



KERALA STATE POLLUTION CONTROL BOARD

കേരള സംസ്ഥാന മലിനീകരണ നിയന്ത്രണ ബോർഡ്

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PCB/HO/EE1/NGT/673/2018

Date: 23/02/2019

From

The Member Secretary

To

The Chairman
Central Pollution Control Board
Parivesh Bhavan
East Arjun Nagar
Delhi - 110 032.

Sub: OA No. 673/2018 - Polluted River Stretches Program Report - Reg.

Ref :1. Order dated 20/09/2018 of Hon'ble NGT in OA No. 673/2018

2. This Office letter of even No. dated 13/12/2018

3. Letter No. 14011/1/2019 - WQM-I/5096 dated 10/01/2019

Sir,

In compliance with the order dated 20/09/2018 of the Hon'ble NGT in OA No. 673/2018, River Rejuvenation Committee, State Level Special Environment Surveillance Task Force and District Level Special Environment Surveillance Task Force were constituted vide Govt. Order No. G.O. (Rt) No. 135/2018/Envr dated 12/12/2018.

The draft report prepared by Board was submitted to CPCB vide ref. (2) above. The Task Team of CPCB after reviewing the report requested to submit revised version of action plans upon approval of River Rejuvenation Committee, vide ref. (3) above. In this connection the presentation arranged by the Task Team CPCB was attended by the SPCB on 11/02/2019 at Delhi. Accordingly revised draft action plan prepared as per the recommendations referred (3) is submitted herewith.

Yours faithfully

MEMBER SECRETARY

Encl: As above

Copy to;

The Principal Secretary
Environment Department

KARAMANA RIVER ACTION PLAN

KERALA STATE POLLUTION CONTROL BOARD

DEPARTMENT OF IRRIGATION

KERALA WATER AUTHORITY

THIRUVANANTHAPURAM CORPORATION

KERALA STATE REMOTE SENSING AND ENVIRONMENT CENTRE

KERALA SOCIO ECONOMIC FOUNDATION

FEBRUARY 2019

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CHAPTER I

INTRODUCTION

1.1 Background

The Edayar Residents Association filed OA No. 302/13 before the National Green Tribunal, Chennai. As per the order dated 15-11-2017, the Tribunal directed Chief Secretary, to hold a meeting with the stakeholders to chalk out an action plan for stopping pollution of the Karamana river. As instructed in the meeting held on 23-12-2017, a concept plan was prepared by the Kerala State Pollution Control Board, Irrigation Department, Kerala Water Authority and Thiruvananthapuram Corporation. The concept plan so prepared was approved in the meeting on 28-12-2017. Based on the concept plan, sanitation survey was conducted with the support of Socio Economic Unit Foundation on either sides of the Karamana and Killiyar passing through the Thiruvananthapuram city using the mobile application was developed by Kerala State Remote Sensing and Environment Centre. The progress on its implementation was ascertained by the Chief Secretary on 11-10-2018. It was instructed to prepare an action plan for the restoration of Karamana river and submit it to the Department of Water Resources.

1.2 Identification of problem

Karamana river passes through the outskirts of the Thiruvananthapuram city. Its main tributary, Killiyar passes through the Thiruvananthapuram city and then meets the Karamana river at Pallathukadavu. Parvathi Puthanar then meets the Karamana river at Moonattumukku. The water quality monitoring of the River Karamana revealed that it is highly polluted due to fecal coliform, which indicates the discharge of sewage into the water body. Moonattumukku comes under the critically polluted stretch by the Central Pollution Control Board due to high BOD and fecal coliform count. It comes under the Priority Category-I. Fecal count is mainly from sewage generated in the City area. This led to the conduct of sanitation survey of 250m on either sides of the River Karamana and Killiyar, when it passes through the Thiruvananthapuram city. Sanitation survey was also conducted on 10 m on either side of six identified polluted streams.

1.3 Causes of the problem

The improper disposal of sewage, sullage and solid wastes generated in the City is mainly responsible for the degradation of water quality of River Karamana.

- (i) Even though the Kerala Water Authority has established 107 MLD sewage treatment plant, the entire sewage cannot reach the plant due to the leak of sewer line/inadequate pumping stations.
- (ii) Corporation had established and operated one common municipal solid waste management facility at Vilappilsala and was closed due to public protest and NGT order. Now they are promoting decentralized waste management facility but not fully catering the waste generated.

1.3.1 Findings of sanitation survey

The sanitation survey was conducted in 45 wards, through which the Karamana and Killiyar passes through the city area. 9263 residences, 706 establishments and 32 flats have been surveyed.

1.3.1.a Residences

- Of the 9263 residences, 5826 residences are in APL, 2552 residences are in BPL, 194 residences are in EWS.
- 157 dengue fever occurred in the downstream stretch of the river i.e in Vellar, Thiruvallom and Poonthura
- 46 residences are having no toilets (Manikavilakom-9, Puthenpally-6, Poonthura-5, Ambalathara-4, Attukal-2, one in Estate, Jagathy, Mudavanmughal, Thrikkannapuram, and Thycaud) , open defecation in 9 residences (Vellar-6, Ambalathara-2, Thiruvallom-1), 17 residences are using common toilets and two toilets are reported to be not useful. Toilet facility shall be given to these families as they are belonging to below poverty line.
- Toilet waste is discharged into rivers from 89 residences; into soak pit from 1201 residences; and reported to be into septic tank from 4810 residences. It is to be verified that system provided in low lying areas on the river banks is septic tank or not, as it is difficult to provide a proper system there due to high ground water table. The practice of discharging into rivers is to be stopped and an alternate system is to be provided.

- Toilet waster is also discharged from 1961 residences into the sewer system available in 11 wards. Its adequacy is to be ascertained and to ensure that there is no overflow through pipeline, manhole and pumping stations, frequent blocks, flow back into toilets, overflow through manholes during rains have also been reported from the wards of Jagathy, Poojappura, Valiyasala, Chalai, Karamana, Nedumcaud, and Attukal. The blocks in sewer line is to be rectified and overflowing from sewer line should be stopped.
- Grey water from kitchen is discharged from 397 houses into river, 237 into road side drain, 2189 residences are discharging into septic tank, which may affect the functioning of septic tank. The practice of discharging into rivers is to be stopped and an alternate system is to be provided.
- Grey water from bathroom is discharge from 361 houses into river, 237 into road side drain, 2272 houses into septic tank, which is not recommended as grey water from bathrooms, contain soap and it will affect the functioning of septic tank. The practice of discharging into rivers is to be stopped and an alternate system is to be provided.
- 7172 residences are not practicing segregation of solid wastes and 1403 residences are practicing segregation of solid wastes.
- Biodegradable solid waste from 629 residences are disposing into river; 1332 residences are burning the biodegradable waste. 271 residences in Poonthura are disposing wastes into river followed by Manickavilakom and Thiruvallam. The burning of wastes is reported maximum in Attukal, Nedumcadu, Kalady, Thiruvallom and Sasthamangalam.
- Non-biodegradable wastes from 371 residences are disposing into river. The wastes are burnt in 2920 residences. 246 residences in Poonthura are disposing wastes into river followed by Thiruvalla and Attukal. The burning of wastes is reported maximum in Thiruvallom(553) followed by Ambalathara, Vellar, Thuruthumoola, Kalady, Jagathy, Melamcode etc.
- 34 locations were identified where waste dumping was being done. Most of this is in water logged areas which homes the breeding ground of mosquitoes and these are in the proximity of the natural river.

There are 32 flats in 250m of the Karamana and Killiyar river. Sewage generated in these flats are either discharged into sewer line or disposed in soak pit. Some are having only up to two flats. Consent to operate from the Kerala State Pollution Control Board is yet to be obtained by high rise building having more flats. The mode of treatment and disposal of solid wastes and sewage generated in these flats is to be closely monitored by the Kerala State Pollution Control Board and the Thiruvananthapuram Corporation. The other flats in the catchment are also to be monitored and to be brought to the consent purview.

1.3.1.c Establishments

A total number of 706 establishments which were located in the buffer region. The establishments situated on the banks of the river include hospitals, hotels, lodges, markets, offices, shops, service stations, workshops etc. The main hospital is S.K. Hospital situated at Pangode. There are 15 hospitals, 33 hotels, 40 educational institutions, five lodges, six markets, 90 offices, 3 restaurants, 43 service stations, 323 shops, and 45 workshops situated on the bank of the river. These are to be closely monitored. The other establishments in the catchment are also to be monitored and to be brought to the consent purview.

1.3.2 Sanitation survey of Parvathi Puthanar

Sanitation survey was earlier carried out by the Kerala State Pollution Control Board through Socio Economic Unit Foundation in October 2012- January 201. Based on the survey, following recommendations were made.

A. Short term recommendations to control pollution of Parvathyputhanar

Providing household latrines

1. Single pit conversion to bio toilet : 310
2. Septic tank-open to canal connected to community septic tank 7
3. New bio toilets for no latrine households and those which are directly connected to water body 246(71+176)

Community latrines

1. Maintenance of existing community toilet and construction of modern septic tank to 100 people at bund colony in ward Kunnukuzhy ward near thekkumoodu
2. Construction of new community toilet from 100 people at Pattom side of bund
3. Construction of common toilet and bathroom for three households near
Thekkummoodu in Pattom ward

4. Connection of outlet pipes to septic tank.

Solid waste management

Decentralized solid waste management is the best option for solid waste management in Thiruvananthapuram where all the centralized systems are encountering problems

Non-Biodegradable waste management

Material Collection Facility is to be provided for the management of non-biodegradable waste.

Liquid waste other than the sewage management

Two sizes of soak pits is proposed as per the needs from the field

Soak pit (0.4m³) 71

Soak pit (0.2m³) 748

Information Education and communication, Capacity building

1. Awareness for residence association: Suchitwamission/LSGD/Corporation
2. SWM training to children, youth, Asha workers and other stake holders
3. Follow up systems: Capacity building of community groups, monitoring system and active involvement of residence association is necessary.

