities in violation of the Water (Prevention and Control of Pollution) Act, 1974.

Hon'ble NGT, Principal Bench, New Delhi constituted joint committee comprising of the Regional Officers of MoEF&CC and CPCB Bengaluru, State PCB, Director, Fisheries, Karnataka and District Magistrate, Dakshina Kannada District. Hence, a joint Committee consisting of above members were constituted by Board Office vide Office Memorandum No. KSPCB/NEIA-OB/NGT-307/22-2023/813 dated: 07.05.2022. First meeting of the Joint Committee along with members of Gurupura River Water Quality Monitoring Committee was held on 08.06.2022 at 1rd

Floor NIC Hall, Zilla Panchayath Office, Mangalore D.K District under the Chairmanship of Deputy Commissioner, Dakshina Kannada District.

During the meeting, Deputy Commissioner sought the details on progress made by the based on the proceedings of meeting conducted under the Chairmanship of Deputy Commissioner on 16.05.2022. **To this, Prof G. Srinikethan, member of the committee briefly presented the progress made so far which is reported as follows:**

1. Internal Meeting of Committee members to discuss on further action plan was held at Regional Office, Mangalore on 21.05.2022. Based on the discussion, it was decided to obtain the maps of land use, land cover, drainage pattern and location sketches of Gurupura river area from NRDM ZP Office and KRSSAC, Bangalore, Accordingly, the maps were obtained by KSPCB from concerned Departments.
2. The Gurupura river water quality monitoring Committee members with other officials conducted the spot inspection on 26-05-2022 by Boat and by Road to identify point/ non-point sources which causes pollution.
3. Basically, the fish kill occurred in two stagnant water ponds where there was no flushing from Phalguni River. At the outset, it appears that lack of adequate water flow, high organic load and also high temperature of the summer might have resulted in depletion of oxygen causing the probable death of small fishes and the extent of impact is minimal (i.e., at area of two small stagnated water pool at Storm water drain). Fish kill was not observed in the Gurupura (Phalguni) river.
4. Deputy Commissioner was informed that earlier also there was a similar fish kill incident happened in 2017 and a committee was formed in the year 2017 for monitoring of river water quality and suggest appropriate actions to DC for maintaining good water quality.
5. At the stretch from Back Water (creek) near ELF Gas Industry, the colour of water was light black by physical observation on 25.04.2022 during inspection by KSPCB. But while observing on 26.04.2022 & 27.04.2022, there was no appearance of black colour. But while observing on 26.04.2022 & 27.04.2022, there was no appearance of black colour. But again, during inspection on 28.04.2022 colour of water was light black and on 29.04.2022 it was colourless again. This phenomenon is as well reported in many research papers. Literature by various researchers reveals that the incidence of river blackening and fish kill at times is not a very uncommon phenomenon and this bio-geochemical phenomenon has been most of the times co-related to

presence of high organic load and inadequate tidal flushing especially in summers. High organic load quickly depletes the dissolved oxygen leading to anaerobic conditions. The anaerobic microbes degrade the dissolved organics which may further react with minerals in water and sediment forming black precipitates.

6. Bacteriological analysis of *Faecal coliforms* and *Faecal streptococci* reveals that there is abundant microbial load in the sample of Backwater collected on 29.04.2022 and the ratio of these parameters indicates sewage as the main source of pollution load. In the year 2018 also CMFRI has monitored the Gurupura river stretch and submitted a comprehensive report where in, they have concluded that the increase in the Organic load into the river indicates the possibility of discharge of sewage.
7. Dumping/disposing of sewage collected from Hotels and selected industries and in other residential areas through Cess Pool at selected places **which needs a proper investigation.**
8. Cess Pool discharge by tankers and lorries across Kudumburu stream and solid waste dumping/ C& D Waste dumping on Jokatte ODC Road illegally was reported Kanara Industrial Association and Industries and informed that they have complained to MCC, Police and KSPCB. KSPCB has addressed letter to MCC and RTO to take suitable action.
9. An old video pertaining to solid waste dumping was displayed during the presentation. To this Deputy Commissioner informed the KASSIA to monitor through CCTV and also look into previous cases booked. He also directed to inform the Concerned RTO Officer and DYSP, Panambur/ACP South to be present for spot inspection and to attend subsequent meetings.
10. Further, there is no UGD with STP and Solid Waste Management in Baikampady Industrial Area and surrounding areas and also towards Kudroli, Dambel and Kulur side which is urgently required. Domestic sewage entry is observed at different places through Storm Water Drain from entire area to all along the river on both sides which needs an urgent attention by MCC.
11. Most of the Large and Medium scale industries have adopted Zero Liquid Discharge (ZLD). Defaulting industries have been identified and notices have been issued.
12. There is no adequate minimum flow from the dam resulting improper flushing causing stagnation of water and increased organic load.
13. Due to sand mining, lot of depth variation is observed. CMFRI in their report has suggested detailed bathymetric studies. Stagnated water pockets all along

- Not to allow any industries to discharge the treated/untreated effluent to the Backwater **(Action: KSPCB)**
- To identify and submit the report on list of godowns, hotels, commercial establishments, hostel, labour sheds with total number of people and water consumption details. **(Action: Development Officer KIADB).**
- To submit details on the number of houses, population, sewage and solid waste management in areas located at Kudroli, Dambel, Bangrakulur, Thannirbhavi area, Angaragundi village. Kudumburu village, surrounding areas of Baggundi Lake, MSEZ RR Colony **(Action: MCC).**

16. In the said meeting, Deputy Commissioner directed to **schedule the spot inspection on 16.06.2022** and directed the member convenor to put up spot inspection intimation letter to all the Joint Committee members and Gurupura river water quality monitoring committee members along with other officials to be present along with details mentioned above.

COMMITTEE CHAIRMAN &
DEPUTY COMMISSIONER
DAKSHINA KANNADA DISTRICT

ANNEXURE-9

Proceedings of the Inspection of the Joint Committee along with members of Gurupura River Monitoring Committee and other officials and in the matter of NGT OA No. 307/2022 pertaining to the flow of industrial/sewage effluent into Phalguni River resulting in fish kill and invitees on 16.06.2022

****

Presiding Officer/ Chairman to the Meeting		**Dr. Rajendra K.V., IAS** Deputy Commissioner, Dakshina Kannada District
Members of Joint Committee appointed by NGT in the matter of OA 307/2022		
1. Dr. S. Prabhu, Scientist D., **(Joined through VC)**		Scientist D., Ministry of Environment, Forest & Climate Change, Integrated Regional Office, Bengaluru.
2. Smt. Sowmya D., Scientist 'D',		Regional Directorate, Central Pollution Control Board,1st Floor, "Nisarga Bhawan",7 C Main, Thimmaiah Road, Shivanagar, Bengaluru-560 010
3. Smt. Vijaya Hegde, Senior Environmental Officer		Zonal Senior Environmental Officer, Karnataka State Pollution Control Board, Mangaluru, D. K
4. Sri K. Keerthi Kumar Environmental Officer, KSPCB, RO-Mangalore		Member Convenor
INVITEES PRESENT IN THE JOINT INSPECTION		
1	Dr. Prathibha Rohith	Principal Scientist and Head, CMFRI
2	Dr. Bindu Sulochan	Principal Scientist, CMFRI
MEMBERS OF THE COMMITTEE PRESENT IN THE MEETING		
1	Prof: G. Srinikethan,	Director Research, Nitte
3	Sri Harish Kumar	Joint Director, Department of Fisheries, Mangalore
4	Sri Gokuldas Nayak	Joint Director, DIC Mangaluru
5	Sri G. Narendra Babu	Executive Engineer, RAWS Division
	Sri Gokuldas	EE, Minor Irrigation Sub-division, Mangalore
7	Smt. Deepthi	Assistant Executive Engineer (Env), Mangaluru City Corporation
9	Sri Isaac Vas	President, Karnataka Small Scale Industries Association, Baikampady
OTHER OFFICERS/INVITEES PRESENT		
1	Sri Ganeshan R.	Deputy Commissioner- Development, MCC
2	Sri Shivalingappa M. N.	AEE, MCC
3	Sri Mahesh Kumar	Deputy Director- Fisheries present on behalf of RD-CRZ

4	Smt. Manjulashree	Assistant Director, Dept. of Fisheries, Mangalore
5	Dr. Maheshwari Singh	Deputy Environmental Officer, KSPCB, RO-Mangalore
6	Smt. Poornakala Y.K.	Chief Officer, Bajpe
	MEMBERS/OFFICERS ABSENT FOR THE MEETING	
1	**The Director of fisheries is yet to depute concerned member from Joint Committee**	
2	Tahsildar, Mangaluru	
3	President Grama Panchayath Maravooru	
4	Panchayath Development Officer-Gurupura Village	
5	Dean College of Fisheries, Mangalore	
6		

Preamble:

Hon'ble NGT, Principal Bench, New Delhi has passed an order OA No:307 of 2022 dated: 29.04.2022 based on the **"News item published in The Hindu dated 26.04.2022 titled "Flow of industrial effluents into Phalguni results in fish kill"** which ***reported as "hundreds of fishes were found dead and floating in Phalguni (Gurupura) river, downstream the Maravooru vented dam, following the flow of industrial and domestic effluent into the river. The administration has remained mute to the happening. The photographs in the media report suggest that colour of the river has turned black due to the effluents released by the industries in Baikampady industrial area in Mangalore, Dakshina Kannada, Karnataka"***.

Hon'ble NGT considered the matter. Prima facie, it appears that untreated effluents are being discharged in the river in question by the industries in the area, without any regulation by the concerned statutory authorities in violation of the Water (Prevention and Control of Pollution) Act, 1974.

Hon'ble NGT, Principal Bench, New Delhi constituted joint committee comprising of the Regional Officers of MoEF&CC and CPCB Bengaluru, State PCB, Director, Fisheries, Karnataka and District Magistrate, Dakshina Kannada District. Hence, a joint Committee consisting of above members were constituted by Board Office vide Office Memorandum cited vide ref (2).

