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Contents

Executive Summary:	4
Action Plan Strategies:	9
1. Brief about Khandepar River:	14
1.1. River Khandepar:	14
1.2. Water Quality of River Khandepar:	15
1.3. Water Sampling Results:.....	16
1.4. Data Analysis and interpretation:	19
1.5. Action Plan Strategies:	20
1.6. Major Concerns:	20
2. Source Control:	21
3. River Catchment Management:	23
4. Flood Plain Zone:	23
5. Greenery Development- Plantation Plan:	24
6. Ecological / Environmental Flow (E-Flow):	25
7. Action Plan Strategies:	27
7.1. Conclusion & Remark:	28

Index of Tables

Table 1 Barrages on Khandepar River.....	7
Table 2 Sampling locations of Khandepar River	15
Table 3 Khandepar River parameters at Opa Ponda.....	17
Table 4 Khandepar River parameters at Codli (u/s of Opa Water works)	18
Table 5 Barrages on Khandepar River.....	25

Table of Maps

Map 1 Map showing the Khandepar River Stretch in Goa State.....	11
Map 2 Khandepar –Polluted Stretch (10 km) From Codli to Opa water works.....	12
Map 3 Map showing stretch of Khandepar River.....	14
Map 4 Map showing the Sampling location on Khandepar River	15
Map 5 Map showing Pollutants to the Khandepar River.....	22

Table of Images

Image 1 Dudhsagar fall on Khandepar River	5
Image 2 Water sampling in Nov. 2018 at Khandepar River.	16
Image 3 Orchard & Coconut Tree along the Bank of Khandepar River.....	24

Abbreviations

BOD	Bio-Chemical Oxygen Demand
CPCB	Central Pollution Control Board, New Delhi
DO	Dissolved Oxygen Content
DMA	Directorate of Municipal Administration, Panjim Goa
GSPCB	Goa State Pollution Control Board, Panjim Goa
FC	Faecal Coliform
MBGL	Meters below ground levels
MLD	Million litters per Day
NEERI	National Environmental Engineering Research Institute Nagpur
NGT	National Green Tribunal
PWD	Public Work Department of Goa State
SEAC	State Level Environment Expert Appraisal Committee
SEIAA	State level Environment Impact Assessment Authority.
SIDCGL	Sewerage Infrastructure Development Corporation of Goa Limited, Panjim Goa.
TC	Total Coliform
ULB	Urban Local Body
WRD	Water Resources Department of Goa

References

- Salinity report by GSPCB, Panjim Goa.
- Annual parameters monitoring by GSPCB (from 2015 till 2018).
- Integrated Coastal Zone Management of Coastal Zone in Goa – Council of Scientific & Industrial Research July 2013.

Executive Summary:

Khandepar River originates in the hilly region (upstream side of Codli village) on western part of the state of the Karnataka. The river enters in the state of Goa through the Castle rock heights and plunges down as a famous waterfall 'Dudhsagar fall', travels about 33 km before it meets Mandovi River near Khandepar. The river flows through areas like Khandepar, Tisk–Codar, Opa and Codli before it discharges into Mandovi River near Khandepar.

The Goa State Pollution Control Board (GSPCB) monitors the water quality of River Khandepar at two locations (i.e. Opa Ponda & Codli- u/s of Opa Water works) between the polluted stretches of the Khandepar River, i.e. Ponda to Opa, which is having 10 Kms (i.e. from Codli to Opa water works & Downstream of Opa water works to Savoi -verem where it discharges in to the Mandovi River) in length.

The said monitoring by GSPCB is carried out on a monthly basis throughout the year under the National Water quality Monitoring Programme (NWMP). This Stretch of the River Khandepar between Ponda to Opa is classified as Class C (for Drinking water source after conventional treatment and disinfection). On the basis of GSPCB reports, Central Pollution Control Board (CPCB) has classified Khandepar River (Stretch from Codli to Opa) under **Priority V**, is having **BOD level 3.4 mg/lit.**

The Report of Monitoring for the period April 2015 to November, 2018 at two locations (i.e. Codli & U/s of Opa water works) for the parameters of DO, BOD and Total Coliform have been taken into consideration for the preparation of Action Plan. The observed DO levels in the polluted river stretch between Codli to Opa water works as can be seen from the GSPCB monitoring reports are well above the desired level of 5 mg/l required for bathing water quality¹ (The river stretch is non saline, i.e. Class-C river wherein the quality of the water shall be suitable for drinking purpose after necessary treatment and disinfection as per Environment protection act 1986). The observed BOD levels in the polluted river stretch between Codli to U/s of Opa water works as can be seen from the GSPCB monitoring reports are well below the desired level of 3 mg/l required for bathing water quality. The observed TC levels in the polluted river stretch Codli to U/s of Opa water works as can be seen from the GSPCB monitoring reports are above the desired levels of 5000 MPN/ 100ML for bathing water quality.

¹ NGT Order dated 20th Sept. 2018, P.N.15,S.N.40



Image 1 Dudhsagar fall on Khandepar River

During the survey conducted for identification of pollution sources, it has been observed that the untreated domestic sewage outfalls mainly from the Khandepar, Opa, Kodar, Codli, Tisk Usgao contributing to the values of faecal & total coliform in the polluted stretch.