B. Long term Recommendations

- 1.Connecting sewers to these sewage treatment plant at Muttathara
- 2.Permanent solution for pollution control in river is to connect outlets of latrines on the banks of the canal through a network of pipes along the canal for the final treatment at the sewage treatment plant at Muttathara.
- 3.The technological feasibility of this suggestion is to be explored by Kerala Water authority
- 4.The masons or skilled workforce should be reoriented for quality assured constructions and ensure the availability of them to people.

Enforcement of rules for proper designing and construction of septic tanks has to be implemented. As the city corporation could not cater to all wards of the city even after the completion of the new sewage plant, desludging from septic tanks could be done. Hence regulations for scheduled desludging are required. It is necessary to identify the septage removal agencies/institutions and process or final disposal of present practice, to have information and develop monitoring systems.

To prevent pollution of canal through waste dumping, strict enforcement of rules is required Corporation has to identify space for treatment systems in decentralized ward wise arrangements and scale up promotion of agriculture, successfully implemented in some wards. Decentralized systems in SW with active participation of

the community and ensure proper SWM systems for houses on the banks of the canal. Innovative pilot projects with stakeholder participation to prevent pollution of water bodies are necessary. The role resident's association is crucial in monitoring the pollution abatement.

1.3.3 Sewerage system in Thiruvananthapuram City

In Thiruvananthapuram, sewer pipes were laid in 1945 itself to carry the sewage for fodder cultivation. In 2015, a common sewage treatment plant of 107MLD came into existence at Muttathara Sewage Farm. But these old sewer pipes were not augmented or replaced, this led to overloaded sewer system. Thus sewage reaches the water bodies causing heavy contamination through manholes, and pumping/lift stations. Hence the Kerala Water authority is required to initiate action either to provide additional sewer line or to provide alternate system such as DEWATS system to avoid the discharge of sewage into the water bodies through manholes, pumping/lift stations. Augmentation of sewer line is urgently required. Present issues in connection with the inadequacy of sewer line is as follows:

The flow through manhole including during raining, back flow to toilets reported in the areas of Attukal, Chalai, Jagathy, Karamana, Nedumcaud, Valiyasala, and Poojappura, Kerala Water Authority is required to take action to rectify the defects permanently.

1.4 Major source of pollution in the Killiar

The contamination of water bodies is due to disposal of untreated sewage and grey water from the houses near to the River Karmana, Killiyar, Parvathiputhanar and to streams in the City area. The improper disposal of both biodegradable and non-biodegradable wastes into the river also creates contamination. Besides the above, old sewage pipeline passing through the commercial area, causes the discharge of sewage into the water bodies through the pipelines, manholes and pumping/lift stations. The pollution of the river can be solved only by stopping the entry of sewage into the water bodies and by providing proper sewage, sullage treatment in the houses in the river banks.

1.5 Solutions to the Problem, authorized person and timeline

Sl.No	Project		Proposed action	Agency	Target date	Per unit	No.	Total budget	Remarks
A. Pollution									
1.	Sanitation	1.1	Providing of toilets to 320 residences (35+9+16+246+3) with treatment and disposal system for sewage and sullage-DEWATS	Thiruvananthapuram Corporation	Three months				As per survey on Karamana and Killiyar and also that on Parvathiputhanar, there are residences which are having no toilets.
2.	Toilet waste disposal	2.1	Providing of community/individual DEWATS systems for sewage and grey water for the 8150 (7000+1132) residences having discharge into rivers, soak pit. Grey water is also to be diverted to the above DEWATS system in the unsewered area Or Provide sewerline with pumping station	Thiruvananthapuram Corporation Kerala Water Authority Revenue department Irrigation department and Local Self Government is to allocate the space	Three months for DEWATS or Two years for sewer line and pumping stations				The discharge from septic tank is also to be diverted to DEWATS
3.	Community toilets	3.1	Construction of new community toilets with treatment system	Thiruvananthapuram Corporation Kerala Water Authority Suchitwa Mission	Six months				In the sanitation survey of Parvathiputhanar, construction of new community toilet from 100 people at Pattom side of bund was proposed by SEUF.

				Revenue department Irrigation department and Local Self Government is to allocate the space					
		3.2	Maintenance of existing community toilets and providing of treatment system	Thiruvananthapuram Corporation Suchitwa Mission	Three months				Maintenance of existing community toilets and construction of modern septic tank to 100 people at bund colony in ward Kunnukuzhy ward near Thekkummoodu
4.	Sewered area	4.1	Frequent block, back flow to toilets identified in the survey are to be rectified Temporary measures such as bucket cleaning	Kerala Water Authority	Temporary measures- 3 months				1861 residences are connected to sewer in the area near to river Poojappura, Jagathy, Valiyasala, Chalai, Karamana, Nedumcaud,
		4.2	Permanent solution to prevent overflow through manholes, pipelines and pumping stations	Kerala Water Authority	Augmentation of pipeline –one year				Proposal of Kerala Water Authority is to be as per concept plan
		4.3	Stop the overflow of sewage into drains, and rivers and alternate mechanism is to be in place for stopping the overflow. Ascertain the adequacy of existing old sewer pumping lines, mainlines, sub lines/manholes in the area especially in	Kerala Water Authority	One month				

			blocks A, B, and C of sewerage network and revamp it. Adequacy of sewer line in Block B in Thampanoor and East Fort is to be checked. The quantity of water consumption in this area and the quantity of sewage reaching common STP is to be ascertained						
		4.4	KWA is to do systematic analysis of sewer line blockage date and find out source and probable entry points of solid wastes into the sewer system. With this information Corporation, and PCB to conduct inspection	Kerala Water Authority	One month				
		4.5	Silt trap to prevent the entry of sediment to sewer system	Kerala Water Authority Thiruvananthapuram Corporation					
		4.6	Entry of rain water into the sewer system is to be stopped	Thiruvananthapuram Corporation and Kerala Water Authority	One year				
		4.7	Rain water harvesting/ground water recharge is to be provided wherever possible	State Ground Water Department	One year				

				Thiruvana nthapuram Corporati on					
		4.8	Entry of solid wastes including sanitary napkin is to be prevented By inspections and by providing facilities such as Modular type incinerator for sanitary disposal facility in hostels, hotels, flat, hospitals, establishments	Thiruvana nthapuram Corporati on Kerala Water Authority	Six months				
		4.9	Septage treatment facility is to be in place as reported. Septage collection and disposal of private parties is to be regularized. Online system shall be implemented to ensure disposal of septage at treatment plant. Revenue shall be shared with Corporation and water authority	Thiruvana nthapuram Corporati on Thiruvana nthapuram Corporati on	Sixmo nths				
5.	Solid wastes	5.1	Awareness is to be created in the ward for the segregation, treatment and disposal of solid wastes as per Solid Wastes Management Rules, 2016.	Thiruvana nthapuram Corporati on Pollution Control Board Health Departme nt	Three months				
		5.2	Aero composting and Material Collection Facility in all 45 wards near river bank	Thiruvana nthapuram Corporati on	Three months		45	225 lakh	The setting of each aero composting and material collection facility will cost 5 lakh including setting up of shed, leveling of

									land etc.
		5.3	Aero composting and Material Collection Facility in other areas of all 45 wards	Thiruvananthapuram Corporation	Three months		180	900 lakh	
		5.4	Aero composting and Material Collection Facility in other areas of all 55 wards	Thiruvananthapuram Corporation	Three months		275	1375 lakhs	
		5.5	Adequate number of kitchen bins shall be provided	Thiruvananthapuram Corporation	Three months				
6.	Market		Providing proper waste handling facility for waste water and solid wastes Kannettumukku Pangode	Thiruvananthapuram Corporation	Six months				
7.	Rendering plant		Rendering plant for poultry wastes	Thiruvananthapuram Corporation	Six months				
8.	Slaughter house and rendering plant		Slaughter house	Thiruvananthapuram Corporation	Six months				
10.	Flats and establishments		Strict monitoring of waste disposal (sewage, sullage, biodegradable waste, non-biodegradable waste) in flats, offices, educational institutions, shops, lodges, auditoriums in surveyed area and also in the catchment of the river i) Verify whether consent to operate of the Board exists ii) Verify on compliance of consent	Pollution Control Board, District Office, Thiruvananthapuram Thiruvananthapuram Corporation	Once in three months				

			conditions in the consent to operate iii) Treated sample should be taken from the flats/establishments once in a month. iv) Ensure proper treatment and disposal facility for sewage, sullage and garbage in the flats and establishments v) Monthly progress report is to be submitted by the District Office to Head Office						
11.	Establishments namely service station, workshops		Strict monitoring of waste disposal (effluent, waste oil and solid wastes) in service station, workshops in surveyed area and also in the catchment of the river i) Verify whether consent to operate of the Board exists ii) Verify on compliance of consent conditions in the consent to operate iii) Treated sample should be taken from the flats/establishments once in a month. iv) Ensure proper treatment and disposal facility for waste water in the establishments	Pollution Control Board, District Office, Thiruvananthapuram Thiruvananthapuram Corporation	Once in three months				

			v) Monthly progress report is to be submitted by the District Office to Head Office						
12	Industrial units namely Hindustran Latex Limited, Thiruvananthapuram Dairy, K.S.R.T.C, Central works Pappanamcode, Popular vehicles and services ltd, Killipalam,		Strict monitoring of waste disposal (effluent, solid wastes, sludge) in industrial units in surveyed area and also in the catchment of the river i) Verify whether consent to operate of the Board exists ii) Verify on compliance of consent conditions in the consent to operate iii) Treated sample should be taken from the flats/establishments once in a month. iv) Quantity of treated water generated and the quantity of water reused) iv) Ensure proper treatment and disposal facility for waste water in the establishments v) Monthly progress report is to be submitted by the District Office to Head Office	Pollution Control Board, District Office, Thiruvananthapuram	Once in three months				
13.	Sanitation survey is to be done for		Sanitation survey is to be conducted for 100m on either sides of the Nedumangad	Pollution Control Board, District	Three months				