First meeting of the Joint Committee along with members of Gurupura River Water Quality Monitoring Committee was held on 08.06.2022 at 1rd Floor NIC Hall, Zilla Panchayath Office, Mangalore D.K District under the Chairmanship of Deputy Commissioner, Dakshina Kannada District. During the meeting, Deputy Commissioner sought the details on progress made by the based on the proceedings of meeting conducted under the Chairmanship of Deputy

Commissioner on 16.05.2022. In the said meeting, Deputy Commissioner **directed to schedule the spot inspection on 16.06.2022 and accordingly spot inspection by all the Joint Committee members and Gurupura river water quality monitoring committee members along with other officials was conducted on 16.06.2022 and during inspection following Locations were inspected:**

1. Inspection of various drain joining points through Boat:
   Following drain joining points to backwater of river Phalguni were inspected
   - Storm Water drain (Major Drain Entering from Mangalore City) joining point at Backwater of Gurupura river near Kudroli (12.870525,74.829327)
   - Storm Water drain (Drain Entering from Bolor, Thannirbhavi) joining point at Backwater of Gurupura river near Amruth Vidyalaya, Bolor (12.888015,74.8206)
   - Storm water drain -Skate City Garden Point, Near Bolar from the area of Ashoknagar (12.894928,74.823993)
   - Storm Water drain (Major Drain Entering from Dambel) joining point at Backwater of Gurupura river near Dambel (12.903643,74.821358)
   - Storm Water drain (Drain Entering from Padukodi, Near Kulur Church) joining point at Backwater of Gurupura river near Kulur (12.927644,74.829748)

   During inspection, Deputy Commissioner and Chairman of the Committee highlighted following issues
   - To verify the Ship Breaking/ship building activities in CRZ Area.
   - Action plan by MCC for entry of Solid waste, C& D waste and sewage entry to the river.
   - Carry out dredging activity to ensure free flowing of water during low tide
   - Stake holders to propose for action plans with estimated budgetary provisions

Further, the area surrounding Baikampady industrial area was

- Kudumbur hole Backwater of Gurupura river at ELF Gas (Drain Entering from Baikampady Industrial Area, Jokatte, MSEZ RR Colony, MRPL Marshy land, Baggundi lake outflow, Angaragundi, Kudumbur village) (12.945400,74.835393)
- Kudumburu Bridge Backwater of Gurupura river (Drain Entering from Jokatte village, MSEZ RR Colony, MRPL Marshy land, Baggundi lake outflow, Angaragundi, Kudumburu village) joining point at Backwater of Gurupura river (12.948843,74.832835)

To this, Prof G. Srinikethan, member of the committee briefly presented the progress made so far which is reported as follows:

1. Internal Meeting of Committee members to discuss on further action plan was held at Regional Office, Mangalore on 21.05.2022. Based on the discussion, it was decided to obtain the maps of land use, land cover, drainage pattern and location sketches of Gurupura river area from NRDM ZP Office and KRSSAC, Bangalore of. Accordingly, the maps were obtained by KSPCB from concerned Departments.
2. The Gurupura river water quality monitoring Committee members with other officials conducted the spot inspection to identify point/ non-point sources of pollution boat and by road on 26.05.2022.
3. Basically, the fish kill occurred in two stagnant water ponds where there was no flushing from Phalguni River. At the outset, it appears that lack of adequate water flow, high organic load and also high temperature of the summer might have resulted in depletion of oxygen causing the probable death of small fishes and the extent of impact is minimal (i.e., at area of two small stagnated water pool at Storm water drain). Fish kill was not observed in the Gurupura (Phalguni) river.
4. Deputy Commissioner was informed that earlier also there was a similar fish kill incident happened in 2017 and a committee was formed in the year 2017 for monitoring of river water quality and suggest appropriate actions to DC for maintaining good water quality.

5. At the stretch from Back Water (creek) near ELF Gas Industry, the colour of water was light black by physical observation on 25.04.2022 during inspection by KSPCB. But while observing on 26.04.2022 & 27.04.2022, there was no appearance of black colour. But while observing on 26.04.2022 & 27.04.2022, there was no appearance of black colour. But again during inspection on 28.04.2022 colour of water was light black and on 29.04.2022 it was colourless again. This phenomenon is as well reported in many research papers. Literature by various researchers reveals that the incidence of river blackening and fish kill at times is not a very uncommon phenomenon and this bio-geochemical phenomenon has been most of the times co-related to presence of high organic load and inadequate tidal flushing especially in summers. High organic load quickly depletes the dissolved oxygen leading to anaerobic conditions. The anaerobic microbes degrade the dissolved organics which may further react with minerals in water and sediment forming black precipitates.
6. Bacteriological analysis of *Faecal coliforms* and *Faecal streptococci* reveals that there is abundant microbial load in the sample of Backwater collected on 29.04.2022 and the ratio of these parameters indicates sewage as the main source of pollution load. In the year 2018 also CMFRI has monitored the Gurupura river stretch and submitted a comprehensive report where in, they have concluded that the increase in the Organic load into the river indicates the possibility of discharge of sewage.
7. Dumping/disposing of sewage collected from Hotels and selected industries and in other residential areas through Cess Pool at selected places **which needs a proper investigation.**
8. Cess Pool discharge by tankers and lorries across Kudumburu stream and solid waste dumping/ C& D Waste dumping on Jokatte ODC Road illegally was reported Kanara Industrial Association and Industries and they informed that they have complained to MCC, Police and KSPCB. KSPCB has addressed letter to MCC and RTO to take suitable action.
9. An old video pertaining to solid waste dumping was displayed during the presentation. To this Deputy Commissioner informed the KASSIA to monitor through CCTV and also look into previous cases booked. He also directed to inform the Concerned RTO Officer and DYSP, Panambur/ACP South to be present for spot inspection and to attend subsequent meetings.
10. Further, there is no UGD with STP and Solid Waste Management in Baikampady Industrial Area and surrounding areas and also towards

Kudroli, Dambel and Kulur side which is urgently required. Domestic sewage entry is observed at different places through Storm Water Drain from entire area to all along the River on both sides which needs a urgent attention by MCC.

11. Most of the Large and Medium scale industries have adopted Zero Liquid Discharge (ZLD).Defaulting industries have been identified and notices have been issued.
12. There is no adequate minimum flow from the dam resulting improper flushing causing stagnation of water and increased organic load.
13. Due to sand mining, lot of depth variation is observed. CMFRI in their report has suggested detailed bathymetric studies. Stagnated water pockets all along the creeks near Baikampady industrial area and lack of tidal effect, Siltation of the Creek could have caused the Block. Further lot of filings, encroachments, Mangroves death, Dumping of Non-Hazardous Waste and Construction Waste, could have lead to blockages and effected the tidal flushing ***which needs the Comprehensive study***.
14. Minor Irrigation Department Officials have to submit compliance to conditions imposed during clearance of vented dam.
15. **Deputy Commissioner, Mangalore D.K District and Chairman of Joint Committee directed the member convenor KSPCB to issue notices to obtain the details as follows:**
    - KIADB and DIC to provide the list of industries located in Baikampady Industrial Area and KSSIDC Estate **(Action: KIADB & DIC)**
    - KSPCB to identify the industries who are discharging Sewage, sullage, effluent outside the industry premises **(Action: KSPCB)**
    - To submit the present sewage and solid waste management status by Jokatte Grama Panchayath, Gurupura Gram Panchayath, Bajpe TP **(Action: PDO-Jokatte Grama Panchayath, Gurupura Gram Panchayath, Chief Officer-Bajpe TP)**
    - To submit the action taken/proposal of installation of Common STP to Baikampady Industrial Area and Solid waste Management by MCC and KIADB **(Action: Development Officer KIADB & Commissioner MCC)**
    - To submit details on land use change for last 10 years on CRZ area all along the river on either side and also to report on reduced water flow

due to stagnation because of lot of fillings on backwater and their impact on mangroves **(Action: RD, CRZ)**

- To install CCTV Cameras and caution sign Boards at Jokatte ODC Road to prevent and identify the illegal discharge of sewage through cess pool to the backwater of Gurupura river and dumping of solid waste (**Action: KIADB, KIA, PDO Jokatte Grama Panchayath**)
- To take action on vehicles dumping the cess pool **(Action: RTO, KIA, MCC/Grama Panchayath).**
- Minor Irrigation Department Officials have to submit compliance to conditions imposed during clearance of vented dam ((**Action: Minor Irrigation)**
- Major Irrigation Department Officials have to submit the details pertaining to minimum flow, current flow rate and desirable flow rate etc. any obstructions to vented dam if any ((**Action: Major Irrigation)**
- Not to allow any industries to discharge the treated/untreated effluent to the Backwater **(Action: KSPCB)**
- To identify and submit the report on list of godowns, hotels, commercial establishments, hostel, labour sheds with total number of people and water consumption details. **(Action: Development Officer KIADB).**
- To submit the number of houses and population located at Kudroli, Dambel, Bangrakulur, Thannirbhavi area, Angaragundi village. Kudumburu village, surrounding areas of Baggundi Lake, MSEZ RR Colony **(Action: MCC)**

COMMITTEE CHAIRMAN &
DEPUTY COMMISSIONER
DAKSHINA KANNADA DISTRICT

KARNATAKA STATE POLLUTION CONTROL BOARD

No 10 B,Industrial Area Baikampady Mangalore 575011 Ph No: 0824-2408420

PCB/RO(MNG)/SW-217-219/2022-23/R No : 124 Date: 2 | 7 | 2022

ANALYSIS REPORT OF WATER QUALITY
REGIONAL LABORATORY

NAME OF THE LOCATION :	Storm water drain samples, joining at Back water of Gurupura River, Mangaluru
SAMPLE COLLECTED BY :	EO, Mangaluru.
DATE OF COLLECTION :	16.06.2022
DATE OF RECEIPT :	16.06.2022
SAMPLE NO & PARTICULARS OF SAMPLE COLLECTED:	1.Storm water drain joining at Back water of Gurupur River at Padukodi Church, Mangaluru (217) 2.Storm water drain joining at Back water of Gurupur River at Total Gas Indy Bridge, Mangaluru (218) 3.Storm water drain collected at Jokatte Bridge (219)

Sl No.	Parameters Analysed	Unit	Results		
			Sample No.217	Sample No.218	Sample No.219
1	pH	pH unit	7.1	7.2	7.3
2	Suspended Solids	mg/L	10	10	8
3	BOD (3 days @ 27 ^{0} C)	mg/L	13	7	4
4	Ammoniacal Nitrogen	mg/L	BDL	BDL	5
5	TKN	mg/L	BDL	BDL	7
6	Free Ammonia	mg/L	BDL	BDL	0.0883
7	Sulphide	mg/L	BDL	BDL	BDL
8	Dissolved Phosphate	mg/L	BDL	BDL	BDL
9	Total Residual Chlorine	mg/L	BDL	BDL	BDL
10	Oil and Grease	mg/L	BDL	BDL	BDL
11	Total Dissolved Solids	mg/L	4636	3982	3300
12	Sulphate	mg/L	546	412	230
13	Copper	mg/L	0.047	0.323	BDL
14	Total Choromium	mg/L	BDL	BDL	BDL
15	Cadmium	mg/L	BDL	BDL	BDL
16	Nickel	mg/L	0.032	BDL	BDL
17	Lead	mg/L	BDL	BDL	BDL
18	Zinc	mg/L	0.054	0.079	0.033
19	Iron	mg/L	0.062	0.063	0.021
20	Dissolved Oxygen	mg/L	3.3	4.8	6.7
INFERENCE					

Note:

1. The above results pertain only to the sample tested.
2. The method of analysis is as per the Standard Method for the examination of Water and Waste Water, and Indian Standard Publication.
3. ND: Not detected. 4. BDL: Below detection limit
5. COD was not carried out due to high interference from Chloride

Scientific Assistant
ANALYSED BY

Scientific Assistant
VERIFIED BY

Scientific Officer
LAB HEAD

KARNATAKA STATE POLLUTION CONTROL BOARD

No 10 B,Industrial Area Baikampady Mangalore 575011 Ph No: 0824-2408420

PCB/RO(MNG)/SW-214-216/2022-23/R No : 123 Date: 21/7/2022

ANALYSIS REPORT OF WATER QUALITY
REGIONAL LABORATORY

NAME OF THE LOCATION :	Storm water drain samples, joining at Back water of Gurupura River, Mangaluru
SAMPLE COLLECTED BY :	EO, Mangaluru.
DATE OF COLLECTION :	16.06.2022
DATE OF RECEIPT :	16.06.2022
SAMPLE NO & PARTICULARS OF SAMPLE COLLECTED:	1.Storm water drain joining at Back water of Gurupur River at Kudroli Mangaluru (214) 2.Storm water drain joining at Back water of Gurupur River at Skate City Point, Boloor, Mangaluru (215) 3.Storm water drain joining at Back water of Gurupur River at Dambel, Mangaluru (216)

Sl No.	Parameters Analysed	Unit	Results		
			Sample No.214	Sample No.215	Sample No.216
1	pH	pH unit	6.7	7.1	7.4
2	Suspended Solids	mg/L	12	16	22
3	BOD (3 days @ 27 ^{0} C)	mg/L	18	8	6
4	Ammoniacal Nitrogen	mg/L	BDL	BDL	BDL
5	TKN	mg/L	BDL	BDL	BDL
6	Free Ammonia	mg/L	BDL	BDL	BDL
7	Sulphide	mg/L	BDL	BDL	BDL
8	Dissolved Phosphate	mg/L	BDL	BDL	BDL
9	Total Residual Chlorine	mg/L	BDL	BDL	BDL
10	Oil and Grease	mg/L	BDL	BDL	BDL
11	Total Dissolved Solids	mg/L	548	10870	15662
12	Sulphate	mg/L	98	892	860
13	Copper	mg/L	BDL	0.011	0.037
14	Total Choromium	mg/L	BDL	BDL	BDL
15	Cadmium	mg/L	BDL	BDL	BDL
16	Nickel	mg/L	0.029	BDL	BDL
17	Lead	mg/L	BDL	BDL	BDL
18	Zinc	mg/L	0.039	0.062	0.05
19	Iron	mg/L	0.121	0.162	0.198
20	Dissolved Oxygen	mg/L	0.3	4.2	5
INFERENCE					

Note:

1. The above results pertain only to the sample tested.
2. The method of analysis is as per the Standard Method for the examination of Water and Waste Water, and Indian Standard Publication.
3. ND: Not detected. 4. BDL: Below detection limit
5. COD was not carried out due to high interference from Chloride

Scientific Assistant
ANALYSED BY

Scientific Assistant
VERIFIED BY

Scientific Officer
LAB HEAD

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COLLEGE OF FISHERIES

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Head of the Department

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Mobile : 09900136070
Email fishmicrobiolmangalore@gmail.com

NO. FCM/AAHM/Rev.Fund/Analysis/2022-23/73 29.06.2022

SAMPLE DETAILS

SAMPLE SUBMITTED BY	KARNATAKA STATE POLLUTION CONTROL BOARD, PARISARA BHAVANA, 10B, BAIKAMPADY INDUSTRIAL AREA, MANGALURU – 575 011		
TYPE OF SAMPLE	SAMPLE No. 1 (Storm water drain joining point at back water of Gurupur river at Bunder, Kudroli, Mangaluru) RIVER BACK WATER		
ANALYSIS REQUIRED	MICROBIOLOGICAL ANALYSIS		
SAMPLE GIVEN BY CUSTOMER/~~SAMPLE COLLECTED BY LAB~~		CONDITION OF SAMPLE	-
SAMPLE RECEIVED ON	17.06.2022	TEST COMPLETED ON	22.06.2022
REFERENCE STANDARD	-		

TEST REPORT

Sl. No.	Parameters	Units	Result
1.	Total coliform count	MPN/100 ml	**>1600**
	Faecal coliform count	MPN/100 ml	**>1600**
2.	Faecal Streptococci	MPN/100 ml	**>1600**

Professor & Head
Professor and Head
Department of Aquatic Animal Health Management
Karnataka Veterinary Animal & Fisheries Sciences University, Nadar
College of Fisheries, Mangalore - 575 002

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NO. FCM/AAHM/Rev.Fund/Analysis/2022-23/74 23.06.2022

SAMPLE DETAILS

SAMPLE SUBMITTED BY	KARNATAKA STATE POLLUTION CONTROL BOARD, PARISARA BHAVANA, 10B, BAIKAMPADY INDUSTRIAL AREA, MANGALURU – 575 011		
TYPE OF SAMPLE	SAMPLE No. 2 (Storm water drain joining at Back Water of Gurupur river at Skate City Point, Boloor, Ashoknagar) RIVER BACK WATER		
ANALYSIS REQUIRED	MICROBIOLOGICAL ANALYSIS		
SAMPLE GIVEN BY CUSTOMER/~~SAMPLE COLLECTED BY LAB~~		CONDITION OF SAMPLE	-
SAMPLE RECEIVED ON	17.06.2022	TEST COMPLETED ON	22.06.2022
REFERENCE STANDARD	-		

TEST REPORT

Sl. No.	Parameters	Units	Result
1.	Total coliform count	MPN/100 ml	**>1600**
	Faecal coliform count	MPN/100 ml	**>1600**
2.	Faecal Streptococci	MPN/100 ml	**>1600**

Professor & Head
Professor and Head
Department of Aquatic Animal Health Management
Karnataka Veterinary, Animal & Fisheries Sciences University, Nandinagar
College of Fisheries, Mangalore-575 002

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NO. FCM/AAHM/Rev.Fund/Analysis/2022-23/75 23.06.2022

SAMPLE DETAILS

SAMPLE SUBMITTED BY	KARNATAKA STATE POLLUTION CONTROL BOARD, PARISARA BHAVANA, 10B, BAIKAMPADY INDUSTRIAL AREA, MANGALURU – 575 011		
TYPE OF SAMPLE	SAMPLE No.3 (Storm water drain joining point at Backwater of Gurupur River at Dambel, Mangaluru) RIVER BACK WATER		
ANALYSIS REQUIRED	MICROBIOLOGICAL ANALYSIS		
SAMPLE GIVEN BY CUSTOMER/~~SAMPLE COLLECTED BY LAB~~		CONDITION OF SAMPLE	-
SAMPLE RECEIVED ON	17.06.2022	TEST COMPLETED ON	22.06.2022
REFERENCE STANDARD	-		

TEST REPORT

Sl. No.	Parameters	Units	Result
1.	Total coliform count	MPN/100 ml	>1600
	Faecal coliform count	MPN/100 ml	>1600
2.	Faecal Streptococci	MPN/100 ml	>1600

Professor & Head
Professor and Head
Department of Aquatic Animal Health Management
Karnataka Veterinary Animal & Fisheries Sciences University
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NO. FCM/AAHM/Rev.Fund/Analysis/2022-23/76 23.06.2022

SAMPLE DETAILS

SAMPLE SUBMITTED BY	KARNATAKA STATE POLLUTION CONTROL BOARD, PARISARA · BHAVANA, 10B, BAIKAMPADY INDUSTRIAL AREA, MANGALURU – 575 011		
TYPE OF SAMPLE	SAMPLE No.4 (Storm water drain joining at Backwater of Gurupur River at Padukodi Church, Mangaluru) RIVER BACK WATER		
ANALYSIS REQUIRED	MICROBIOLOGICAL ANALYSIS		
SAMPLE GIVEN BY CUSTOMER/~~SAMPLE COLLECTED BY LAB~~		CONDITION OF SAMPLE	-
SAMPLE RECEIVED ON	17.06.2022	TEST COMPLETED ON	22.06.2022
REFERENCE STANDARD	-		

TEST REPORT

Sl. No.	Parameters	Units	Result
1.	Total coliform count	MPN/100 ml	**>1600**
	Faecal coliform count	MPN/100 ml	**>1600**
2.	Faecal Streptococci	MPN/100 ml	**>1600**

Professor & Head
Professor and Head
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NO. FCM/AAHM/Rev.Fund/Analysis/2022-23/77 23.06.2022

SAMPLE DETAILS

SAMPLE SUBMITTED BY	KARNATAKA STATE POLLUTION CONTROL BOARD, PARISARA BHAVANA, 10B, BAIKAMPADY INDUSTRIAL AREA, MANGALURU – 575 011		
TYPE OF SAMPLE	SAMPLE No.5 (Storm water drain joining at Backwater of Gurupur River at Total Gas Industry Bridge) RIVER BACK WATER		
ANALYSIS REQUIRED	MICROBIOLOGICAL ANALYSIS		
SAMPLE GIVEN BY CUSTOMER/~~SAMPLE COLLECTED BY LAB~~		CONDITION OF SAMPLE	-
SAMPLE RECEIVED ON	17.06.2022	TEST COMPLETED ON	22.06.2022
REFERENCE STANDARD	-		

TEST REPORT

Sl. No.	Parameters	Units	Result
1.	Total coliform count	MPN/100 ml	**>1600**
	Faecal coliform count	MPN/100 ml	**>1600**
2.	Faecal Streptococci	MPN/100 ml	**300**

Professor & Head
Professor and Head
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NO. FCM/AAHM/Rev.Fund/Analysis/2022-23/78 23.06.2022

SAMPLE DETAILS

SAMPLE SUBMITTED BY	KARNATAKA STATE POLLUTION CONTROL BOARD, PARISARA BHAVANA, 10B, BAIKAMPADY INDUSTRIAL AREA, MANGALURU – 575 011		
TYPE OF SAMPLE	SAMPLE No.6 (Storm water drain collected at Jokatte Bridge , Kudumbur) STORM WATER		
ANALYSIS REQUIRED	MICROBIOLOGICAL ANALYSIS		
SAMPLE GIVEN BY CUSTOMER/~~SAMPLE COLLECTED BY LAB~~		CONDITION OF SAMPLE	-
SAMPLE RECEIVED ON	17.06.2022	TEST COMPLETED ON	22.06.2022
REFERENCE STANDARD	-		

TEST REPORT

Sl. No.	Parameters	Units	Result
1.	Total coliform count	MPN/100 ml	**>1600**
	Faecal coliform count	MPN/100 ml	**>1600**
2.	Faecal Streptococci	MPN/100 ml	**1600**