The proposed action plan for Khandepar River comprises of the following key issues and action necessary to be implemented:

A. Source Control: The source control includes the industrial pollution control and treatment and disposal of domestic sewage, as detailed below;

a) Industrial Pollution Control: The source identification studies were conducted during the month of January and February 2019. There are no industrial outfalls contributing the pollution in this stretch, except overflows/ outfalls from the mining areas near Codli during monsoon in the nearby vicinity. Sanjeevani Sakhar Karkhana, MRF Industries Ltd and Finolex Industries Ltd are located along the northern bank of the River, however they have their own independent treatment plants wherein the treated water is partly recycled and remaining used for gardening, hence there is no discharge from these Industries into the Khandepar River.

b) Channelization, treatment, utilisation and disposal of treated domestic sewage:

- The physical survey carried out during January and February 2019, the domestic untreated sewage discharge is observed from the areas like Khandepar, Kodar, Opa, Tisk Usgaon, and Codli along the bank of the river.

- ◆ Discharge from individual house directly into the River and also into storm water drains/Nallahs leading to the River were observed on the Northern as well as Southern Bank during the physical survey. The Directorate of Panchayat and Directorate of health services will initiate the following action through village Panchayat and the health officers after carrying out detail survey.

1. Disconnection of the direct discharge into the river/storm water drain/Nallah.
2. Installation of Bio toilets.
3. Construction of septic tank and soak pits by residential houses and monitoring the frequent cleaning the septic tanks in order to avoid untreated domestic sewage discharge in to the natural drains.

B. River Catchment / Basin Management: Controlled ground water extraction and periodic quality assessment.

- i. **Periodic monitoring of ground water resources and regulation of ground water extraction by industries particularly in over exploited and critical zones:**

The central Ground Water Board has carried out survey of Aquifer System in the State of Goa in Sept. 2013. After studying the aquifer report, it is observed that the ground water table along the Khandepar river stretch is 2 m to 5 m below the ground level during Post monsoon season. The water table lowers down in summer by 2 to 4 M. As the ground water table is high within the Khandepar river basin, there are no such actions proposed for improvement of the ground water table².

C. Flood Plain Zone:

- i. **Regulating activity in flood plain zone:**

During the physical survey, domestic untreated sewage disposal in the storm water drains/ Nallahs is observed near, Codli, Khandepar, Codar. The Directorate of Panchayat and Directorate of health services will initiate action through the Village Panchayat and Health Officer Concern to ensure that the domestic sewage is diverted to septic tank and soak pit.

² Aquifer System of Goa, Central Ground Water Board Sept. 2013

ii. Management of Municipal, Plastic Hazardous Bio-Medical & Electrical and Electronic Waste:

The Local bodies are collecting segregated non bio degradable waste which is sent to the Goa Waste Management Corporation (GWMC) and subsequently transported to the baling station at Verna within the state which has its own solid waste management facility including windrows composting, baling and a landfill. The baled non-biodegradable waste is thereafter transported to cement plants in Karnataka for co-incineration. The remaining Panchayats are predominantly having single dwelling units and there is no major issue of disposal of biodegradable waste.

However, improvement in the house to house collection of segregated waste and necessary installation of transfer station for non-biodegradable waste would be completed within period of 6 months. Necessary direction for the same will be issued by the Directorate of Panchayat.

iii. Greenery Development – Plantation Plan:

It was observed during the Physical survey that there are extensive coconut, orchards, and other local species along both the bank of the River.

D. Ecological / Environmental Flow (E-Flow):

- i. **Issues relating to E- Flow:** There are in all 18 Bandhara's constructed on the Khandepar River to fulfil the water demand in the surrounding vicinity.

Table 1 Barrages on Khandepar River.

Sr. No.	Name of Bandharas	Storage in Lakh Cu. M.
1.	Opa Barrage	5.00
2.	Okhamba	2.00
3.	Signewal	2.00
4.	Kumbharwadi	2.15
5.	Dhaucond	1.50
6.	Tatodi	1.37
7.	Kodli	2.00
8.	Matojanwada	1.50

Sr. No.	Name of Bandharas	Storage in Lakh Cu. M.
9.	Velipwada	1.80
10.	Shigao	1.75
11.	Bimbol	2.61
12.	Collem -1, Collem -2	4.00
13.	Biskar	—
14.	Babulwada	—
15.	Durkarkond	—
16.	Devlemol	—
17.	Pimple Queen	—
18.	Kale	—
	Lift irrigation Scheme:	—
	1. Nirankal – in operation	—
	2. Tatodi – not in operation	—

The Mhadei Water Dispute tribunal has passed an award on 14th August 2018 in which the State of Karnataka have been directed to insure sufficient flows in order to maintain the E-flow in the River Khandepar basin in Goa State. Further the water of 50 MLD is release from Salaulim dam to Kale during the lean season to maintain the E-flow throughout the year. The state WRD is also maintaining the E-flow during summer season by pumping the water from the mining pits along the river bank. The WRD is also pumping 40 MLD water from Ganje to Opa during summer.

- ii. **Irrigation practices:** Water from Khandepar has been used to fulfil the drinking water demand and some extent Irrigation purpose in nearby areas through the lift irrigation schemes. Khandepar River is the source of drinking water for 30% population of the state of Goa³ through WTP schemes built on Khandepar River near Opa. The nearby farms, use this water for irrigation. The water from the Opa Weir is released for irrigation purpose from the month of December to May.