	Neduman gad town		town and of 10 m on either sides of polluted streams if any located near Killiyar	Office, Thiruvana nthapuram					
14,	Sanitatio n survey is to be done beyond other parts of the city		Sanitation survey is to be conducted for 100m on either sides of the other parts of streams namely Ulloor stream, Pattom stream, Kannamoola stream, Thekkanankara canal and Parvathy Puthanar and of 10 m on either sides of polluted streams if any located nearby	Pollution Control Board, District Office, Thiruvana nthapuram	Three months				
15.	Water quality monitori ng of Karaman a and Killiyar		Water quality monitoring of different stations of Karamana and Killiyar, and its streams and submission of water quality report once in four months	Pollution Control Board, District Office, Thiruvana nthapuram	Once in four months				
16.	Awarene ss		Awareness for residence association:	Suchitwa mission/L SGD/Corp oration	Once in a month				
17	Training on solid waste and liquid waste managem ent		Training to children, youth, Asha workers and other stakeholders	Suchitwa mission/L SGD/Corp oration	Once in a month				
18.	Capacity building		Capacity building of community groups, monitoring system and active involvement of residence association is necessary		Once in a month				

CHAPTER II

PLAN/STUDIES ON ABATEMENT OF POLLUTION OF RIVER KARAMANA

2.1 General

The river Karmana, the second longest river (68 km) in the Thiruvananthapuram district has been taken for the study. The River originates in the Chemmunji Peak and the Adurai Malai of the Western Ghats and flows west. It is formed by the confluence of several small streams like the Kavi Aar, the Attai Aar, the Vaiyapadi Aar and the Thodai Aar. The River Karamana has a catchment area of 702 sq. km, lying entirely within the Thiruvananthapuram district. The river basin is bounded by the Vamanapuram river basin on the north and the Neyyar Basin on the south. Thiruvananthapuram, the capital of Kerala is situated in this river basin. The Corporation of Thiruvananthapuram is having an area of 74.93 sq.km with a population of 8, 89, 191 as per the 2001 census. The river skirts through the boundary of the City. Nedumangad town and the grama panchayaths of Aryanad, Karakulam, Vilavoorkkal, Vilappil, Nemom, Thiruvallom etc., are situated in this River Basin. Fig. 2.1 shows the Karamana River Basin.

Killiyar which starts from the Nedumangad Hills is the main tributary of the river Karmana. It is having a length of 24 km. It flows through the Thiruvananthapuram City and joins the river Karmana at Pallathukadavu. The T. S (Thiruvananthapuram-Shornur) Canal meets the river Karamana at Moonnattumukku. The Canal flow through the thickly populated areas of the Thiruvananthapuram city namely Poonthura, Vallakkadavu and Chackai. The River then empties into the Arabian Sea near Pachalloor. Fig. 2.2 shows water bodies of Thiruvananthapuram city.

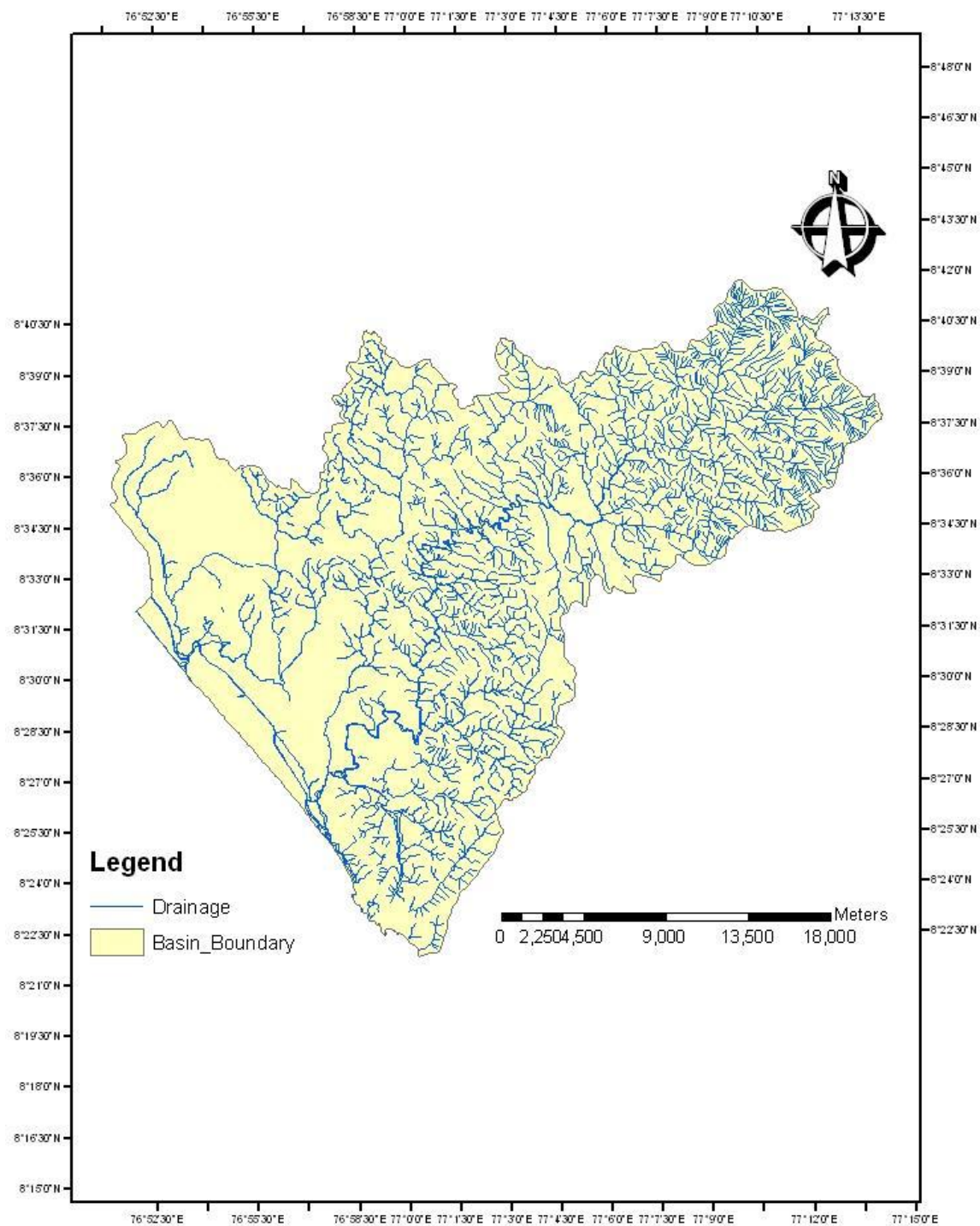


Fig 2.1 Catchement area of Karamana river(Report of Rites)

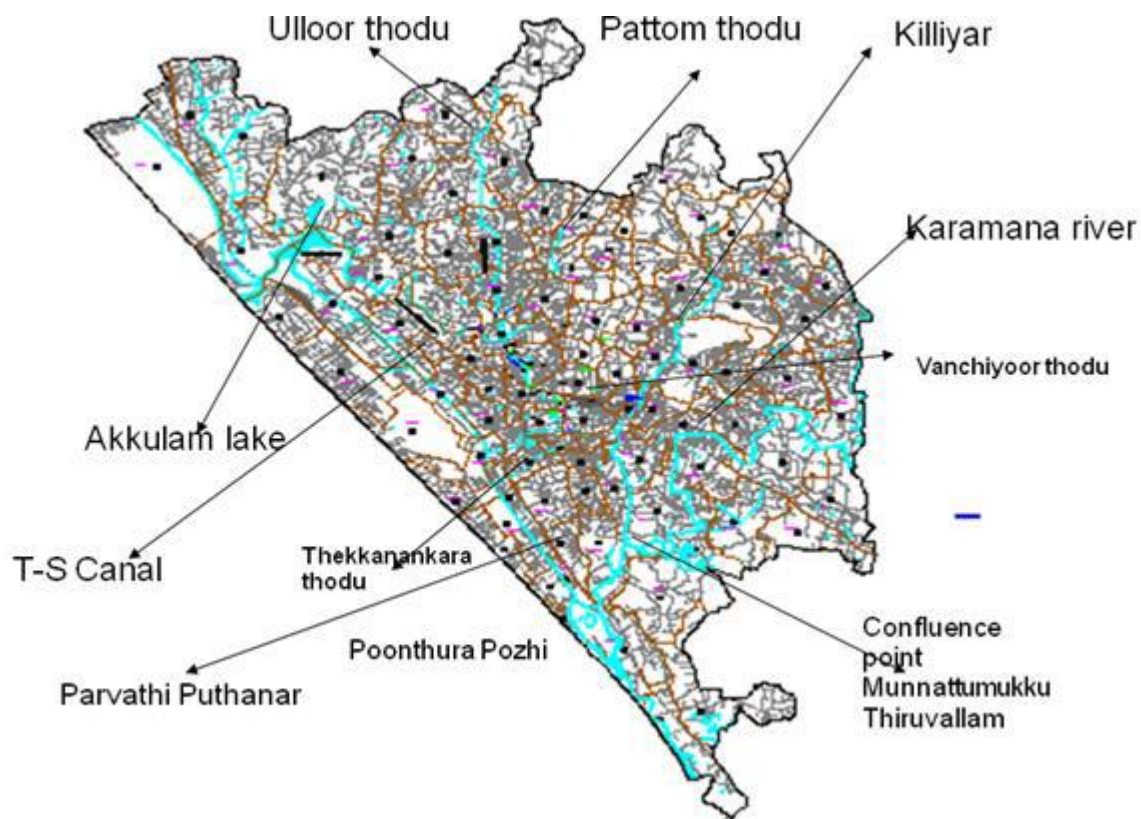


Fig. 2.2 Water bodies of Thiruvananthapuram city(Report of Rites)

2.2 Monitoring conducted by the Kerala State Pollution Control Board

The Pollution Control Board is conducting monthly water quality monitoring of River Karamana and Killiyar. The recent monitoring report is given below in Table study revealed that total coliform and fecal coliform count are very high. Total coliform count in Karamana river varies from 39000 to 53000 in the city area and fecal coliform count varies from 5000 to 18800 in the city area. For Killiyar, it varies from 4000 to 12200 MPN/00ml and from 1000 to 8500 MPN/100ml in city area.