Professor & Head
Professor and Head
Department of Aquatic Animal Health Management
Karnataka Veterinary Animal & Fisheries Sciences University
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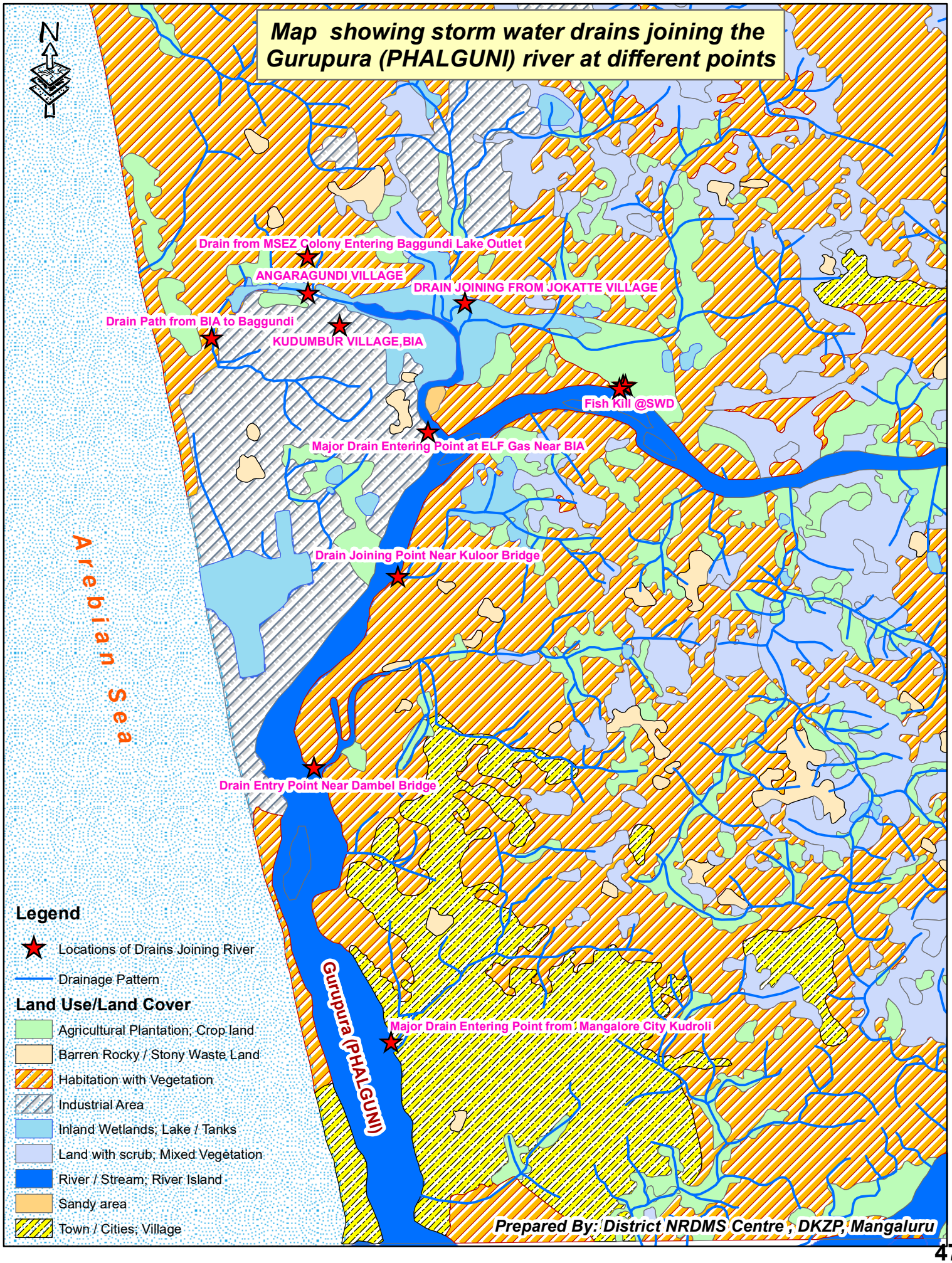
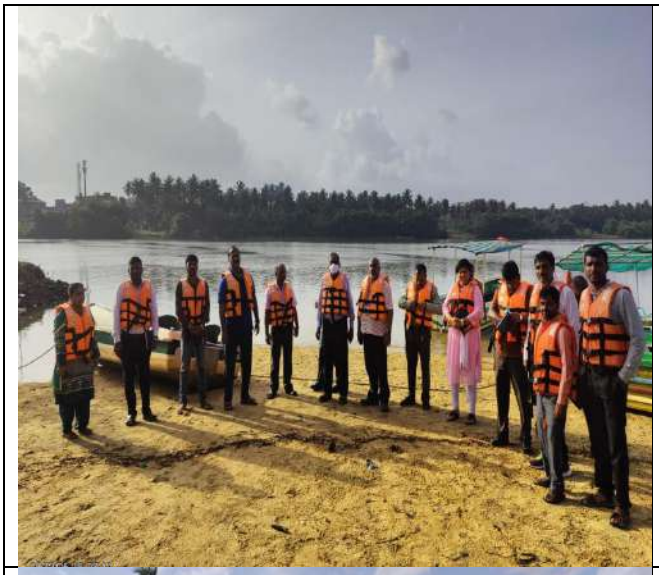

Map showing storm water drains joining the Gurupura (PHALGUNI) river at different points
N
Drain from MSEZ Colony Entering Baggundi Lake Outlet
ANGARAGUNDI VILLAGE
DRAIN JOINING FROM JOKATTE VILLAGE
Drain Path from BIA to Baggundi
KUDUMBUR VILLAGE,BIA
Fish Kill @SWD
Major Drain Entering Point at ELF Gas Near BIA
Drain Joining Point Near Kuloor Bridge
Arebian Sea
Drain Entry Point Near Dambel Bridge
Gurupura (PHALGUNI)
Major Drain Entering Point from Mangalore City Kudroli
Legend
Locations of Drains Joining River
Drainage Pattern
Land Use/Land Cover
Agricultural Plantation; Crop land
Barren Rocky / Stony Waste Land
Habitation with Vegetation
Industrial Area
Inland Wetlands; Lake / Tanks
Land with scrub; Mixed Vegetation
River / Stream; River Island
Sandy area
Town / Cities; Village
Prepared By: District NRDMS Centre , DKZP, Mangaluru

Annexure-12: ***Photographs a. taken during the Inspection by the Joint Committee and b. Photographs of Municipal and other Solid Waste heaps dumped along road sides in Baikampady industrial area***

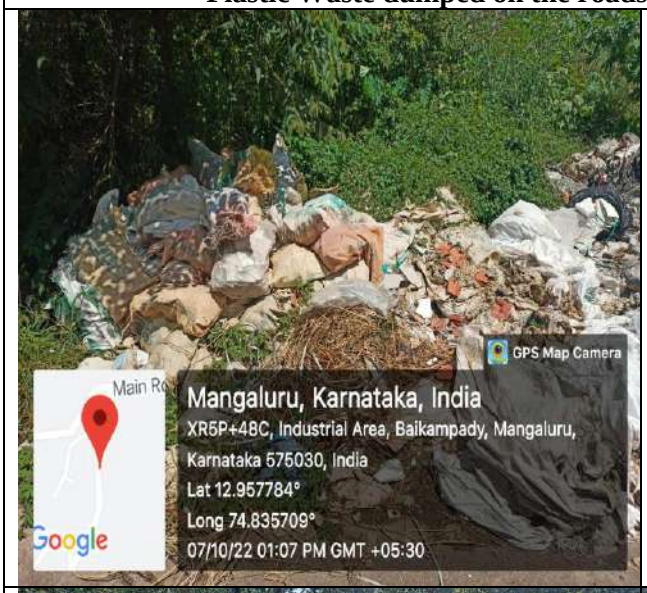


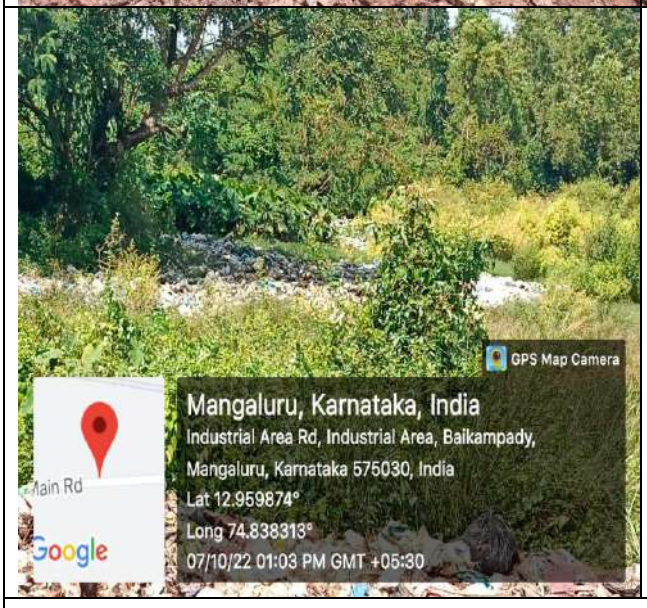
Photographs of Joint Committee taken during Spot Inspection

Points of Drain Joining river Gurupura (Phalguni) as observed by the Joint Committee during inspection

Heaps of Solid Waste packed in bags dumped on the roadside along the backwater of river

Plastic Waste dumped on the roadside in Baikampady Industrial Area





Various Types of Waste dumped in and around Baikampady Industrial Area

C&D Waste dumped in and around Baikampady Industrial Area

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Minireview

MINIREVIEW

Blackening and odorization of urban rivers: a bio-geochemical process

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One sentence summary: This review comprehensively summarizes the complex bio-geochemical processes in blackening and odorization of urban rivers.
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ABSTRACT

Urban rivers constitute a major part of urban drainage systems, and play critical roles in connecting other surface waters in urban areas. Black-odorous urban rivers are widely found in developing countries experiencing rapid urbanization, and the mismatch between urbanization and sewage treatment is thought to be the reason. The phenomena of blackening and odorization are likely complex bio-geochemical processes of which the microbial interactions with the environment are not fully understood. Here, we provide an overview of the major chemical compounds, such as iron and sulfur, and their bio-geochemical conversions during blackening and odorization of urban rivers. Scenarios explaining the formation of black-odorous urban rivers are proposed. Finally, we point out knowledge gaps in mechanisms and microbial ecology that need to be addressed to better understand the development of black-odorous urban rivers.