³ Report on Status of India's Rivers for India River Week, 2016

Action Plan Strategies:

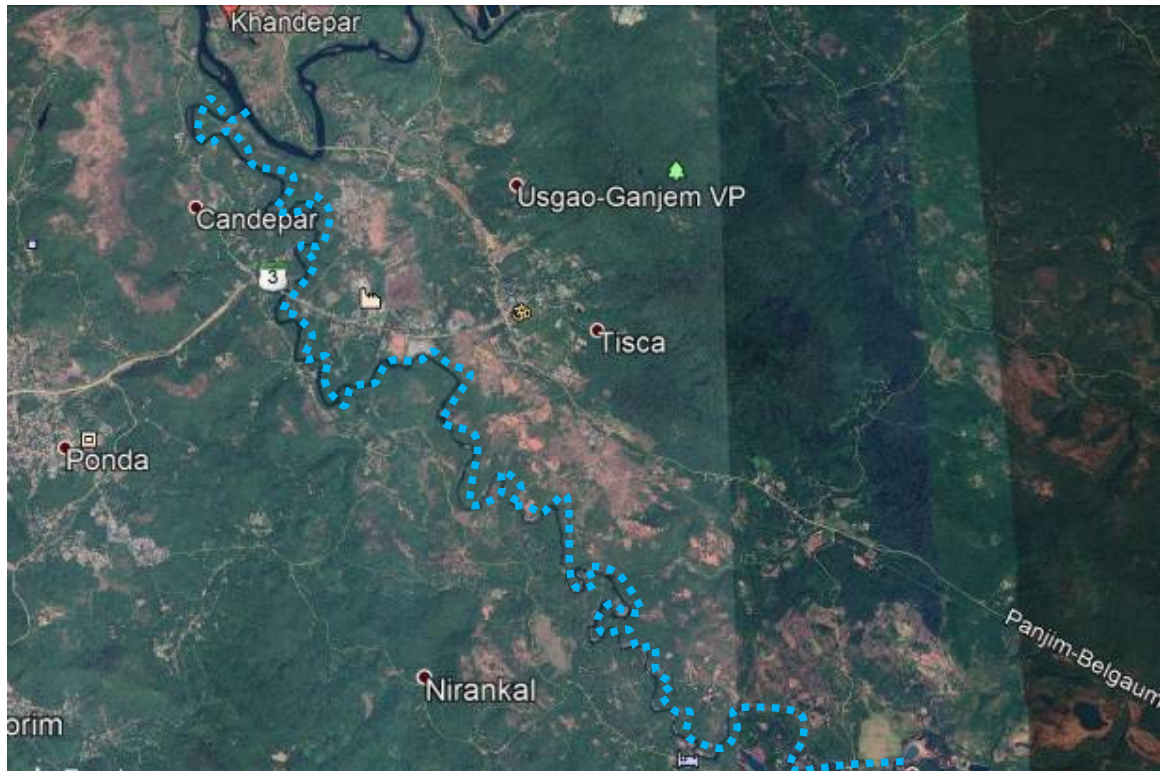
The action plan strategies based on the sampling analysis of the GSPCB, site survey and observations are listed below. These strategies are classified on the basis of the existing proposal in place, recommended up gradation in order to achieve the desired objective on short term and long term basis.

Sr. No.	Action Strategy	River Stretch	Agency	Time Frame
1.	<p>Disconnection of direct discharges of domestic sewage into the Khandepar. River/storm water drains/ nallah.</p> <ul style="list-style-type: none"> ➤ Disconnection of the direct discharge into the river/storm water drain / Nallah. ➤ Construction of septic tank and soak pits by residential houses and monitoring the frequent cleaning the septic tanks in order to avoid untreated domestic sewage discharge in to the natural drains. 	<p>Codli to U/s of Opa water works</p> <p>a) Khandepar b) Usgao</p>	<p>Directorate of Panchayat, Directorate of Health Services;</p>	6 months
2.	<p>The State of Goa has identified site for construction of Common Biomedical waste at Kundaim Industrial Estate. The National Environmental Engineering Research Institute (NEERI, Nagpur) has conducted the EIA study. The study report has been submitted to the SEIAA /SEAC seeking Environmental Clearance for the facility. The facility expected to be commissioned and operation within next 18 months. In the meanwhile the Healthcare facilities have their own treatment facilities such as Autoclave, Deep</p>	<p>The Common Bio-medical waste treatment facility at Kundaim will treat all the Bio-medical waste generated in the State of Goa.</p>	<p>Goa Waste Management Corporation</p>	18 months

Sr. No.	Action Strategy	River Stretch	Agency	Time Frame
	burial pit and encapsulation pit, needle burners etc.			
3.	The Goa Waste Management Corporation and Producer Responsibility organization are collecting the E-waste generated throughout the State and the E waste is there after transported to authorized recyclers in other states.	The complete state of Goa	Goa Waste Management Corporation	Ongoing

Introduction:

Khandepar River originates in the hilly region (upstream side of Codli village) on western part of the state of the Karnataka. The river enters in the state of Goa through the Castle rock heights and plunges down as a famous waterfall 'Dudhsagar fall', travels about 33 km before it meets Mandovi River near Khandepar. The river flows through areas like Khandepar, Tisk–Codar, Opa and Codli before it discharges into Mandovi River near Khandepar. The catchment area of the Khandepar River is about 380 Sq. Km and out of which 24 Sq. Km. is notified saline stretch⁴.



Map 1 Map showing the Khandepar River Stretch in Goa State.

The Goa State Pollution Control Board (GSPCB) monitors the water quality on a monthly basis throughout the year in Khandepar River under the Central Pollution Control Board Programme at two locations, namely, Codli (u/s of Opa) & Opa (U/s of Opa Waterworks). On the basis of GSPCB reports, Central Pollution Control Board (CPCB) has classified Khandepar River (from Codli u/s of Opa till Codli) under priority V, having BOD level 3.4 mg/lit.

⁴ WRD justification about water disputes Nov. 2017.