Table . 2.1 Karamana river monitoring report by KSPCB

KARAMANA RIVER MONITORING						
Date of Sampling : 2/9/2018 September						
Sampling Station Parameters	Peppara	Aruvikkara	Mangattukadu	Pallathukadave	Thiruvallam	Moonattumukku
pH	6.9	6.7	6.6	6.8	6.5	6.4
Temperature °C	31	31	31	31	31	31
Total Suspended Solids mg/l	13	34	35	44	140	280

Conductivity μ mhos/cm	28	102	95	386	225	662
Chlorides mg/l	23	17	36	156	58	136
Total Hardness mg/l	38	36	68	158	56	195
DO mg/l	6.9	7	6.4	6.5	2.8	1.2
BOD mg/l	1.3	1.7	1.5	1.6	8.9	6.2
COD mg/l	4	4	4	4	30	48
TKN mg/l	BDL	BDL	BDL	BDL	2.6	BDL
Ammo.Nitrogen mg/l	BDL	BDL	BDL	BDL	1.9	1
Sulphates mg/l	BDL	BDL	BDL	BDL	1	41
Total Coliform/100 ml	100	110	2500	53000	52000	39000
Fecal Coliform/100ml	80	79	1600	5000	4200	18800

Table . 2.2 Killiyar river monitoring report by KSPCB

KILLIYAR RIVER MONITORING					
Date of Sampling : 2/9/2018 September					
Sampling Station Parameters	Karipur	Vazhayila	Maruthamkuzhy	Jagathy	Killipalam
PH	6.9	6.7	6.3	6.8	6.5
Temperature °C	32	32	32	32	32
Total Suspended Solids mg/l	16	18	15	29	35
Conductivity μ mhos/cm	68	150	154	208	176
Chlorides mg/l	27	36	39	53	68
Total Hardness mg/l	36	46	48	76	116
Calcium Hardness mg/l	23	33	35	48	78
Magnesium Hardness mg/l	13	13	23	28	38
DO mg/l	6.2	6.3	5.9	2	1.9
BOD mg/l	1.7	1.6	1.8	6.5	6.1
Total alkalinity mg/l	20	24	26	35	34
Ammo.Nitrogen mg/l	BDL	BDL	BDL	BDL	BDL
Sulphates mg/l	0.6	3	4.2	7.8	8.4
Total Coliform/100 ml	250	710	4000	7200	12200
Fecal Coliform/100ml	50	340	1000	3500	8500

2.3 Approved Concept plan on 28-12-2017

As per order dated 15-11-2017 in O.A. 302/13 filed by The Edayar Residents Association of the National Green Tribunal, Chennai, Concept plant prepared by Kerala State Pollution Control Board, Irrigation Department, Kerala Water Authority and Thiruvananthapuram Corporation was approved. The action to be taken by different departments are given below:

2.2.1 Kerala State Pollution Control Board

- Sanitation survey
- GIS database
- Monitoring of rivers and streams
- Inspection of sewage treatment plant of flats, hospitals, commercial establishments
- Inspection of solid waste treatment in flats, hospitals, commercial establishments etc

2.2.2 Kerala Water Authority

- Stop the overflow of sewage into drains, and rivers and alternate mechanism is to be in place for stopping the overflow.
- Ascertain the adequacy of existing old sewer pumping lines, mainlines, sub lines/manholes in the area especially in blocks A, B, and C of sewerage network and revamp it.
- Adequacy of sewer line in Block B in Thampanoor and East Fort is to be checked. The quantity of water consumption in this area and the quantity of sewage reaching common STP is to be ascertained
- KWA is to do systematic analysis of sewer line blockage date and find out source and probable entry points of solid wastes into the sewer system. With this information Corporation, and PCB to conduct inspection
- Special attention is to be paid for the manholes in the low lying area and those near flats, hotels, hospitals.
- Ensure that sewer line from individual house/flat/establishments/hospitals connected to sub line/main line so that no leakage to road side drain/gutter.
- Water Authority is to give utmost priority to four pumping stations namely Thaliyal, Pattom, Murinjapalam and Kannamoola. The availability of spare pump is to be ensured.
- A GIS database showing the location of sewer pipelines, manholes, pumping lines. The low lying area with n sewerage connection, frequently blocking area, residences/flats/hotels with sewerage and no sewerage connection to be included
- Septage treatment facility is to be in place. Septage collection and disposal of private parties is to be regularized.
- Online system shall be implemented to ensure disposal of septage at treatment plant. Revenue shall be shared with Corporation and water authority
- Silt trap to prevent the entry of sediment to sewer system

- Disposal of solid waste including napkins into sewer system is to be stopped
- Entry of rain water into sewer system is to be stopped
- Ground water recharge is to be encouraged wherever possible

2.2.3 Irrigation Department

- Identification of illegal outlets into drains
- Ensure adequate capacity of road side drains
- Measures to stop disposal of solid wastes
- Renovation of two ponds in Jagathy
- Providing of shutters for Kuriyathy and Kannettumukku stream

2.2.4 Thiruvananthapuram Corporation

- Adequate number of aerobins in 100 wards. Minimum five in each ward
- Adequate number of kitchen bin in 100 wards
- Adequate number of solid waste treatment in 100 wards
- For newly constructed building, sewage and sullage are to be separated. Sewage to toilet linked biotanks and septic tank
- Prevention of disposal of solid wastes and sanitary napkins into sewer system
- Proper segregation and disposal of sanitary napkins, diapers etc.
- Disposal of such waste in hospitals, hotels, flats to be carefully monitored.
- Rendering plant is to be constructed

2.4 Study by the Department of Irrigation through RITES

The Water Resources Department in Government of Kerala prepared the action plan for the pollution abatement of Karamana and Killiyar vide G.O.(Rt)No. 658/12/WRD dated 2-6-2012 as the stretch of the Karamana river at Moonattumukku has been classified as polluted stretch by Central Pollution Control Board. Water quality monitoring stations were set up in stretch of Karamana river passing through the Thiruvananthapuram city area and through the entire stretch of the Killiyar.

The conclusions are the present use of the river water has got reduced due to polluted river water within city limit; the sources of pollution is drain and house outlets. The drains carry sullage and effluent from the sources like

restaurants, garages, hospitals etc; about 19 wards of Thiruvananthapuram Corporation, and three panchayath areas were found as major contributor of pollution; other sources of pollution is dumping of solid wastes, disposal of animal dead body etc., the major sources of pollution to the river Karamana is due to discharge of sewage from the sewage farm through Parvathy Puthanar and there is no disposal system for dead animals. The pollution factors in the river are high value of BOD and bacteriological counts and total dissolved solids in water.

The main recommendations are to set up two more sewage treatment plant of 100MLD capacity. Four numbers of sanitary landfills of 130TPD each are to be provided at four locations. Carcass incinerator was suggested. Green bio-tech floating island and landscaping/parks for beautification of river was also proposed. The cost of implementation of pollution abatement measures was estimated to be Rs. 513 crore.

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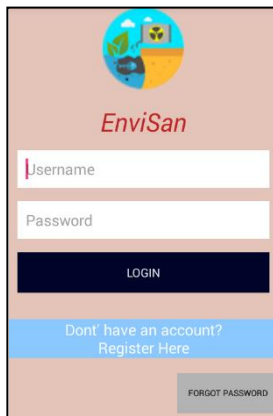
CHAPTER III

SANITATION SURVEY OF KARMANA-KILLIYAR

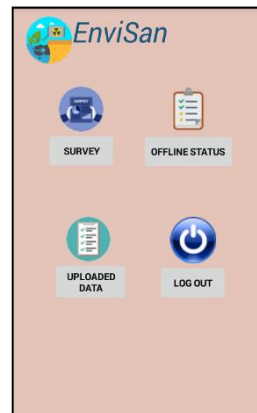
The pollution of Karamanariver is mainly in its downstream where Killiyar joins. Killiyar is polluted due to the domestic wastes when it passes through the city area. One of the decisions of concept plan is to conduct sanitation survey of the area i.e 250m on either sides of the Karmana and Killiyar when it passes through the Thiruvananthapuram city. 6 polluted streams are also joining the Killiyar and sanitation survey was also conducted on either sides of these streams.

3.1 EnviSan – Mobile Application

The mobile application can be installed on android mobile phones and the home page view of the mobile application is shown below.

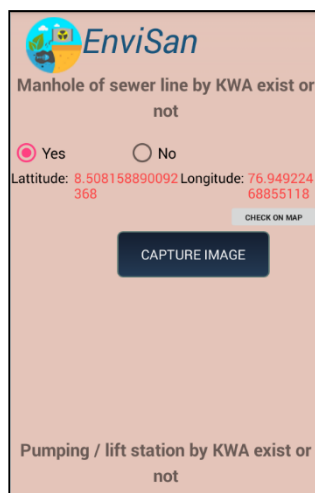


The login screen features the EnviSan logo at the top. Below it are input fields for 'Username' and 'Password', followed by a 'LOGIN' button. At the bottom, there is a link for 'Forgot Password' and a button for 'Register Here' for users who do not have an account.

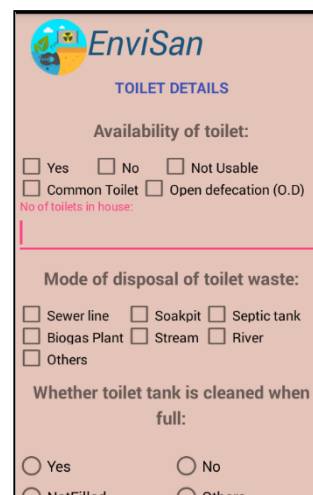


The home screen displays four main functional buttons: 'SURVEY', 'OFFLINE STATUS', 'UPLOADED DATA', and 'LOG OUT', each accompanied by a relevant icon.

The user has to register himself the first time by providing his credentials such as name, a username, email, mobile number, and a password. Care is to be taken to note down his/her username and password as it is to be used for login purposes. In case the username and password is forgotten, click on the “forgot password” option to retrieve the username and password. After the username and password is retrieved it can be used to login into the mobile application.