Keywords: black-odorous; urban river; bio-geochemical process; blackening and odorization; sediment

INTRODUCTION

Rivers and lakes serve urban populations as water resources and drainage systems. They play important roles as domestic, industrial and agricultural water resources. Urban rivers are also a convenient route of transportation and as centers for aquatic recreation impact on property prices and city development decisions. However, rapid urbanization caused by fast population growth often does not keep pace with construction of sewage treatment systems, resulting in visible and smellable pollution of urban rivers. Historically, rapid urbanization has always been accompanied by urban river pollution. In London in 1855, the English scientist and inventor Michael Faraday wrote to *The Times* after his passage across the river Thames: 'The smell [of the river] was very bad, and common to the whole of the water; it was the same as that which now comes up from the

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Table 1. Differences between organic matter in soil and surface water.

Soil			Surface water		
Soil type	SOM content (%)	Humus (%)	Source	DOC (mg/L)	Humus (mg/L)
Histosols	>80	32–60	Sea water	0.2–2.0	0.06–0.6
Most mineral soils	<5	<3	River	1.0–10	0.5–4.0
Tropical soils	2	0.8–1.2	Lake	1–50	0.5–40

DOC, dissolved organic carbon; SOM, soil organic matter.
Sources: Thurman 1985; Stanley 2000; Juo and Franzluebbers 2003; He *et al.* 2010; Zhang *et al.* 2012; Osman 2013; Tfaily *et al.* 2017.

gully-holes in the streets; the whole river was for the time a real sewer' (Faraday 1855). More recently, many developing countries have experienced the problem of polluted urban rivers as well. River pollution's most visible manifestation is a change in color, usually to black, often accompanied by strong unpleasant odors.

In China, after the first report of blackening and odorization of the Huangpu River in 1983 (Gu and Cai 1983), similar phenomena were observed in other urban rivers as well as in their tributaries throughout the whole country, e.g. the Suzhou River in Shanghai (Ying, Zhang and Wu 1997), the Pearl River Delta, in particular in Guangzhou (Luo 2001), and the Weigong River in Shenyang (Li, Zhang and Yu 2003). By the end of 2016, there were around 1880 identified black-odorous urban rivers in 295 Chinese cities, and 64% of those rivers were located in coastal areas of southern China (Zhu 2016). The Chinese government recently released a national plan for water pollution control, the 'Action Plan for Prevention and Treatment of Water Pollution', and set targets for cleaning up polluted urban rivers. Nevertheless, only 45% of the identified black-odorous urban rivers were under or had finished treatment at that time (Kong 2016).

Better pollution control is an urgent need to address blackening and odorization of urban rivers. However, it is often unclear what the exact reasons for the observed phenomena are. To better allocate resources for effective pollution control, it is necessary to identify the sources of pollution. A thorough understanding of the bio-geochemical processes underlying formation of black-odorous rivers is the first step, not only to apply effective pollution control but also to monitor the success of these measures and make adjustments if necessary. Organic pollutants from untreated waste streams or other non-point sources, e.g. agricultural and urban storm water runoffs (McCoy *et al.* 2015), along river banks are believed to trigger blackening and odorization of urban rivers (Zhou, Gibson and Foy 2000; Fang *et al.* 2012; Zhu 2016). The common understanding of the process is that high organic loading quickly depletes dissolved oxygen, leading to anaerobic conditions. Then, anaerobic microorganisms degrade dissolved organics, such as carbohydrates, fatty acids and proteins, into smaller molecules including odorous organic acids and reduced sulfur compounds, e.g. H_2S and organic sulfides. These small molecules may then further react with minerals in the water and sediment, and, mediated by microorganisms, form black precipitates (Stahl 1979; Ji *et al.* 2016).

Inorganic fertilizer pollutants, such as phosphorous and nitrogen, are involved in odorization of urban rivers as well. They, for example, accelerate growth of phototrophs, a phenomenon known as eutrophication. In summer 2007, an odorous tap water crisis occurred in Wuxi, China, in which odorous volatile sulfide compounds, including methyl thiols, dimethyl sulfide and dimethyl disulfide, were produced in the river from the decomposition of massive cyanobacterial blooms (Zhang *et al.* 2010). While such events are well documented for seawater environments (Yan, Zhou and Zou 2002), freshwater blooms have been less monitored in China. For example, the notoriously cyanobacteria-infested Lake Taihu in China experienced major blooms about every 3 years between 1960 and 1996 with increasing magnitude and frequency in recent years due to massive fertilizer pollution (Chen *et al.* 2003).

In this review, we focus on the key mechanisms and compounds involved in blackening and odorization of urban rivers. Based on the most relevant bio-geochemical processes, we propose scenarios to describe the formation of black-odorous urban rivers. We describe microbial communities in polluted and pristine freshwater systems that catalyze these processes. Lastly, we discuss challenges and possible strategies to control blackening and odorization, and propose key questions to be addressed in future studies.

ELEMENTS AND COMPOUNDS CONTRIBUTING TO BLACKENING AND ODORIZATION OF URBAN RIVERS

Large quantities of anthropogenic pollutants, both organic and inorganic, destabilize urban river ecosystems. The composition and concentration of organic matter in water, soil and sediment varies (Table 1). Biorecalcitrant humus, which is dominating fully decomposed organic matter, accounts for ≥40% of total organic matter present in urban rivers (Thurman 1985). These humic substances are resistant to further microbial degradation, and form black chelates with metal ions (Davies, Ghabbour and Khairy 1998; Fiedler *et al.* 2002).

The abundance of inorganic substances in urban river sediments is similar to that in the Earth's crust and soil (Table 2). Dominant metallic elements in river waters are iron, magnesium, aluminum and manganese, which originate from major clay minerals in sediments (Table 3; Abdullah *et al.* 2014). Abundant metals in the Earth's crust such as Fe and Mn are major blackening ingredients in black-odorous urban rivers (Tables 2 and 3; Metzger *et al.* 2014). Other major metallic elements, e.g. Al, Ca, Mg and Zn, are either of white color when forming minerals or their redox potentials are too low (≤−760 mV at standard conditions) for participation in natural redox processes. Sulfur, nitrogen and carbon are the three major non-metallic elements contributing to the stench of urban rivers through formation of volatile compounds, e.g. H_2S, organic sulfides, NH_3, amines and short chain fatty acids (Tables 2 and 3; Ginzburg *et al.* 1999; Bentley and Chasteen 2004; Ebil, Dursun and Dentel 2014). In coastal areas, urban rivers are often tributaries of tidal rivers with high concentrations of sulfate and magnesium (Latha and Rao 2012).

Table 2. The content of main elements in crust, soil, surface sediment and surface water.

Elements	Crust (%)	Soil (%)	Surface sediments (%)	Surface water (ppm)
O	46–50	49		
Si	26–27	33		
Al	7.5–8.3	7.1	6.72	0.72084
Fe	4.7–5.8	4	2.61	0.80041
Ca	3.39–5.2	1.5	1.2	
K	2.3–2.64	1.4	2.46	
Na	1.7–2.4	0.15	2.39	
Mg	1.87–2.8	0.5	1.24	6.158
Ti	0.45–0.64	0.5	0.3186	
Cl	0.13–0.19	0.01		
P	0.09–0.12	0.08	0.05485	
C	0.02–0.09	2		
Mn	0.08–0.10	0.1	0.06239	0.01697
S	0.026–0.048	0.07		
N	0.002–0.003	0.2		
Cr	0.01–0.03	0.007	0.00997	0.00588
F	0.054–0.059	0.02		
Ni	0.008–0.009	0.005	0.00829	0.00188
V	0.009–0.019	0.009	0.00547	
Co	0.0018–0.0025	0.0008	0.00114	0.00045
Cu	0.005–0.006	0.003	0.0108	0.00626
Zn	0.007–0.009	0.0009	0.0388	0.010943
Pb	0.0012–0.0016	0.0035	0.00547	0.00807
As	0.00018–0.00022	0.0006	0.000885	0.003108
Br	0.00021–0.00025	0.001		
Cd	0.000015–0.00002	3.5E-05	0.0000778	0.00007

Sources: Gaillardet, Viers and Dupré 2003; Yang *et al.* 2003; JeffersonLab 2007; Liu *et al.* 2007; Landaud, Helinck and Bonnarme 2008; Viers, Dupré and Gaillardet 2009; Feng *et al.* 2010; Lin *et al.* 2012; Song *et al.* 2013; Gao *et al.* 2016; Song *et al.* 2017.

Additionally, metallic elements, e.g. Fe, Mn and Mg, are mobile between sediment and water phase, sometimes mediated by microorganisms (Rzepecki 2012). These exchange rates are accelerated by organic pollution of urban rivers (Odigie *et al.* 2014).

BIO-GEOCHEMICAL TRANSFERS OF THE KEY ELEMENTS INVOLVED IN WATER BLACKENING AND ODORIZAITON

Black color formation via metal precipitates

Black matter in urban rivers comprises black metallic precipitates and precipitates of brown, green, or other colors that together form a dark color. In O_2-depleted surface waters, metals precipitate with sulfide and stain the water black (Fig. 1; Table 4; Nealson and Little 1997; Metzger *et al.* 2014). Common metals such as iron and nickel form black or dark sulfides. Iron, nickel and copper sulfides are the thermodynamically most favorable precipitates (Table 4). Stahl (1979) investigated a black water lake in Illinois and demonstrated that ferrous sulfide was responsible for the black color. Mixed minerals such as copper–iron sulfides have been observed as well, for example, in the Danube River Basin (Brankov, Milijašević and Milanović 2012). Copper and other heavy metal precipitates were also detected in the Pearl River Estuary, China (Fang, Li and Zhang 2005) as well as the Reno River watershed, Italy (Ferronato *et al.* 2013). In reduced environments, Mn exists as soluble Mn^{2+}, due to its low affinity for sulfur, and dose not precipitate (Nealson and Little 1997).

While iron sulfide formation is spontaneous, microorganisms such as *Geobacter*, *Geothrix*, *Rhodoferax* and *Shewanella* can harvest the released energy for their cell growth (Fig. 1; Lovley 1991). Thermodynamically, formation of FeS is favored followed by FeS_2 and Fe_3S_4 (Table 4). Greigite (Fe_3S_4) is formed in excess of sulfide. Elemental sulfur (S^0) and polysulfide (S_n^{2-}) formation are thought to be the intermediate steps leading to pyrite and greigite (Table 4; Rickard 1975; Luther 1991). Similar to biogeochemical transfers in marine sediments, the FeS and FeS_2 as well as other metals play central roles in the sulfur cycle in urban rivers (Schippers and Jørgensen 2002). That is, metals and

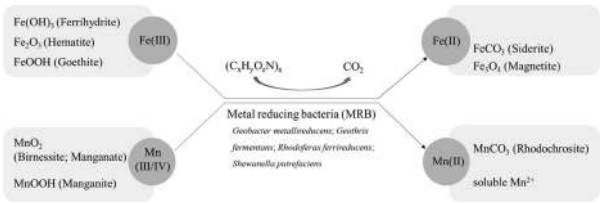

Figure 1. The microbially mediated reduction of Fe/Mn-minerals in urban rivers.