Map 2 Khandepar –Polluted Stretch (10 km) From Codli to Opa water works

During the Physical Survey it has been observed that there are indigenous / endemic flora, Coconut & Cashew plantations along the bank of the River. Direct discharge of untreated domestic sewage from individual households into the River and storm water drains / nallah leading to the river were observed.

a) Objectives:

The Hon'ble National Green Tribunal in the Original Application No 673 of 2018, vide its Order dated 20th September, 2018 directed the State Governments to prepare an Action Plan within two months for bringing all the polluted river stretches to be fit at least for drinking water source after treatment and disinfection (i. e. BOD < 3 mg/L and TC < 5000 MPN/100 ml for C- Class rivers as per Environment Protection act 1986) within 6 months from the date of finalisation of the action plans.

In the said order the Hon'ble National Green Tribunal has directed that the Action Plan should cover aspects pertaining to Source control, Industrial Pollution Control, Channelization treatment, utilisation and disposal of treated domestic sewage, river catchment/ basin management /control, ground water extraction and periodic quality assessment, flood plain zone , ecological / environmental flow (e-flow) and such other issues may be found relevant for restoring water quality to the prescribed standards. The Hon'ble

National Green Tribunal in their order has further directed to take into account the Model Action Plan for Hindon River, already prepared by CPCB while preparing the Action plans for other polluted river stretches.

Vide the said order the Hon'ble NGT directed that the four member committee comprising of Director Environment, Director Urban Development, Director Industries and Member Secretary, State Pollution Control Board shall be the Monitoring Committee for the execution of the Action Plan. The Committee shall be called "River rejuvenation Committee (RRC)" and will function under the overall supervision & co-ordination of the principal Secretary of the concern state. The action plan shall include components like identification of polluting sources including functioning / status of STP's, ETP's CETP, and solid wastes management processing facilities, quantification and characterisation of solid waste, trade & sewage generated in the catchment areas of polluted river stretch. The action plan should address issues related to, ground water extraction, adopting good irrigation practices, protection and management of flood plain zones, rain water harvesting, ground water charging, maintaining minimum environmental flow of rivers & plantation on both sides of the river.

The Hon. NGT has directed that setting of bio-diversity Park on flood plains by removing encroachments shall be considered as an important component of river rejuvenation. The action plan is expected to focus on proper interception and diversion of sewage carrying drains to the sewage treatment plant and emphasis should be on utilisation of treated sewage so as to minimise extraction of ground or surface water.

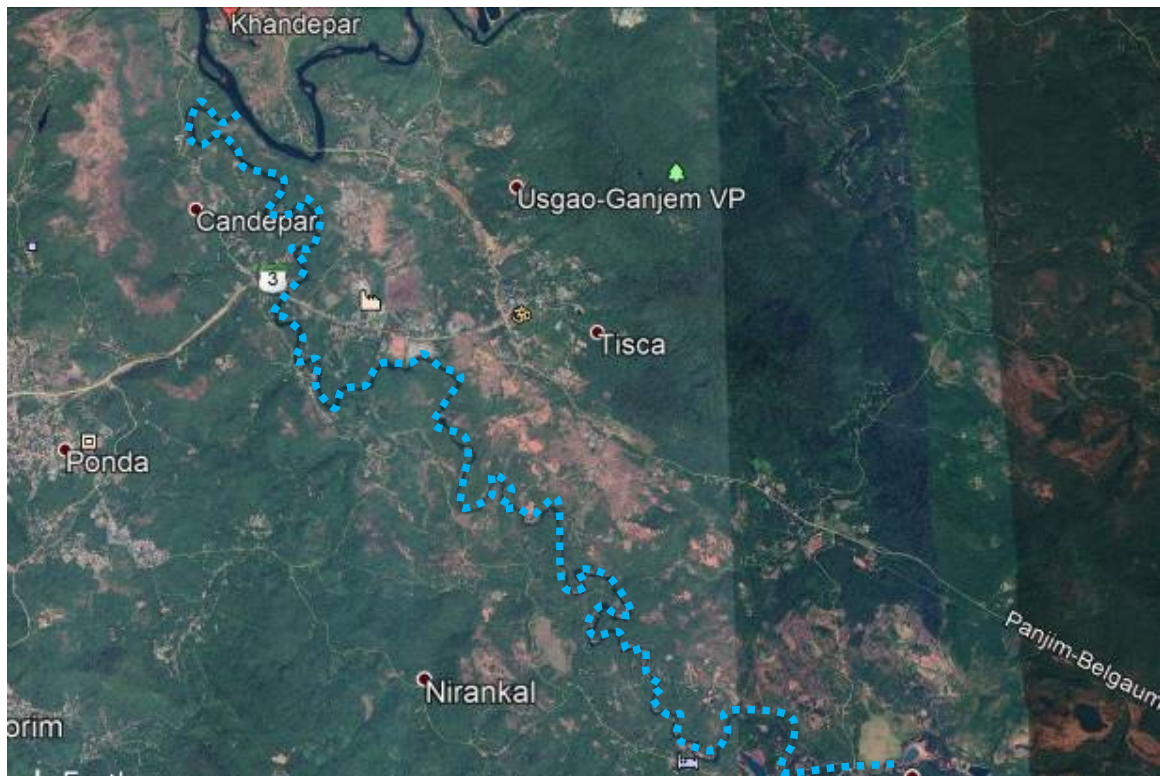
The Hon'ble NGT has directed to ensure that the action plan should have definite or specific timelines for execution steps. The State Government is required to set up a special environment surveillance task force in terms of this order. The said task force has to ensure that no illegal mining takes place in river bed of such polluted stretches. The river rejuvenation committee is directed to have web site inviting public participation from educational, religious institutions and commercial establishment. The achievement and failure may also be published on such website. The Committee may consider suitably rewarding those contributing significantly to the success of the project.