This section of the survey form asks if a 'Manhole of sewer line by KWA exist or not' with 'Yes' and 'No' radio button options. It displays the current 'Latitude: 8.508158890092' and 'Longitude: 76.94922468855118', with a 'CHECK ON MAP' link. A 'CAPTURE IMAGE' button is provided for location verification. At the bottom, it asks if a 'Pumping / lift station by KWA exist or not'.



This section contains 'TOILET DETAILS'. It asks about the 'Availability of toilet:' with options for 'Yes', 'No', and 'Not Usable', and further specifies 'Common Toilet' or 'Open defecation (O.D)'. It also includes a field for 'No of toilets in house:'. Below this, it asks for the 'Mode of disposal of toilet waste:' with options like 'Sewer line', 'Soakpit', 'Septic tank', 'Bioqas Plant', 'Stream', 'River', and 'Others'. Finally, it asks 'Whether toilet tank is cleaned when full:' with 'Yes', 'No', 'Not Filled', and 'Others' options.

After successful installation the current location is verified in google map and the type of asset is selected, the local body is selected and image is captured and uploaded successfully. The necessary fields are to be filled.

The details such as grey water from kitchen, washing, bathroom details are to be filled. The details of manholes, blocks, joins, pumping etc. are to be collected and corresponding photos. The details of toilet and septic tank etc. are also to be filled.

EnviSan

DRINKING WATER DETAILS

Drinking Water source:

☐ KWA Connection ☐ Own well ☐ Stream
☐ Common tap ☐ Own tube well
☐ Tanker ☐ Common well ☐ Bottle water

Whether drinking water is purified :

☒ Yes ☐ No

Type of purification :

☐ Boiled ☐ Chlorinated
☐ Filtered ☐ Others

Enter remarks if any:

DESEASE DETAILS

EnviSan

Any vector borne/water borne disease in their family in 12 months :

☒ Yes ☐ No

Mention type of disease:

☐ Diarrhoea ☐ Cholera ☐ Typhoid
☐ Jaundice ☐ Chikunguniya
☐ Dengue fever ☐ Malaria ☐ Filaria
☐ Others

Enter remarks if any:

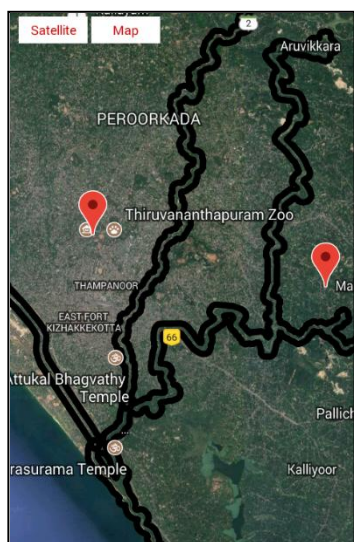
GARBAGE DETAILS

Segregation practised in house :

☐ Yes ☒ No

Mode of disposal of biodegradable

The drinking water source, details about its purification, any vector borne disease affect in last 12 months, mode of disposal of biodegradable waste etc. are to be entered. The quantity of plastic waste generated, glass waste generated, scrap waste generated, e-waste generated etc. is to be specified and corresponding photograph is to be uploaded.



The map view tab of the mobile application helps the user to view the plotted assets and view its details. The asset type, asset name, owners name, district etc. can be viewed and their location can also be viewed in the google map.

3.2 Residences

3.2.1 Classification based on Wards

The survey conducted in a total distance of 250 m on either side of the Karamana and Killiyar passing through the Thiruvananthapuram City and also 10 m on either side of the identified polluted streams. Envisan application portal is given in Fig. 2.1. Survey was conducted in 45 wards of the Thiruvananthapuram Corporation. Table 2.1, Table 2.2 and Fig. 2.2. Consolidated list of survey in different wards is given. Table 2.3 shows the list of wards and the number of residences surveyed in each ward. The maximum number of residences are surveyed in the wards of Valiyasala, followed by Thiruvallom, Attukal, Sasthamangalam, Kalady, Poonthura, Karamana, Jagathy, Ambalathara, Pappanamcode, Thururthumoola, Vellar, Nedumcaud, Thrikkanpuram, Pangode and Poojappura. The residences fall in the range of 786 to 226.

Table 3.1 Consolidated report in different wards

Ward Name	Residences	Establishment	Flats	Other Assets					
				Manhole	Pumping	Blocks	Joins	Others	Sub-Total
Ambalathara	422	10	1	3	Nil	1	3	11	18
Arannoor	121	28	1	19	3	1	Nil	26	49
Attukal	736	20	1	432	10	6	15	130	593
Chalai	45	6	Nil	109	2	4	6	21	142
Estate	124	1	Nil	5	Nil	1	Nil	Nil	6
Jagathy	393	45	6	16	Nil	6	2	48	72
Kachani	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	0
Kalady	737	22	Nil	81	1	Nil	5	19	106
Kalippankulam	20	Nil	Nil	28	1	5	2	15	51
Kanjirampara	101	Nil	1	Nil	Nil	Nil	Nil	Nil	0
Karamana	153	14	Nil	71	1	12	12	13	109
Kodungannoor	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	0
Kowdiar	2	Nil	Nil	Nil	Nil	Nil	Nil	Nil	0
Kudappanakkunnu	11	7	1	4	Nil	Nil	Nil	5	9
Melamcode	244	36	Nil	1	Nil	Nil	1	8	10
Mudavanmughal	157	5	Nil	3	Nil	Nil	4	Nil	7
Nedumcaud	379	33	Nil	240	8	4	16	75	343
Nemom	28	Nil	Nil	4	Nil	Nil	Nil	Nil	4
Nettayam	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	0
Pangode	132	32	Nil	1	Nil	Nil	Nil	14	15
Pappanamcode	438	35	1	23	Nil	Nil	1	2	26
Peroorkada	364	6	1		Nil	Nil	2	1	29 3

Poojapura	279	29	2	11	Nil	1	4	65	81
Poonthura	606	12	5	3	Nil	Nil	Nil	5	8
PTP Nagar	1	Nil	Nil	Nil	Nil	Nil	Nil	Nil	0
Punchakkari	21	Nil	Nil	Nil	Nil	Nil	Nil	Nil	0
Punnakkamughal	16	3	Nil	Nil	Nil	Nil	Nil	Nil	0
Sasthamangalam	259	52	Nil	1	1	2	1	4	9
Thampanoor	Nil	Nil	Nil	12	Nil	Nil	Nil	Nil	12
Thirumala	28	Nil	Nil	1	Nil	Nil	Nil	Nil	1
Thiruvallam	699	43	Nil	1	Nil	1	17	32	51
Thrikkannapuram	203	Nil	Nil	10	Nil	Nil	Nil	Nil	10
Thuiruthumoola	398	44	Nil	33	Nil	Nil	1	14	48
Thycaud	1	Nil	Nil	1	Nil	4	Nil	Nil	5
Valiyasala	856	118	5	48	2	14	14	111	189
Valiyavila	33	Nil	Nil	Nil	Nil	Nil	Nil	Nil	0
Vattiyoorkavu	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	0
Vazhottukonam	nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	0
Vazhuthacaud	34	11	1	Nil	Nil	1	Nil	2	3
Vellar	371	31	Nil	2	Nil	1	8	10	21
Total	9263	706	32	1204	33	108	180	670	2153

Table 3.2 Details of surveyed assets

Assets Plotted		Count
Residence		9263
Establishment		706
Others (Total - 2010)	Manhole	1204
	Pumping	33
	Blocks	108
	Joins	180
	Others	2153
Flats		32
Total Assets		12144