Table 3. Major clay minerals composition and content (%) in river sediments.

Minerals	Pearl River	Pearl River estuary	Huanghe River	Changjiang River	Changjiang estuary	Molecular formula
Kaolinite	46	40	10	16	10	$Al_2Si_2O_5(OH)_4$
Chlorite	25	28	16	12	26	Clinochlore: $(Mg_5Al)(AlSi_3)O_{10}(OH)_8$ Chamosite: $(Fe_5Al)(AlSi_3)O_{10}(OH)_8$ Nimite: $(Ni_5Al)(AlSi_3)O_{10}(OH)_8$ Pennantite: $(Mn,Al)_6(Si,Al)_4O_{10}(OH)_8$
Illite	26	26	62	66	58	$(K,H_3O)(Al,Mg,Fe)_2(Si,Al)4O_{10}[(OH)_2,(H_2O)$
Smectite	<2	<6	<12	<6	3	Montmorillonite: $(Na,Ca)_{0.33}(Al,Mg)_2(Si_4O_{10})(OH)_2{\cdot}nH_2O$ Nontronite: $Na_{0.3}Fe_2((Si,Al)_4O_{10})(OH)_2{\cdot}nH_2O$ Saponite: $Ca_{0.25}(Mg,Fe)_3((Si,Al)_4O_{10})(OH)_2{\cdot}nH_2O$
Minor mineral (Pyrite)	<1	<1	NP	NP	<3	FeS_2

NP, not provided.
Sources: Liu *et al.* 2007; Wang *et al.* 2006; Yang *et al.* 2003.

Table 4. Thermodynamics of some black or dark metal mineral reactions.

Net reaction			$\Delta G^{\circ\prime}$/M (kJ mol^{-1})	$\Delta G^{\circ\prime}$/S (kJ mol^{-1})
Reductive environments				
$SO_4^{2-} + H_3C–COO^- + 3\ H^+$	→	$HS^- + 2\ HCO_3^- + 3\ H^+$	n/a	−48
$Fe^{2+} + HS^- + H^+$	→	FeS[a] + 2 H^+	−231	−231
8 FeOOH[b] + 9 $H_3C–COO^-$ + 8 SO_4^{2-} + 25 H^+	→	8 FeS + 18 HCO_3^- + 18 H^+ + 12 H_2O	−93	−93
2 FeOOH + 3 HS^- + 3 H^+	→	FeS + FeS_2[c] + 4 H_2O	−74	−50
Fe3O4 + 4 HS^- + 4 H^+	→	2 FeS + FeS_2 + 4 H_2O	−61	−46
FeS + S^0	→	FeS_2	−60	−30
4 FeOOH + 6 HS^- + 6 H^+	→	FeS_2 + Fe_3S_4[d] + 8 H_2O	−57	−38
2 FeOOH + 3 HS^- + 3 H^+	→	2 FeS + S^0 + 4 H_2O	−45	−30
Fe_3O_4[e] + 4 HS^- + 4 H^+	→	Fe_3S_4 + 4 H_2O	−38	−28
9 FeS + 5 HS^- + 5 H^+	→	3 FeS_2 + 2 Fe_3S_4	−2	−1
4 S^0 + $H_3C–COO^-$ + H^+ + 4 H_2O	→	4 HS^- + 2 HCO_3^- + 6 H^+	n/a	−2
24 FeOOH[a] + $H_3C–COO^-$ + H^+	→	8 Fe_3O_4 + 2 HCO_3^- + 2 H^+ + 12 H_2O	−5	n/a
8 FeOOH + $H_3C–COO^-$ + 17 H^+	→	8 Fe^{2+} + 2 HCO_3^- + 2 H^+ + 12 H_2O	186	n/a
$Ni^{2+} + HS^- + H^+$	→	NiS[f] + 2 H^+	−184	−184
$Cu^{2+} + HS^- + H^+$	→	CuS[g] + 2 H^+	−171	−171
CuS + S^0	→	CuS_2[h]	−33	−16
$Pb^{2+} + HS^- + H^+$	→	PbS[i] + 2 H^+	−126	−126
$Zn^{2+} + HS^- + H^+$	→	ZnS[j] + 2 H^+	−106	−106
$Mn^{2+} + HS^- + H^+$	→	MnS[k] + 2 H^+	−42	−42
MnS + S^0	→	MnS_2[l]	167	167
Oxidative environments			$\Delta G^{\circ\prime}$/Fe (kJ mol^{-1})	$\Delta G^{\circ\prime}$/ox (kJ mol^{-1})
2 Cr_2O_3[m] + 3 O_2 + 4 H_2O	→	4 $HCrO_4^-$ + 4 H^+	−1094	−1459
10 FeS + 6 NO_3^- + 6 H^+ + 2 H_2O	→	10 FeOOH + 10 S^0 + 3 N_2	−250	−417
4 FeS + 3 O_2 + 5 H_2O	→	4 FeOOH + 4 S^0 + 3 H_2O	−270	−359
$HS^- + MnO_2$[n] + 3 H^+	→	$S^0 + Mn^{2+}$ + 2 H_2O	n/a	−130
2 FeS + 3 MnO_2 + 6 H^+	→	2 FeOOH + 3 Mn^{2+} 2 S^0 + 2 H_2O	−150	−100
2 FeS_2 + 3 MnO_2 + 6 H^+	→	2 FeOOH + 3 Mn^{2+} + 4 S^0 + 2 H_2O	−90	−60

Black or dark minerals: [a]iron sulfide, [b]goethite, [c]pyrite, [d]greigite, [e]magnetite, [f]millerite, [g]covellite, [h]α-chalkosite, [i]lead sulfide, [j]sphalerite (disulfide not known for Zn and Pb), [k]alabandite (pink, orange or green), [l]hauerite, [m]eskolaite, [n]pyrolusite (light grey). M, metal; n/a, not applicable; ox. oxidant.

especially abundant iron, are reduced by organic pollutants, such as volatile fatty acids (such as acetic, butyric and propionic acids), or other reducing equivalents (Table 4). If iron then again enters oxidizing zones, for example by currents or shift of oxic zones, it can be re-oxidized by dissolved oxygen, nitrate, or manganese oxides. Iron oxides, such as goethite, can also be reduced biologically. Humic substances enhance the bioavailability of insoluble Fe(III) oxides as electron acceptors and therefore improve the thermodynamics of biological iron reduction (Lovley *et al.* 1996, 1998). Quinone moieties in humic substances serve as electron shuttles in Fe(III)-respiring microorganisms, e.g. *Ferribacterium limneticum* and *Geobacter metallireducens*, accelerating the rate of both Fe(III) oxide reduction in river sediments and contaminant oxidation coupled to Fe(III) reduction (Lovley *et al.* 1996; Finneran and Lovley 2001; Nevin and Lovley 2000). Other iron reducers such as *Shewanella oneidensis* (Venkateswaran *et al.* 1999), *Paludibaculum fermentans* (Kulichevskaya *et al.* 2014) and *Anaeromyxobacter dehalogenans* (Sanford, Cole and Tiedje 2002) are able to utilize a number of different electron donors including sugars and long chain fatty acids. The broad variety of electron acceptors and donors used by iron reducers makes these microorganisms ubiquitous in freshwater sediments.

In sediments, pyrite (FeS_2) is oxidized abiotically at mineral interfaces, for example between FeS_2 and MnO_2 (Table 4; Schippers and Jørgensen 2002). Immediate products of this oxidation are thiosulfate and polythionates, which can be further oxidized to sulfate by manganese-reducing bacteria (Jørgensen and Nelson 2004). Additionally, Fe(II) and Mn(II) were released from sediment pore waters to form black oxides in anoxic–oxic water interface zone of the black rivers (Atkinson *et al.* 2007). Small amounts of dissolved ferrous iron released from FeS_2 in sediments can be re-oxidized by oxygen, nitrate and MnO_2 and precipitated as black magnetite in river beds. After reentry in oxic zones or through mediation, reduced Mn(II) is recycled to MnO_2 via microbial oxidation in the presence of, even trace amounts of, O_2 or nitrate in surface waters (Boogerd and de Vrind 1987; Marcus *et al.* 2017). Nitrate has therefore been suggested as a cost-effective remediation method for black urban rivers (He *et al.* 2017).

Odorous volatile compounds

Sulfur compounds

Odorous compounds in urban rivers are volatile organic and inorganic compounds. Volatile sulfur compounds generated from microbial sulfate reduction or degradation of sulfur-containing organic matter normally have an unpleasant odor, including that of inorganic H_2S and organic sulfides (Kadota and Ishida 2003). Sources of such reduced sulfur compounds vary. River deltas discharging into oceans often experience seawater influx due to tidal activity. Therefore, sulfide, as a result of microbial sulfate reduction, is detected in significant amounts in urban rivers connecting to major deltas in coastal areas, particularly in the Pearl River estuary where 3 mM sulfide in the sediment was reported as a result of sulfate reduction (Fang *et al.* 2005). Most sulfide in estuaries is produced by sulfate reducing

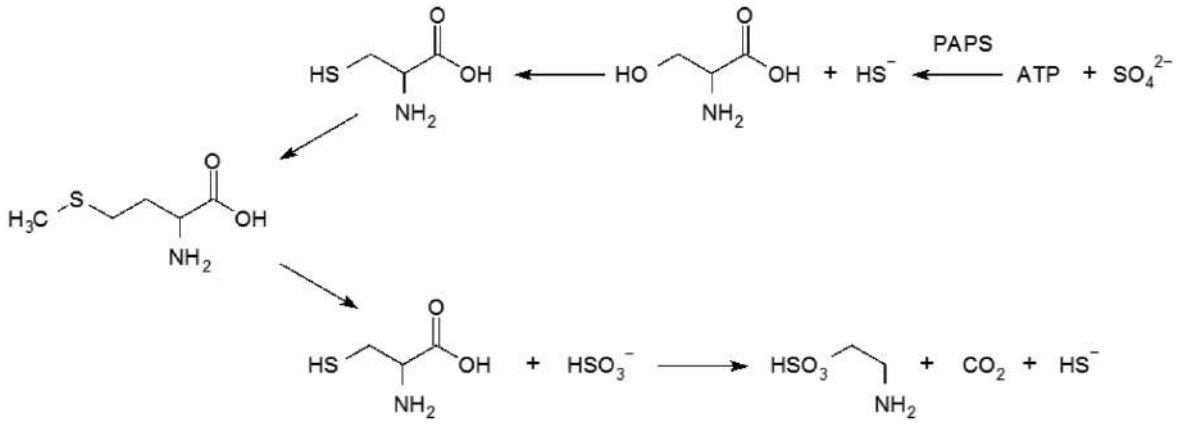

Figure 2. Methionine biosynthesis (top) and degradation (bottom) proceed via cysteine. The biosynthetic pathway requires ATP for sulfate reduction to sulfide, producing the intermediate 3′-phosphoadenosine-5′-phosphosulfate (PAPS). Together with serine, sulfide then forms cysteine and ultimately methionine. Under anaerobic conditions, methionine is degraded to taurine, CO_2 and sulfide in exchange for sulfite.

microorganisms using dissimilatory sulfate reduction for respiration. Sulfate reducing microorganisms are broadly dispersed across the prokaryotic phylogenetic tree but are often found among *δ-Proteobacteria* and *Firmicutes* as well as *Archaea* (Zhou *et al.* 2011). In addition to the production of odorous H_2S, sulfate reduction may eventually lead to the formation of black iron sulfide species even with trace amounts of iron in the water and sediment (Wu *et al.* 2016).