The RRC's will have the authority to recover the cost rejuvenation in Polluter pays Principal from those whose may be responsible for the pollution, to the extent found necessary. In this case principal laid down by this tribunal in the said order. Voluntary donations, CSR contribution voluntary services and private participation may be considered in consultation with the RRC.

1. Brief about Khandepar River:

1.1. River Khandepar:

Khandepar River originates in the hilly region (upstream side of Codli village) on western part of the state of the Karnataka. The river enters in the state of Goa through the Castle rock heights and plunges down as a famous waterfall 'Dudhsagar fall', travels about 33 km before it meets Mandovi River near Khandepar. The river flows through areas like Khandepar, Tisk–Codar, Opa and Codli before it discharges into Mandovi River near Khandepar. The catchment area of the Khandepar River is about 380 Sq. Km and out of which 24 Sq. Km. is notified saline stretch⁵.



Map 3 Map showing stretch of Khandepar River

Nomenclature

Identification



Khandepar river stretch

The water sampling was carried out by GSPCB under NWMP, as per directions of the CPCB for the stretch between Opa Ponda & Codli- u/s of Opa Water works having length 33 Kms,

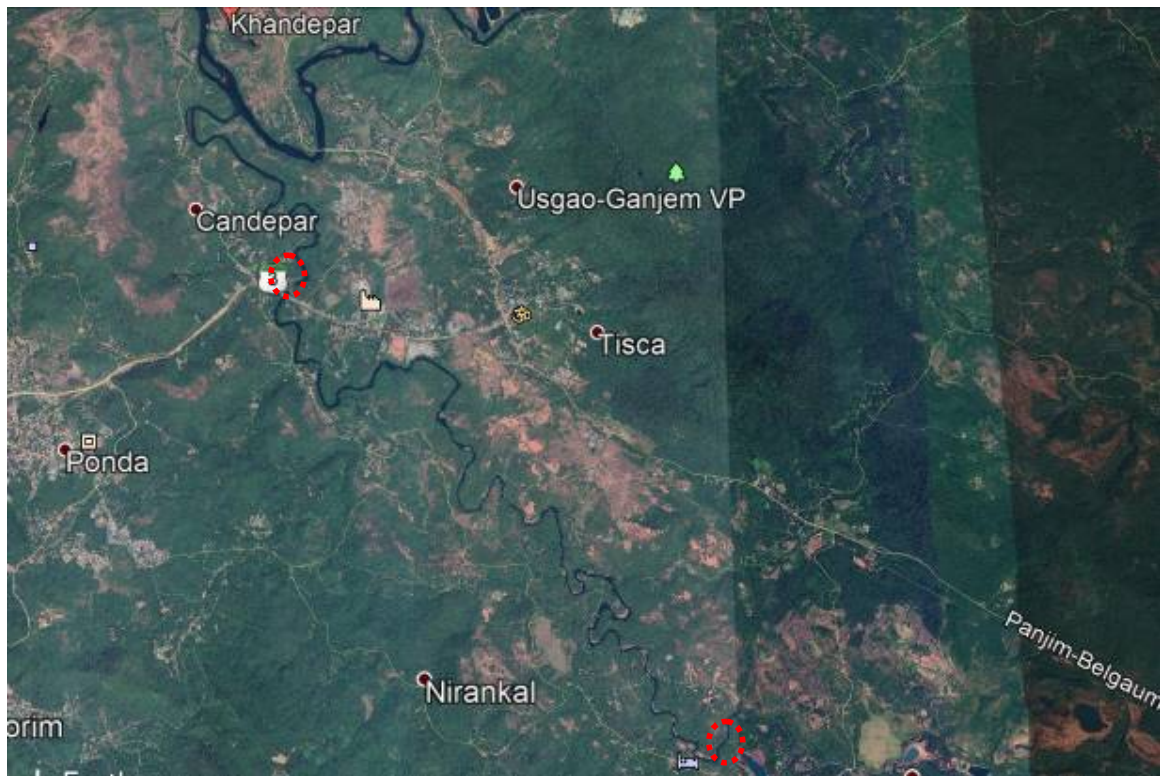
⁵ WRD justification about water disputes Nov. 2017.

at two locations, viz. U/S of Opa water works and Codli- u/s of Opa water works. The monitoring reports at two locations have been summarized in following table:

Table 2 Sampling locations of Khandepar River

Location	Co-ordinates	
	Latitude	Longitude
Opa Ponda	15°24'38.10"N	73°3'16.67"E
Codli near Bridge, u/s OPA waterworks, Sanguem	15°21'28.64"N	74°7'36.05"E

The map showing the locations of the sampling is referred in map below.



Map 4 Map showing the Sampling location on Khandepar River

Nomenclature

Identification



NWMP Sampling point location on Khandepar river

1.2. Water Quality of River Khandepar:

For the purpose of conceptualising the action plan for the polluted river stretch of Khandepar River the data of water quality monitoring carried out by GSPCB for three seasons was

considered from year 2015 to 2018, the reports for the same have been summarized as below:

- a) Pre monsoon (January - May)
- b) Monsoon (June – September)
- c) Post Monsoon (October - December)

1.3. Water Sampling Results:

The water sampling was carried out by GSPCB under NWMP, as per directions of the CPCB for the stretch between Opa Ponda & Codli- u/s of Opa Water works having length 33 Kms, at two locations, viz. U/S of Opa water works and Codli- u/s of Opa water works. The monitoring reports at two locations have been summarized in following table:



Image 2 Water sampling in Nov. 2018 at Khandepar River.