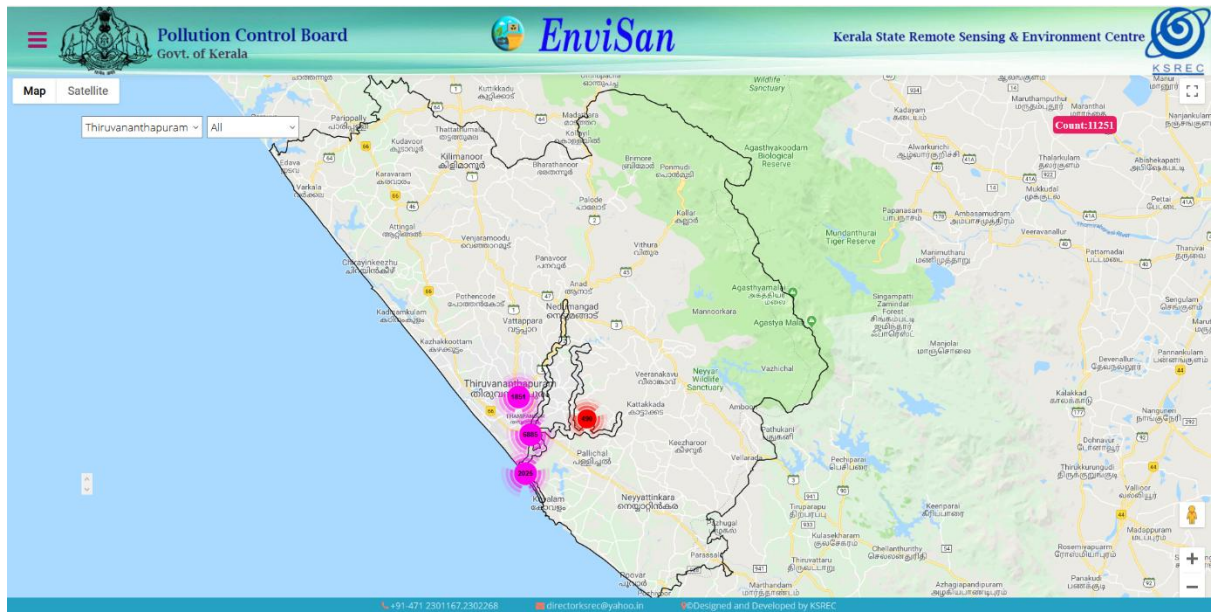


Fig. 3.1 EnviSan application portal

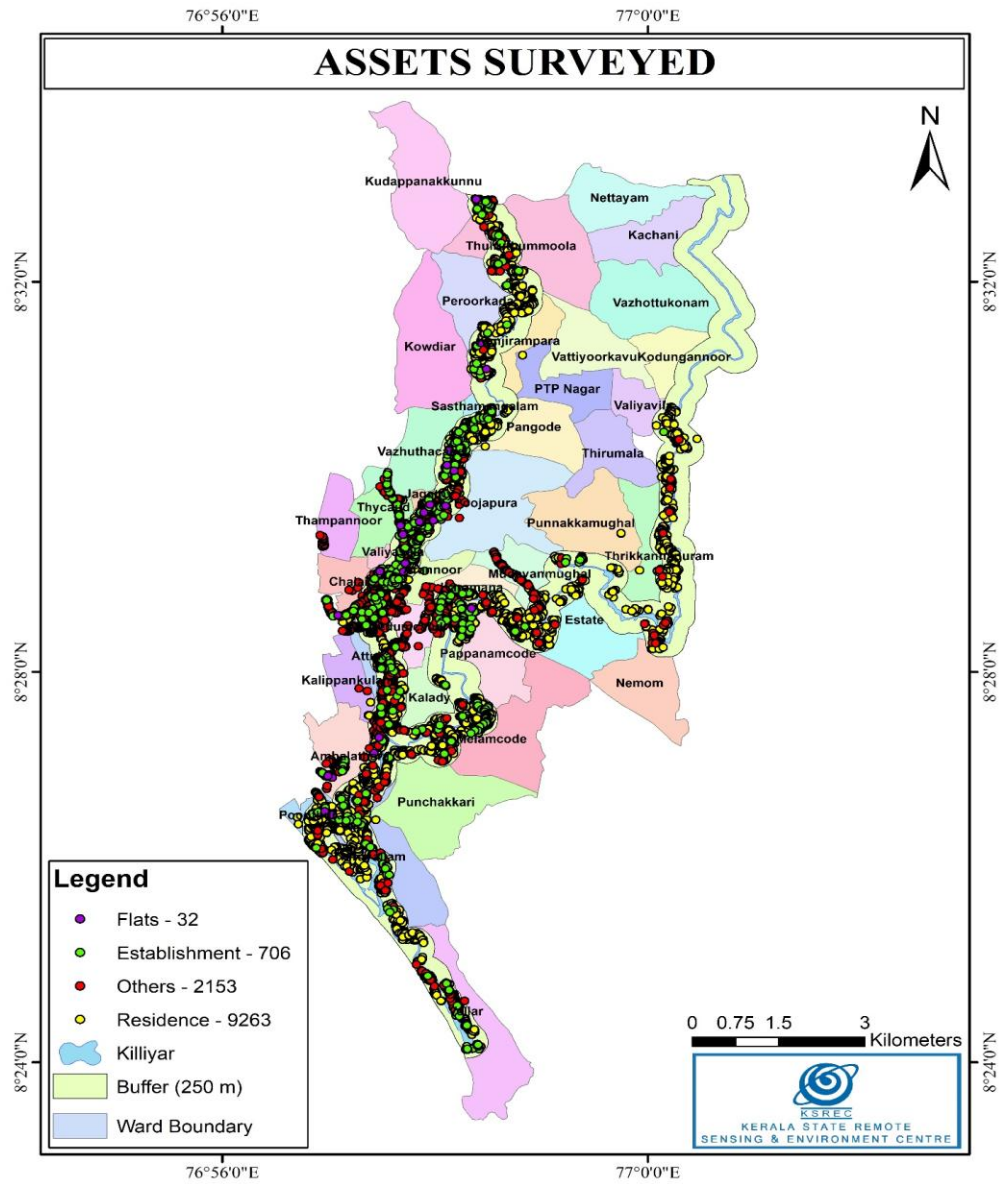


Fig. 3.2 Assets surveyed

Table 3.3 Details of Wards in which Survey Conducted

No.	Ward	Total number of residences surveyed	APL	BPL	EWS
1	AMBALATHARA	388	198	190	0
2	ARANOOR	59	55	4	0
3	ATTUKAL	702	415	276	12
4	CHALAI	71	52	19	0
5	ESTATE	105	72	32	1
6	HARBAR	11	5	6	0
7	JAGATHY	424	305	103	16
8	KALADI	438	306	110	22
9	KALIPPANKULAM	103	38	62	3
10	KAMALESWARAM	2	2	0	0
11	KANJIRAMPARA	72	49	19	4
13	KARAMANA	429	331	80	18
14	KODUGANOOR	32	26	6	0
16	KUNDAMANKADAVU	1	1	0	0
17	KURIYATHI	14	5	9	0
18	MANACAUD	67	67	0	0
19	MANIKAVILAKAM	146	40	98	8
20	MELAMCODE	141	117	24	0
22	MUDAVANMUGHAL	117	69	41	7
23	NEDUMCAUD	284	204	76	5
24	NEMOM	50	35	15	0
25	NETTAYAM	107	90	17	0
26	PANGODE	226	200	24	2
27	PAPPANAMCODE	356	292	53	11
28	PEROORKADA	124	108	16	0
29	PONNUMANGALAM	7	2	4	1
30	POOJAPPURA	167	145	22	0
31	POONTHURA	433	184	244	5
32	PUNCHAKARI	14	5	9	0
33	PUNNAKKAMUGHAL	9	8	1	0
34	PUTHENPALLY	81	43	37	1
35	SASTHAMANGALAM	505	395	75	33
36	THIRUMALA	61	55	6	0
37	THIRUVALLAM	738	557	180	1
38	THRIKANNAPURAM	259	191	68	0
39	THUCAUD	156	152	4	0
40	THURURTHUMoola	320	249	69	2
41	VALIYASALA	974	787	154	33
42	VALIYAVILA	78	55	22	1
43	VATTIYOORKAVU	10	4	6	0
44	VAZHUTHACAUD	17	14	1	2
45	VELLAR	295	120	173	2
		8593	6048	2355	190

3.2.2 Classification based on Economic Status

The survey conducted in 9263 residences, of which 5826 residences are Above Poverty Line (APL); 2552 residences in Below Poverty Line (BPL) and 194 residences are in Economic Weaker Section (Fig. 3.3).

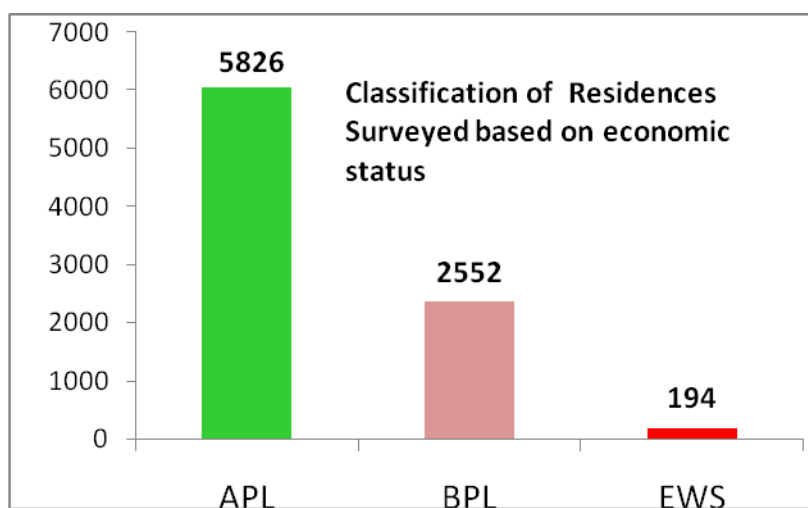


Fig. 3.3 Classification of residences surveyed based on economic status

The residences in the BPL category are more in Attukal, Poonthura, Ambalathara, Thiruvallom, Vellar, Valiyasala, Kalady and Jagathi (Annexure). The number varies from 276 to 103. More number of Economically weaker section are noted in Valiyasala, Sasthamangalam, Kalady, Karamana, and Jagathy.

3.2.3 Occurrence of vector borne diseases

The survey results show that (Table3.4) 176 water borne/water related diseases have been occurred in the area. The occurrence of vector borne disease namely dengue fever is maximum with 157 followed by Chikungunya, malaria and jaundice. The maximum cases of dengue fever occurred in Vellar, Thiruvallom and Poonthura and these places are situated in the downstream portion of the river.

Table 3.4 Occurrence of Vectorborne diseases

Ward	Dengue	Chikunguniya	Malaria	Jaundice
Ambalathara	4		1	
Attukal	1			
Jagathy	6	2		
Kalady	3			
Kanjirampara	8	1		1
Melamcode	6	1		
Mudavanmughal	1			
Netttayam	5			
Pangode	11			
Pappanamcode	6	2		
Peroorkada	2	2		
Poonthura	12			
Sasthamangalam	3	2		
Thiruvallom	32	2	3	
Thuruthumoola	6			
Thycaud	1	2		
Valiyasala	8			
Vattiyoorkavu	1			
Vazhuthacaud	1			
Vellar	40			
Total	157	14	4	1

3.2.4 Drinking water

Table 3.5 shows the water source in the wards in which survey was done. The tap water supplied by the Kerala Water Authority is used by 7927 residences. 218 residences depend on open well and 86 residence depend on tube well.

Table 3.5 Drinking water dependency of households

Drinking water source details	Count
Bottle water	11
Common tap	205
Common well	5
Kerala Water AuthoritConnection	7603
Tube well	60
Own Well	222
River	2
Data not obtained	1131
Total units	9263

3.2.5 Availability of toilets

Table 2.5 and Fig. 2.5 show the availability of toilets in different wards of the survey area. 46 residences are having no toilets (Manikavilakom-9, Puthenpally-6, Poonthura-5, Ambalathara-4, Attukal-2, one in Estate, Jagathy, Mudavanmughal, Thrikkannapuram, and Thycaud) , open defecation in 9 residences (Vellar-6, Ambalathara-2, Thiruvallom-1), 17 residences are using common toilets and two toilets are reported to be not useful. Toilet facility shall be given to these families as they are belonging to below poverty line.