Another source of sulfide in urban rivers is organic sulfur (Giordano *et al.* 2005). It enters the sulfur cycle via assimilatory sulfate reduction (Fig. 2). The amount of sulfur in domestic waste streams or other anthropogenic sources, however, is negligible compared with the massive cyanobacterial blooms in the surface waters (Zhang *et al.* 2010). CO_2-fixing cyanobacteria frequently are the main source of organic matter in surface waters. They assimilate sulfur via cysteine/methionine biosynthetic pathways (Fig. 2). This organic sulfur is subsequently released in the form of volatile organic sulfur compounds, which include thiols and thioethers in methylated sulfide species, e.g. methyl sulfide, dimethyl sulfide and dimethyl disulfide, as byproducts—all of which are characterized by their notoriously bad smell (Bentley and Chasteen 2004).

Nitrogen and organic carbon compounds

Nitrogen compounds are the largest group of malodorous compounds generated by proteolytic microorganisms, and their smells range from that of ammonia to the typical smell of corpse decomposition (Wang *et al.* 2017). Microbiogenic malodorous nitrogen compounds include organic amines such as cadaverine (1,5-pentanediamine) and putrescine (1,4-butanediamine). Cadaverine is produced via decarboxylation of lysine, whereas putrescine is a product of degradation of ornithine, an essential building block of bacterial cell walls (Wunderlichová *et al.* 2014; Ma *et al.* 2017). Other abundant malodorous nitrogen compounds are volatile alkylated amines of characteristic fishy smell, which is sensed even in trace amounts. These compounds comprise alkylated amines, such as methylamine, dimethylamine, trimethylamine, ethaneamine, propaneamine and butaneamine (Ge *et al.* 2011). Methylamines are degradation products of N-methylated amino acids, with glycine, betaine, choline, trimethylamine and carnitine as their natural precursors in biomass, which, in turn, is introduced into urban rivers via wastewater or algal blooms (Ikawa and Taylor 1973).

All organisms are able to hydrolyze proteins using proteases as this is an essential part of their metabolism. Cell internal proteolysis is necessary in every organism, for example to tune its enzymatic machinery to novel environmental conditions or to control vital cell functions. Microorganisms specifically feeding on peptides can be isolated using casamino acids and tryptic case peptone media, and often yield strains closely related to *Clostridium* species when grown anaerobically. Such proteolytic microorganisms are ubiquitous in anaerobic and aerobic environments alike. Examples of anaerobic environments are rumens (Blackburn and Hobson 1962), anaerobic digesters (Abendroth *et al.* 2015), peat bogs (Juottonen *et al.* 2005) and rice paddies (Weber *et al.* 2001). Typical aerobic environments are many processed food products such as cabbage (Borla, Davidovich and Roura 2010) and dairy products (Frazier and Rupp 1931). Despite the presence of proteolytic microorganisms, none of the mentioned environments are known for their obnoxious smell. The reason is that protein concentrations are either relatively low or, in the case of food products, aerobic conditions prevail. When oxygen is absent, alkylated amines cannot be further oxidized and serve as substrates for sulfate reducers or methanogens (Lovley and Klug 1983). However, since alkylated amines are gaseous or at least volatile, they often escape before slow growing anaerobic microorganisms are able to degrade them, causing the typical smell in surface waters.

Odorous organic compounds without S and N elements are mostly VFAs, which are generated by anaerobic fermentation of organic pollutants in the waste streams or of decomposed compounds produced by algal blooms (Verstraete *et al.* 1996; Pham *et al.* 2012). VFAs in urban rivers play critical roles in coupling organic carbon compounds with iron and sulfur cycles in the surface water (Fig. 4). For example, when sulfate is present, VFAs can be further used as electron donors by sulfate reducing microorganisms and produce malodorous sulfide (Hao *et al.* 2009).

MICROBIAL ECOLOGY OF PRISTINE AND POLLUTED FRESHWATER ENVIRONMENTS

Urban river pollution affects microbial communities in water and sediments with measurable effects in the short (Schöll and Szövényi 2011) and long term (Ibekwe, Ma and Murinda 2016; Lu, Chen and Zheng 2017). This makes microbial community analysis an additional monitoring tool for water quality (Drury, Rosi-Marshall and Kelly 2013; García-Armisen *et al.* 2014; Li, Sharp

and Drewes 2016; Xie *et al.* 2016; Köchling *et al.* 2017). Diversity (Drury, Rosi-Marshall and Kelly 2013; Staley *et al.* 2013), richness (Lin *et al.* 2014) and variability (Lu, Chen and Zheng 2017) of microbial communities have been affected by anthropogenic pollutants. As expected, coliform growth is correlated with fecal anthropogenic contamination, for example in large rivers such as the Danube (Hoch *et al.* 1996; Kirschner *et al.* 2009) and the Mississippi (Staley *et al.* 2013), as well as smaller rivers such as the Jaboatão River in Brazil (Köchling *et al.* 2017), the Reno River in Italy (Ferronato *et al.* 2013) and small creeks of a California watershed (Ibekwe, Ma and Murinda 2016). A clear impact of treated wastewater on community composition and metabolism was reported for the Taif River in Saudi Arabia, where pristine samples showed a higher representation of carbohydrate metabolic genes along with fatty acid and amino acid anabolic genes as opposed to samples impacted by wastewater (Li, Sharp and Drewes 2016). The latter were enriched in genes associated with nitrogen and sulfur metabolism, as would be expected in nutrient rich environments. Inverse metabolic patterns were reported for river sediments in China where energy-, carbohydrate- and amino acid-related genes were enriched or equal to pristine control sediments (Lu, Chen and Zheng 2017).

Algal growth is often considered to be linked to anthropogenic contamination in freshwater systems such as Taihu Lake in China (Huang *et al.* 2017) or the Zenne River in Belgium (García-Armisen *et al.* 2014). However, the mechanisms by which pollution and algal growth are connected are not always clear. For example, Huang *et al.* (2017) found that phosphate as well as organic matter concentration were correlated with cyanobacterial growth in the Taihu Lake, whereas in the Danube River, Kirschner *et al.* (2009) identified only a link to organic matter but not any other of the factors investigated, such as phosphate, nitrogen and temperature. This suggests that cyanobacteria live heterotrophically or that low bioavailability of inorganic nutrients are responsible for algal blooms.

Despite the ongoing DNA sequencing revolution, it is not clear which factors shape river sediment communities. Some recent attempts indicate that, indeed, organic matter released into urban rivers by sewage streams promotes growth of certain microbial lineages such as *Acinetobacter*, *Flaviobacterium*, *Thauera* and *Rhodococcus* in the Zenne River flowing through the Brussels metropolitan area (García-Armisen *et al.* 2014). A similar correlation between organic matter and *Cyanobacteria* was linked to fecal coliforms and *Enterococci* in the Danube (Kirschner *et al.* 2009). The dependence of fecal coliforms on environmental factors, however, was stronger in the water column than in the sediments studied in selected creeks of a southern California watershed (Ibekwe, Ma and Murinda 2016). In the Rhône River prodelta, microbial variation could be explained by organic matter as well (Fagervold, *et al.* 2014). In addition to organic matter, Ji *et al.* (2016) found that iron and sulfate concentrations as well as pH were associated with methanogenic networks identified in Amazonian lake sediments.

The pioneering works of Zwart *et al.* (2002) and Newton *et al.* (2011) identified an appreciable bacterial diversity in freshwater systems showing that river and lake communities are similar. In addition, our own comparison of published 16S rRNA gene-sequencing data of three Chinese lakes, two rivers and one reservoir from three distant areas shows that geographical location best explained the differences between the investigated freshwater environments (Fig. 3). Though microbial populations of contaminated and pristine sites of the same region cluster closely, communities still show some difference.

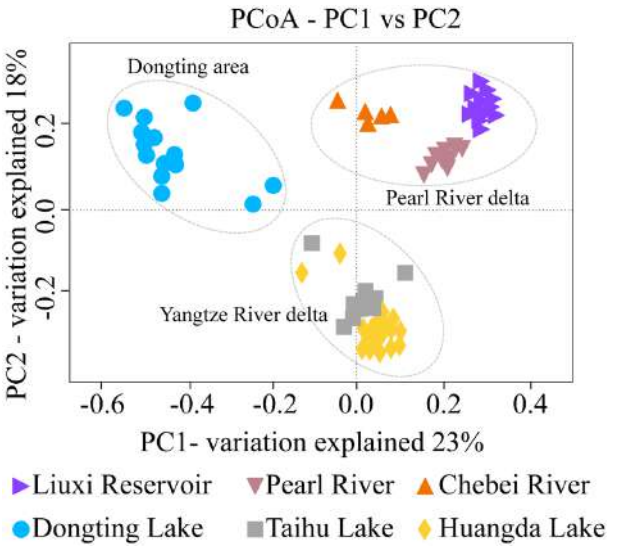

Figure 3. Principal coordinate analysis (PCoA with Bray–Curtis distance matrices) of six surface-water sediment samples collected from three different geographic areas, i.e. Pearl River Delta, Yangtze River Delta and Dongting area. This figure is plotted with published 16S rRNA gene-sequencing data (Wang *et al* 2012; Liu *et al* 2014; He *et al* 2017; Huang *et al* 2017). The trophic states of the six surface waters are: eutrophic for Taihu Lake and Chebei River (black-odorous river); mesotrophic for Dongting Lake, Huangda Lake and Pearl River; and oligotrophic for Liuxi Reservoir.