Table 3 Khandepar River parameters at Opa Ponda⁶

Sr. No.	Year Parameters	2015	2016	2017	2018	Range
Pre - Monsoon (January to May)						
1.	DO (mg/l)	7.1-7.9	5.8 – 8.4	6.8 – 7.2	6.7-7.8	5.8-8.4
2.	BOD (mg/l)	1.3 – 1.5	0.7 – 2.0	1.1-1.8	0.9-2.2	0.7-2.2
3.	Total Coliform (MPN/100ml)	330 - 330	33-790	110-5400	780-4900	33-5400
Monsoon (June to September)						
1.	DO (mg/l)	6.2 – 7.4	5.2 – 7.6	7.0-7.6	7.5-7.9	5.2-7.9
2.	BOD (mg/l)	0.4 – 1.1	0.6 – 2.7	0.5-2.1	0.5-2.4	0.4-2.7
3.	Total Coliform (MPN/100ml)	1300 - 4900	330-1300	790- 5400	1100-5400	330-5400
Post - Monsoon (October to December)						
1.	DO (mg/l)	6.8 - 7	7.4-7.9	7.3-7.6	6.5-7.2	6.5-7.9
2.	BOD (mg/l)	0.6 – 1.6	0.7-2.7	0.6-1.9	0.6-0.8	0.6-2.7
3.	Total Coliform (MPN/100ml)	130- 1300	330-1300	1100-2200	230-2300	130-2300

The DO in Khandepar River at Opa during pre-monsoon season varies from 5.8mg/l to 8.4 mg/l and 5.2 mg/l to 7.9 mg/l during monsoon and 6.5 mg/l to 7.9 mg/l in post monsoon.

The BOD in Khandepar River at Opa during pre-monsoon season varies from 0.7 mg/l to 2.2 mg/l and 0.4 mg/l to 2.7 mg/l during monsoon and 0.6 mg/l to 2.7 mg/l in post monsoon.

The TC in Khandepar River at Opa during pre-monsoon season varies from 33 MPN/ 100ml to 5400 MPN/ 100ml and 330 MPN/ 100ml to 5400 MPN/ 100ml during monsoon and 130 MPN/ 100ml to 2300 MPN/ 100ml in post monsoon.

⁶ GSPCB Sampling under NWMP

Table 4 Khandepar River parameters at Codli (u/s of Opa Water works) ⁷

Sr. No.	Year Parameters	2015	2016	2017	2018	Range
Pre - Monsoon (January to May)						
1.	DO (mg/l)	7.3-7.7	6.3-8.4	7.2-7.7	7-8.1	6.3-8.4
2.	BOD (mg/l)	0.5-1	0.2-3.4	0.1-1.2	1.3-4.2	0.1-4.2
3.	Total Coliform (MPN/100ml)	330-790	70-3500	460-1700	450-2300	70-3500
Monsoon (June to September)						
1.	DO (mg/l)	6.2-7.8	6.6-7.5	6.9-7.6	-	6.2-7.8
2.	BOD (mg/l)	0.1-1	0.4-1.6	0.5-2	-	0.1-2
3.	Total Coliform (MPN/100ml)	490-3500	790-2400	790-3500	-	490-3500
Post - Monsoon (October to December)						
1.	DO (mg/l)	7.1-7.8	8.0-8.7	6.7-7.1	-	6.7-8.7
2.	BOD (mg/l)	0.6-2.4	1.4-1.5	0.7-1.8	-	0.6-2.4
3.	Total Coliform (MPN/100ml)	230-1100	490-3500	1100-5400	-	230-5400

The DO in Khandepar River at Codli during pre-monsoon season varies from 6.3mg/l to 8.4 mg/l and 6.2 mg/l to 7.8 mg/l during monsoon and 6.7 mg/l to 8.7 mg/l in post monsoon.

The BOD in Khandepar River at Codli during pre-monsoon season varies from 0.1 mg/l to 4.2 mg/l and 0.1 mg/l to 2 mg/l during monsoon and 0.6 mg/l to 2.4 mg/l in post monsoon.

The TC in Khandepar River at Codli during pre-monsoon season varies from 70 MPN/ 100ml to 3500 MPN/ 100ml and 490 MPN/ 100ml to 3500 MPN/ 100ml during monsoon and 230 MPN/ 100ml to 5400 MPN/ 100ml in post monsoon.

⁷ GSPCB Sampling under NWMP

Summary of the Sampling analysis

Dissolved Oxygen (DO)

All the observed Dissolved Oxygen values are normal and indicate well oxygenated water during all the three season i.e. Pre-monsoon, Monsoon and Post – monsoon and good for aquatic life and well within limits required for Class C water quality.

Biochemical Oxygen Demand (BOD)

All the observed values of BOD are less than 3 mg/l and within limits for Class C water quality and indicate low organic matter addition to the Khandepar River.

Total Coliform

The observed values of Total coliform are marginally above the prescribed limit of 5000 MPN/100 ml.

1.4. Data Analysis and interpretation:

The results of the water sampling carried out by Goa state Pollution Control Board at **Codli (u/s of Opa Water works) & Opa** on Khandepar River from April 2015 to December 2018, in respect of DO, BOD and Total coliform have been considered for preparation of action plan.

- **Dissolved Oxygen (DO)**

The observed DO levels in the polluted river stretch between Codli (u/s of Opa Water works) to Opa as can be seen from the GSPCB monitoring reports are well above the desired level of 4 mg/l required for Class C water quality i.e. for drinking water source after conventional treatment and disinfection.

- **Biochemical Oxygen Demand (BOD)**

The observed BOD levels in the polluted river stretch between Codli (u/s of Opa Water works) to Opa as can be seen from the GSPCB monitoring reports are well below the desired level of 3 mg/l required for Class C water quality i.e. for drinking water source after conventional treatment and disinfection.