Open defecation was practiced in 9 residences. Hence it is highly essential to provide toilets with proper treatment and disposal facility for 81 houses for the residences with not toilets/not usable/open defecation/using combined toilets. The open defecation practiced in six residences in Vellar, two residences in Ambalathara and in residence in Thiruvallom. The toilets are not available for nine residences in Manikkavilakom ward, six residences in Puthenpally, five residences in Poonthura, four residences in Ambalathara, two residences in Attukal and one each in Estate, Jagathy, Mudavanmughal, Thrikkannapuram, and Thycaud.

The vector borne diseases occurred in Vellar, Thiruvallom and Poonthura and these places are situated in the downstream portion of river, where the absence of toilets and open defecation are reported in the survey.

Table 3.6 Toilet Availability of Households

Toilet availability	Count
Available	8747
Not Available	46
Open defecation	9
Not usable	2
Common Toilet	17
Data not obtained	442
Total Units	9263

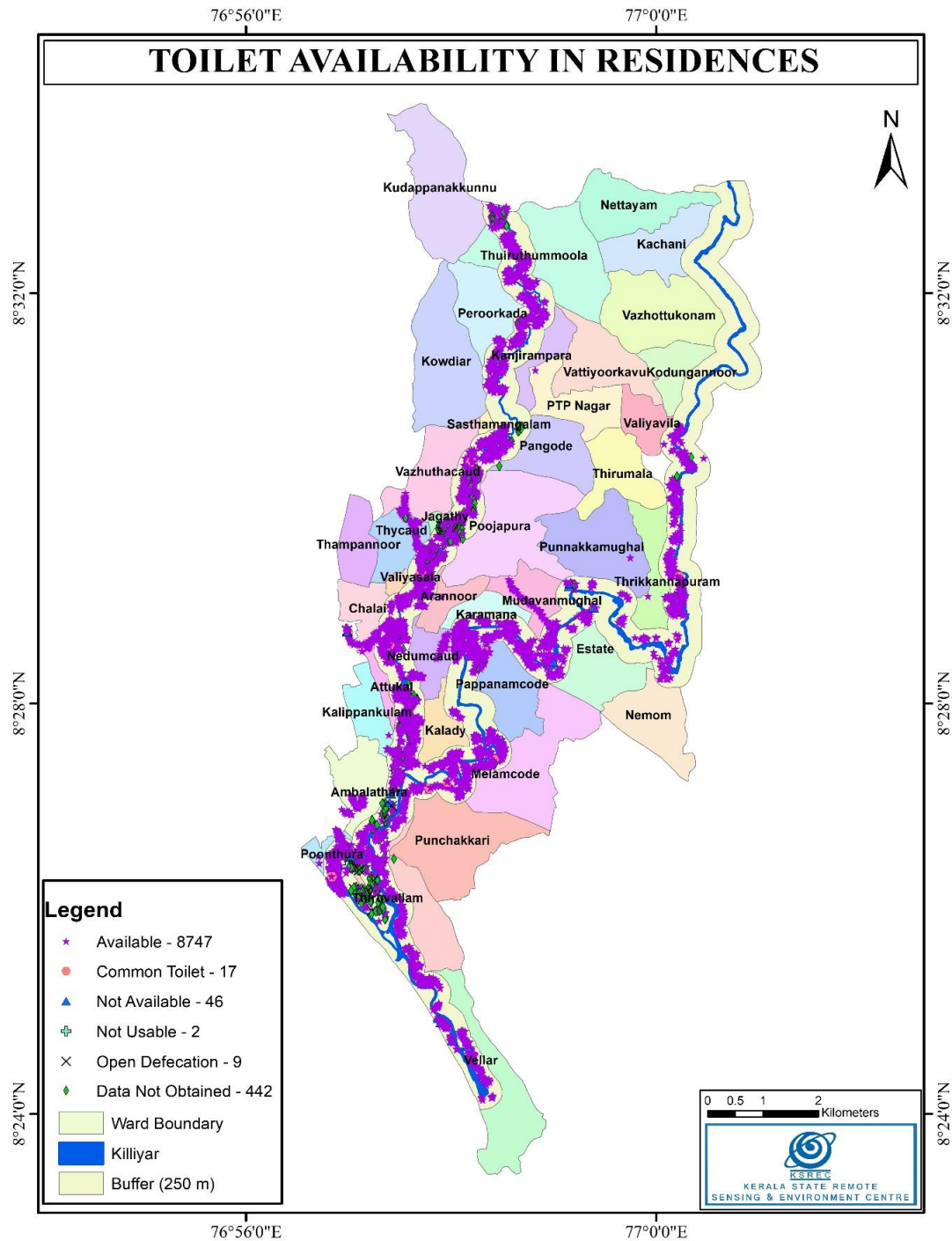


Fig. 3.4 Availability of toilets in residences

3.2.6 Toilet waste disposal

a) Rivers, soak pits

Annexure shows the details on the discharge of toilet wastes. The survey results show that toilet waste is discharged into rivers from 89 residences; into soak pit from 1201 residences; and into septic tank from 4810 residences. It is to be verified that system provided in low lying areas on the river banks is septic tank or not, as it is difficult to provide a proper system there due to high ground water table. The mentioned under others are to be checked and waste treatment system shall be in place.

b) Sewer

Regarding the sewer system, waste water is also discharged from 1961 residences into the sewer system available in 11 wards. The entry of grey water into the sewer system is to be prevented and the same is to be diverted to DEWATS for Grey water.

Further for the sewer system, frequent blocks, flow back into toilets, overflow through manholes during rains have also been reported from the wards of Jagathy, Poojappura, Valiyasala, Chalai, Karamana, Nedumcaud, and Attukal. The details are available in database and the same is to be rectified. Fig. 2.6 shows the mode of sewage disposal. Fig. 2.7 shows the location of manholes. Fig. 2.8 shows the distribution of areas of frequent blocks and overflow of manholes.

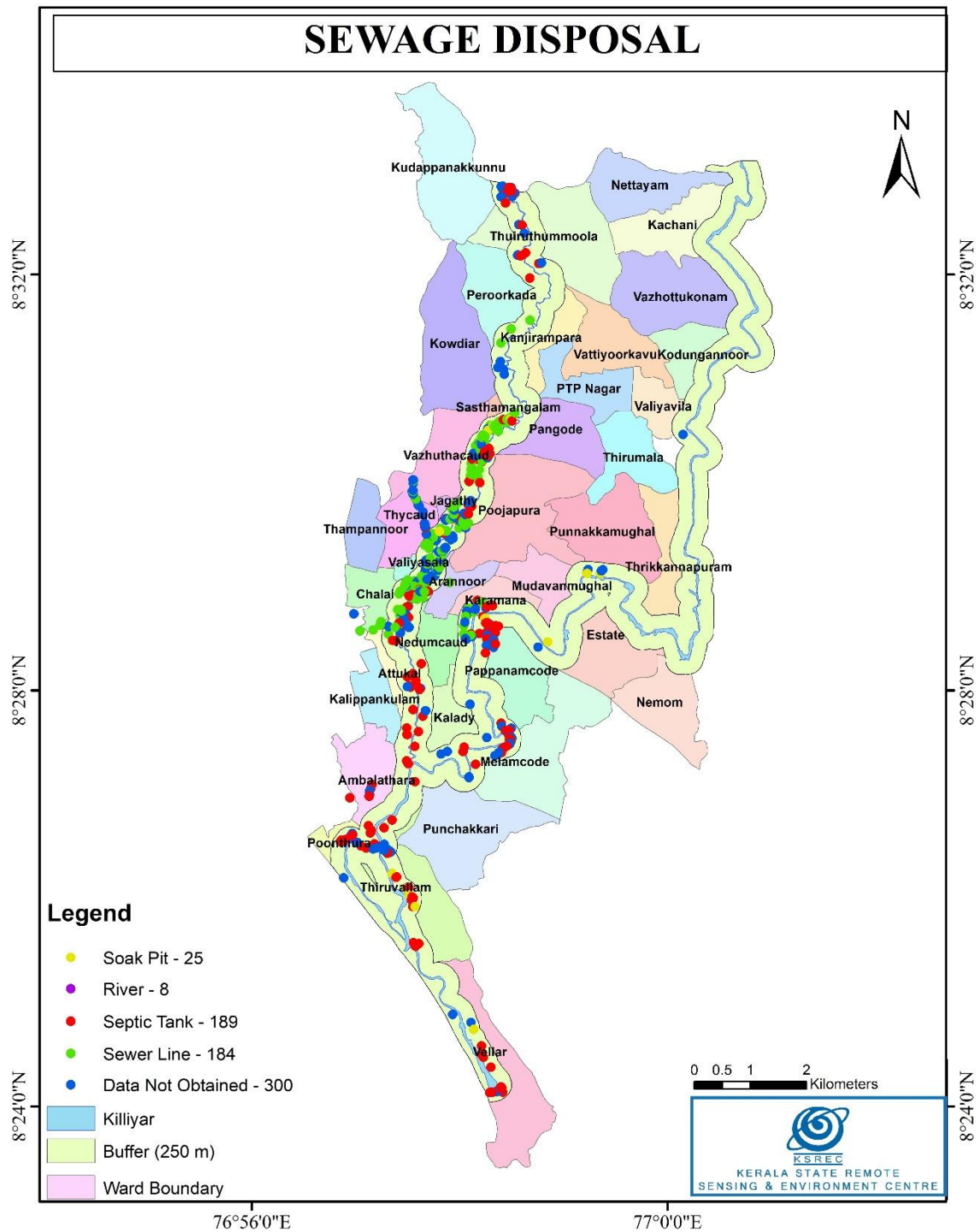
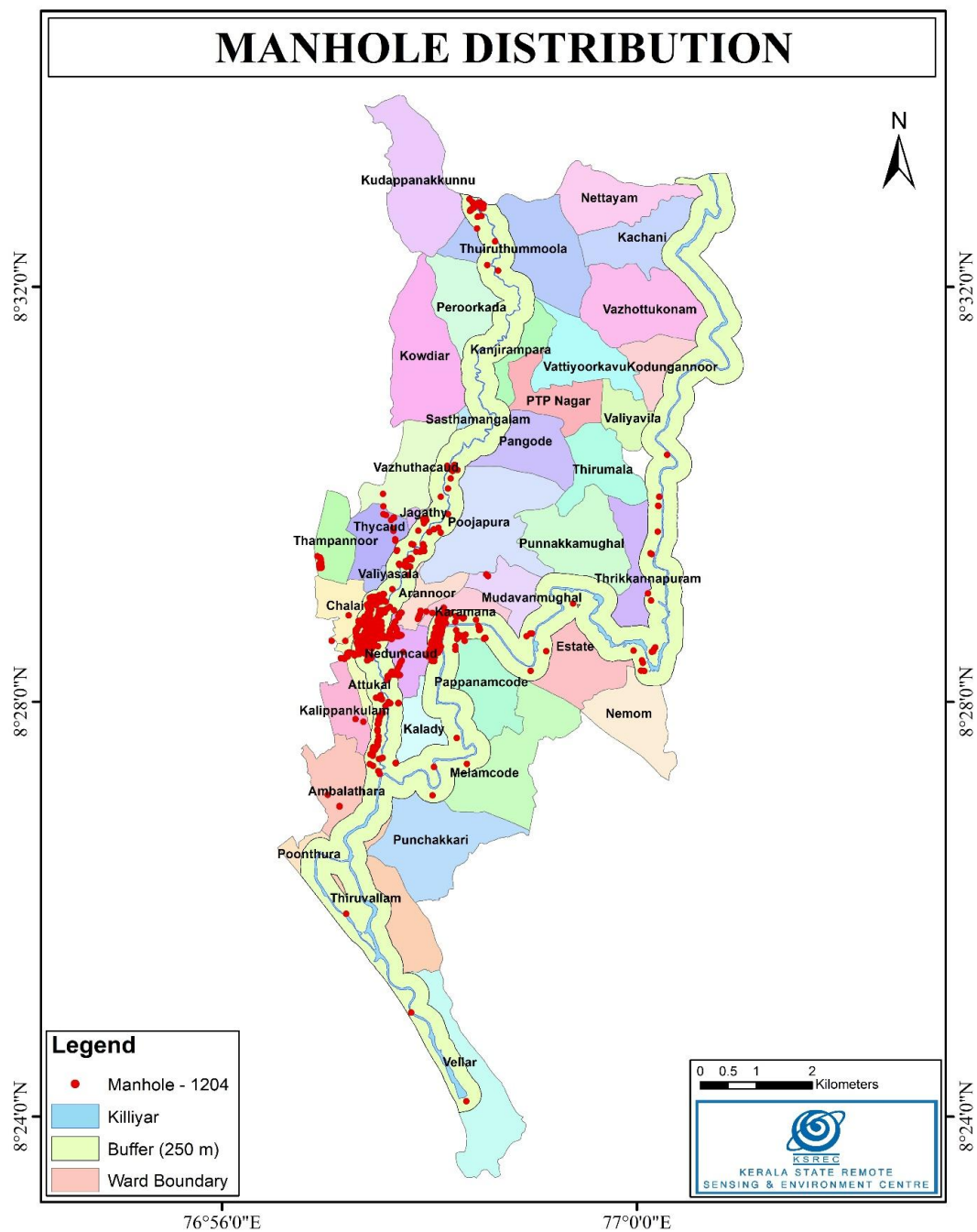