Proteobacteria are the largest phylum in the prokaryotic tree of life and are therefore also highly abundant in river sediments—polluted or not. Nearly all river and lake sediments surveyed here harbored α-, β- and γ-*Proteobacteria*. The most prominent representative of freshwater α-*Proteobacteria* is the SAR11 clade (*Pelagibacter*; Salcher *et al.* 2011; Savio *et al.* 2015). Also *Bacteroidetes* were found in nearly all freshwater sediments. Together, these four groups cover 40% of all cultured prokaryotic species, making their dominance in freshwater sediments only natural. Consequently, microbial communities in freshwater sediments are often very similar at the phylum level (Ji *et al.* 2016). Nonetheless, a study screening 68 publications of lake microbial communities using only high quality Sanger-sequencing data reported a large heterogeneity at lower taxonomic levels, termed tribes (Newton *et al.* 2011). This finding was confirmed for Mississippi River sediments where only 12% of the identified operational taxonomic units (>97% sequence identity) were shared across all sites (Staley *et al.* 2013). It is hence the less abundant groups, such as *Acidobacteria*, *Actinobacteria*, *Verrucomicrobia*, *Chloroflexi*, *Planctomycetes*, *Gemmatimonadetes* and *Archaea*, or tribes that may act as distinctive indicators for metabolic processes. Many such tribes are uncultured representatives of freshwater environments and do not match with Linnaean taxonomic boundaries. While broad surveys of our drinking water resources need to be continued, it remains unclear how under-represented parts of microbial communities adapt to pollution. Indeed, a recent metagenomic survey of a wastewater impacted river showed that small community factions are major hubs in microbial assemblages (Li, Sharp and Drewes 2016). This is an observation that has also been made in the pristine Lake Cadagno, Switzerland, where 0.3% of the cells in the lake were responsible for 40% of the substrate turnover (Musat *et al.* 2008). In conclusion, more studies on natural environments are necessary to understand the

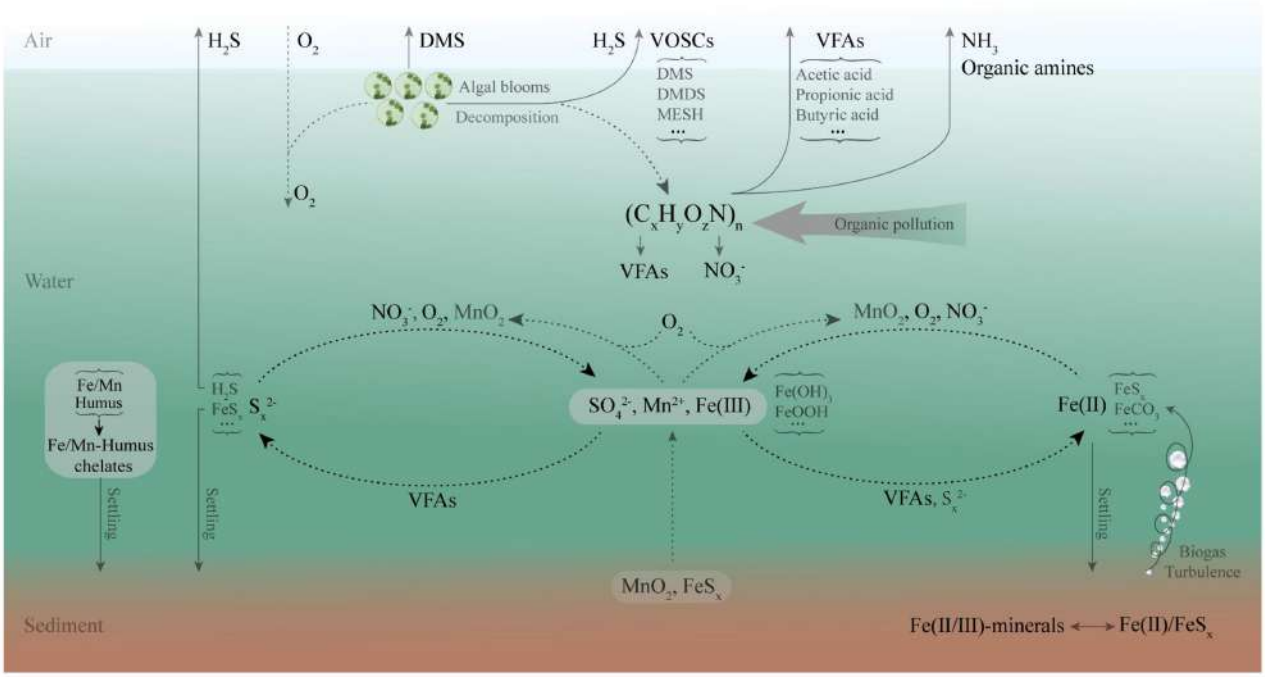

Figure 4. Scenarios describing bio-geochemical transfers of major black and odorous elements/compounds in urban rivers. In the process of organic matter degradation, odors result from production of volatile organic sulfur compounds, methylamines and VFAs, which escape into the atmosphere. In addition, organic matter supplies reducing power for SO_4^{2-} and Fe(III) to form FeS_x. The processes for black/odorous compounds are shown with solid lines, and others with dotted lines. DMS, dimethyl sulfide; VFAs, volatile organic sulfur compounds; VOSCs, volatile organic sulfur compounds.

above mentioned discrepancies and to establish a baseline for future research on pollution affected environments.

A SCENARIO OF THE BIO-GEOCHEMICAL PROCESS IN BLACKENING AND ODORIZAITON OF URBAN RIVERS

In the scenario depicted in Fig. 4, organic matter originates either directly from anthropogenic sources, e.g. waste streams and other non-point source pollution, or from decomposition of cyanobacteria biomass. These are the main suspects in generating odors by production of volatile (organic) sulfides, odorous amines and VFAs (Van Neste *et al.* 1987; Ginzburg *et al.* 1998; Hu *et al.* 2007; Zhang *et al.* 2010). Organic matter is also the major source of reducing equivalents for the reduction of sulfate and iron to produce black minerals such as iron sulfides, which link the sulfur and iron cycles in urban rivers (Fig. 4; Berner *et al.* 1985; Lovley 1987). Therefore, input of organic matter into urban rivers is likely the key factor for triggering water blackening and odorization. Sulfur input from sediment, seawater, or decomposing algal biomass is directly involved in the formation of black- and odorous-matter in urban rivers, e.g. via formation of sulfide species such as H_2S and iron sulfides. Alkylated sulfides are often byproducts of cyanobacterial metabolism and biomass degradation and their volatility makes them strong odorous constituents of some urban rivers' stench. Sulfate reduction by diverse sulfate reducing microorganisms dominates in sediments because their redox potential confers growth advantages to these microorganisms over their competitors. For example, the standard redox potential of sulfate reduction (−217 mV) is slightly more positive than that of hydrogenotropic methanogenic process (−240 mV). This and the higher energy gain compared with iron reduction suggest that sulfur is the link between the different element cycles as shown for Black Sea sediments (Siegert *et al.* 2013).

CONCLUSIONS AND FUTURE PERSPECTIVES

The blackening and odorization of urban rivers is a complex bio-geochemical process involving five key elements, i.e. Fe, Mn, S, N and C. Outstanding issues include the following.

(i) While we propose several mechanisms that contribute to blackening and odorization of urban rivers such as organic matter degradation and metal precipitation, there is no evidence yet that these are indeed the driving factors. In the past, measures to counter river pollution were taken, such as widespread treatment of industrial wastewater in the Pearl River Delta and sediment removal, yet they only mitigated the problem for a short time. Evidence for our hypothesized mechanisms needs to be collected in order to take targeted action. Gathering this evidence requires application of standard tests to assess water quality (listed in Table 5) along with novel molecular techniques and may involve the development of new methods that are more efficient. As shown in this review, the suspected blackening elements (metal sulfides) and three odor-forming elements (S, N and C) should be first targets for water quality analysis investigating blackening and odor formation in the urban rivers.

(ii) What, if any, are the core microbial communities, taxonomically and physiologically, mediating bio-geochemical transfers of the key elements in black-odorous urban rivers? Despite the progress in studies of metabolism and element cycles in surface waters, many puzzles remain, for example, the discrepancy in some reports and our own investigations showing that pollution sometimes does not affect microbial communi-

Table 5. Routine methods for surface water quality assessment.

Analyte	Method	References
Dissolved inorganic carbon	Spectrophotometry/potentiometry/conductimetry	Oshima *et al.* 2001; Carlson 1978; Linares *et al.* 1989
Dissolved organic carbon	Chemical oxidation	Sharp 1973
	Ultraviolet oxidation	Beattie *et al.* 1961; Armstrong *et al.* 1966
	High-temperature combustion	Sharp 1973; Salonen 1979
Chemical oxygen demand	Dichromate oxidation method	Moore *et al.* 1949; Jirka and Carter 1975
	Potassium permanganate oxidation method	Korenaga 1980
Metal content (Fe, Mn, Cu, Zn, etc.)	Spectroscopic analysis method (inductively coupled plasma mass spectrometry)	Houk *et al.* 1989
Total dissolved nitrogen	Alkaline persulfate digestion	Solorzano and Sharp 1980
	High temperature oxidation	Suzuki *et al.* 1985
Dissolved inorganic nitrogen	Phenol hypochlorite reaction method (NH_3/NH_4^+)	Bolleter *et al.* 1961
	Nessler's reagent spectrophotometry (NH_3/NH_4^+)	Vanselow 1940; Leonard 1963
	Ion chromatography (NO_2^-, NO_3^-)	Gjerde *et al.* 1979
	Colorimetry (NO_2^-)	APHA 1998
	Ultraviolet spectrophotometry (NO_3^-)	Hoather and Rackham 1959
Dissolved organic nitrogen	High-temperature catalytic oxidation	Badr *et al.* 2003
Dissolved and precipitated sulfides	CuS colloidal solution method	Cord-Ruwisch 1985
Dissolved sulfate	Turbidimetry	Tabatabai 1974
Volatile organic sulfur compounds	Chromatography analysis method (gas chromatography–sulfur chemiluminescence detection)	Sun *et al.* 2014
	Chromatography analysis method (gas chromatography–mass spectrometry)	Van Langenhove *et al.* 1985
Element content (C, H, N, S)	Elemental analysis	Kirsten 1971; Fadeeva *et al.* 2008

ties. There is a need for better understanding of the core communities coupling all these element cycles in black-odorous urban rivers. Current meta-omic technologies may help to provide in-depth insights.

(iii) What is the role of minor elements, e.g. Cu and Zn, in the blackening and odorization of urban rivers? Hitherto, very few studies have investigated their contribution to blackening and odorization in surface waters. Whether these trace elements play critical roles in connecting the Fe, Mn, S, N and C cycles warrants future investigation.

(iv) New water quality standards to address blackening and odorous surface waters need to be developed in China. Current guidelines are insufficient, mostly because it is not clear what the reasons for blackening and odorization are. Defining baselines will be essential to develop standards. Understanding the pathways involved in blackening and malodor-generating metabolism is key to controlling these processes and developing environmentally friendly microbial technologies. For example, scaling bio-electrochemical technologies to use polluted rivers for power production can be an environmentally friendly alternative to current treatment strategies (Ewing *et al.* 2014). Also, microbial inhibitors may be used to block microbial participation in Fe, Mn, S, N and C cycles.

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