- **Coliforms**

The observed TC levels in the polluted river stretch between Codli (u/s of Opa Water works) to Opa as can be seen from the GSPCB monitoring reports are marginally above the desired

levels of 5000 MPN/ 100ML for drinking water quality after necessary treatment and disinfection (Class C water quality).

1.5. Action Plan Strategies:

This Khandepar River (Class- C) polluted stretch has been identified under Priority V as identified by the CPCB. The action plan is limited to the Regulatory interventions proposed in order to restore the Water Quality to the desired bathing water quality standards notified by the CPCB. The Action Plan has been prepared to achieve Class C water quality. Total coliform count has been reported above 5000 MPN/ 100 ml in the River Khandepar in the identified polluted stretch.as other parameters of DO and BOD are within the desired limits.

1.6. Major Concerns:

The polluted river stretch of Khandepar River **falls under priority V**. The parameters like dissolved oxygen and bio-chemical oxygen demand are meeting prescribed statutory requirement but the levels of Total Coliforms (TC) exceeds the prescribed limits to achieve Class C water quality.

2. Source Control:

The reconnaissance survey was conducted along with the GSPCB officials for the polluted stretch between Codli (u/s of Opa Water works) to Opa during the month of Jan. & Feb. 2019. The objective of this study is to analyse the sources of pollutants.

a) Industrial Pollution Control :

The source identification studies were conducted during the month of January and February 2019. There are no industrial outfalls contributing the pollution in this stretch, except overflows/ outfalls from the mining areas near Codli during monsoon in the nearby vicinity. Sanjeevani Sakhar Karkhana, MRF Industries Ltd and Finolex Industries Ltd are located along the northern bank of the River, however they have their own independent treatment plants wherein the treated water is partly recycled and remaining used for gardening, hence there is no discharge from these Industries into the Khandepar River.

b) Channelization, treatment, utilisation and disposal of treated domestic sewage:

The reconnaissance survey was carried out during the month of January, February 2019, for identification of the sources of pollution of River Khandepar.

i. Sources of Pollutants:

The polluted river stretch between **Codli-u/s of Opa Water works to Opa**) was physically surveyed along both the banks of river during month of January and February 2019, for identification of sources of pollution. During the physical survey the discharge of untreated domestic sewage through nallah/ storm water drains was observed mainly on the northern and southern bank of the river from Khandepar & Tisk Usgaon.



Map 5 Map showing Pollutants to the Khandepar River

Nomenclature



Identification

Khandepar river stretch

Tributaries & Sources of Pollutants on the Khandepar river

3. River Catchment Management:

The catchment area of the Khandepar River is about 380 Sq. Km and out of which 24 Sq. Km. is notified saline stretch⁸.

i. Periodic monitoring of ground water resources and regulation of ground water extraction by industries particularly in over exploited and critical zones:

The central Ground Water Board has carried out survey of Aquifer System in the State of Goa in Sept. 2013. After studying the aquifer report, it is observed that the ground water table along the Khandepar river stretch is 2 m to 5 m below the ground level during Post monsoon season. The water table lowers down in summer by 2 to 4 M. As the ground water table is high within the Khandepar river basin, there are no such actions proposed for improvement of the ground water table⁹.

4. Flood Plain Zone:

i. Regulating activity in flood plain zone: During the physical survey, domestic untreated sewage disposal in the tributaries is observed near Khandepar, Codli, and Codar. The Directorate of Panchayat and Directorate of health services will initiate action through the Village Panchayat and Health Officer Concern to ensure that the domestic sewage is diverted to septic tank and soak pit.

ii. Management of Municipal, Plastic, Hazardous, Bio-Medical & Electrical and Electronic Waste:

The Local bodies are collecting segregated non bio degradable waste which is sent to the Goa Waste Management Corporation (GWMC) and subsequently transported to the baling station at Verna within the state which has its own solid waste management facility including windrows composting, baling and a landfill. The baled non-biodegradable waste is thereafter transported to cement plants in Karnataka for co-incineration. The remaining Panchayat's are predominantly having single dwelling units and there is no major issue of disposal of biodegradable waste.

However, improvement in the house to house collection of segregated waste and necessary installation of transfer station for non-biodegradable waste would be

⁸ WRD justification about water disputes Nov. 2017.

⁹ Aquifer System of Goa, Central Ground Water Board Sept. 2013

completed within period of 6 months. Necessary direction for the same will be issued by the Directorate of Panchayat.

The State of Goa has identified site for construction of Common Biomedical waste at Kundaim Industrial Estate. The National Environmental Engineering Research Institute (NEERI, Nagpur) has conducted the EIA study. The study report has been submitted to the SEIAA /SEAC seeking Environmental Clearance for the facility. The facility expected to be commissioned and operation within next 18 months. In the meanwhile the Healthcare facilities have their own treatment facilities such as Autoclave, Deep burial pit and encapsulation pit, needle burners etc.

There are no hospital waste observed in the stretch of the Khandepar River, however for futuristic provision the state Govt. is taking appropriate action in order to avoid further pollution due to hospital waste management.

The Goa Waste Management Corporation and Producer Responsibility organisation are collecting the E-waste generated throughout the State and the E waste is there after transported to authorised recyclers in other states.

5. Greenery Development- Plantation Plan:

It was observed during the Physical survey that there are extensive coconut, orchards, and other local species along both the bank of the River.



Image 3 Orchard & Coconut Tree along the Bank of Khandepar River.

6. Ecological / Environmental Flow (E-Flow):

i. Issues relating to E- Flow:

There are in all 18 Bandhara's constructed on the Khandepar River to fulfil the water demand in the surrounding vicinity.

Table 5 Barrages on Khandepar River.

Sr. No.	Name of Bandhara's	Storage in Lakh Cu. M.
1.	Opa Barrage	5.00
2.	Okhamba	2.00
3.	Signewal	2.00
4.	Kumbharwadi	2.15
5.	Dhaucond	1.50
6.	Tatodi	1.37
7.	Kodli	2.00
8.	Matojanwada	1.50
9.	Velipwada	1.80
10.	Shigao	1.75
11.	Bimbol	2.61
12.	Collem -1, Collem -2	4.00
13.	Biskar	–
14.	Babulwada	–
15.	Durkarkond	–
16.	Devlemol	–
17.	Pimple Queen	–
18.	Kale	–
	Lift irrigation Scheme:	–
	1. Nirankal – in operation	–
	2. Tatodi – not in operation	–

The Mhadei Water Dispute tribunal has passed an award on 14th August 2018 in which the State of Karnataka have been directed to insure sufficient flows in order to maintain the E-flow in the River Khandepar basin in Goa State. Further the water of 50 MLD is release from Salaulim dam to Kale during the lean season to maintain the E-flow throughout the year. The state WRD is also maintaining the E-flow during summer season by pumping the water from the mining pits along the river bank. The WRD is also pumping 40 MLD water from Ganje to Opa during summer.

- ii. **Irrigation practices:** Water from Khandepar has been used to fulfil the drinking water demand and some extent Irrigation purpose in nearby areas through the lift irrigation schemes. Khandepar River is the source of drinking water for 30% population of the state of Goa¹⁰ through WTP schemes built on Khandepar River near Opa. The nearby farms, use this water for irrigation. The water from the Opa Weir is released for irrigation purpose from the month of December to May.

¹⁰ Report on Status of India's Rivers for India River Week, 2016.

7. Action Plan Strategies:

The action plan strategies based on the sampling analysis of the GSPCB, site survey and observations are listed below. These strategies are classified on the basis of the existing proposal in place, recommended up gradation in order to achieve the desired objective on short term and long term basis.

Sr. No.	Action Strategy	River Stretch	Agency	Time Frame
1.	<p>Disconnection of direct discharges of domestic sewage into the Khandepar. River/storm water drains/ nallah.</p> <ul style="list-style-type: none"> ➤ Disconnection of the direct discharge into the river/storm water drain / Nallah. ➤ Construction of septic tank and soak pits by residential houses and monitoring the frequent cleaning the septic tanks in order to avoid untreated domestic sewage discharge in to the natural drains. 	<p>Codli to U/s of Opa water works</p> <p>a) Khandepar b) Usgao</p>	<p>Directorate of Panchayat, Directorate of Health Services;</p>	6 months
2.	<p>The State of Goa has identified site for construction of Common Biomedical waste at Kundaim Industrial Estate. The National Environmental Engineering Research Institute (NEERI, Nagpur) has conducted the EIA study. The study report has been submitted to the SEIAA /SEAC seeking Environmental Clearance for the facility. The facility expected to be commissioned and operation within next 18 months. In the meanwhile the Healthcare</p>	<p>The Common Bio-medical waste treatment facility at Kundaim will treat all the Bio-medical waste generated in the State of Goa.</p>	<p>Goa Waste Management Corporation</p>	18 months

Sr. No.	Action Strategy	River Stretch	Agency	Time Frame
	facilities have their own treatment facilities such as Autoclave, Deep burial pit and encapsulation pit, needle burners etc.			
3.	The Goa Waste Management Corporation and Producer Responsibility organization are collecting the E-waste generated throughout the State and the E waste is there after transported to authorized recyclers in other states.	The complete state of Goa	Goa Waste Management Corporation	Ongoing

7.1. Conclusion & Remark:

- i) The stretch of River Khandepar from Codli & U/s of Opa water works having length of 33 Kms is categorized as **Priority V**. The parameters such as DO and BOD and TC are well within the CPCB prescribed standards. The only cause of concern is high levels of Total Coliform which is mostly due to the discharge of untreated domestic sewage through nallah, storm water drains including direct discharge from residential houses into the River. However, the Directorate Village Panchayat will take appropriate action in order to stop the discharge from the residential houses.
- ii) Khandepar River was categorized as priority V river, on the basis of maximum BOD value (i.e. 3.4 mg/lit) among the monitoring reports carried out and submitted by GSPCB. It was also observed that, apart from the single report of maximum value of BOD, all values during monitoring period were below 3 mg/lit. Also values of DO and total coliform are also always within limit of standards to be maintained for Class C water quality. The latest reports during January to December 2018, carried of by GSPCB, were well within limits of Class C criteria. Hence, the Khandepar river polluted stretch, shall be dropped from priority V. However, GSPCB will continue monitoring the water quality at two locations to as per Class C water quality standards.
- iii) The Directorate Village Panchayat will take appropriate action in order to stop the discharge from the residential houses.
- iv) The action plan strategies have been elaborated above and will be implemented by concerned stake holder departments/ corporations by taking necessary action for

disconnection of direct discharges of domestic sewage and improvement in the collection and storage of the Solid Waste in the concerned Panchayat.

- v) The Mhadei Water Dispute tribunal has passed an award on 14th August 2018 in which the State of Karnataka have been directed to insure sufficient flows in order to maintain the E-flow in the River Khandepar basin in Goa State. Further the water of 50 MLD is release from Salaulim dam to Kale during the lean season to maintain the E-flow throughout the year. The state WRD is also maintaining the E-flow during summer season by pumping the water from the mining pits along the river bank. The WRD is also pumping 40 MLD water from Ganje to Opa during summer.
- vi) The implementation and execution of the proposed action plan will be monitored by the River Rejuvenation Committee constituted by the order of the Hon'ble National Green Tribunal.