Fig. 3.5 Mode of sewage disposal

Fig.3.6
of



Distribution
manholes

Fig. 3.6 Distribution of manholes

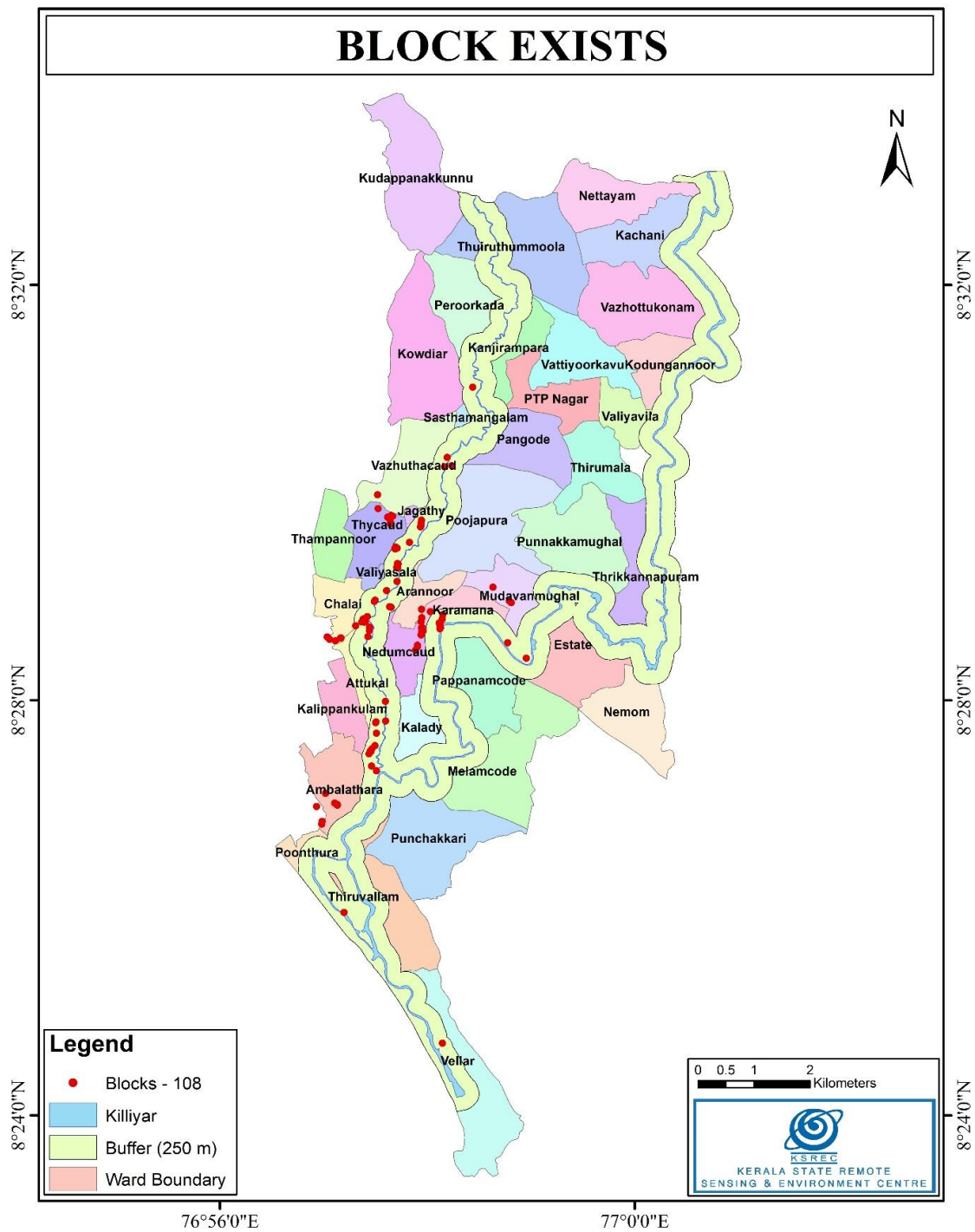


Fig.3.7 Location of blocks

3.2.7 Discharge of grey water

Annexure shows the survey results on the discharge of grey water from bathrooms. The results shows that grey water reaches the rivers, road, etc causing the contamination of river. Hence it is essential to provide DEWATS for grey water in the premises.

- Grey water from kitchen is discharged from 397 houses into river, 237 into road side drain, 2189 residences are discharging into septic tank, which may affect the functioning of septic tank. The practice of discharging into rivers is to be stopped and an alternate system is to be provided.
- Grey water from bathroom is discharge from 361 houses into river, 237 into road side drain, 2272 houses into septic tank, which is not recommended as grey water from bathrooms, contain soap and it will affect the functioning of septic tank. The practice of discharging into rivers is to be stopped and an alternate system is to be provided.

3.2.8 Segregation of solid wastes

Fig.2.2 shows the classification of residences based on segregation practiced. As per the Solid Wastes Management Rules, 2016, segregation of solid wastes is to be practiced. However as per the present survey, 84% of the residences are not segregating degradable wastes and non bio degradable wastes. Urgent initiative is to be taken by the Thiruvananthapuram Corporation to make aware about the mode of segregation/treatment/ disposal of solid wastes generated in the wards.

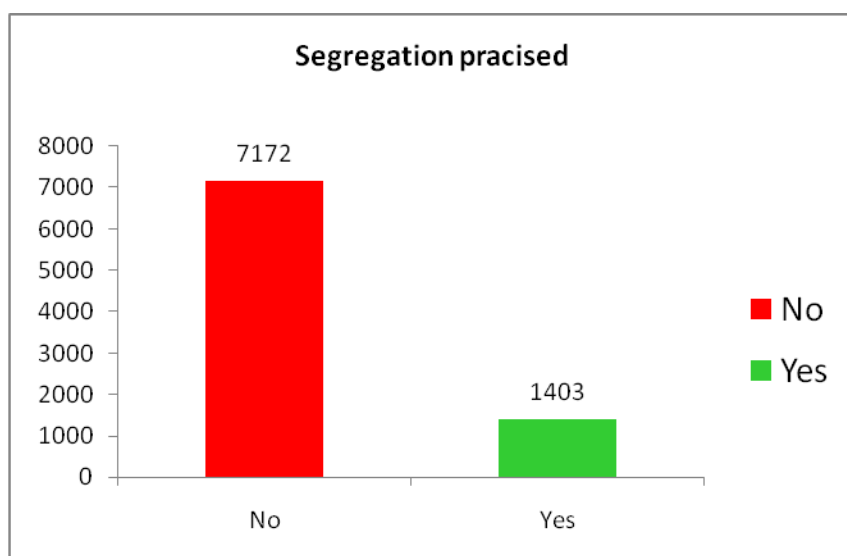


Fig 3.8 Classification of Residences based on Segregation

3.2.9 Mode of handling of biodegradable solid wastes

The survey output shows that biodegradable wastes from 638 residences are disposed into river (Fig. 2.3). The wastes are burnt in 1586 residences (Table 2.6). There is urgent need to provide proper biodegradable treatment and disposal facilities in these wards. 271 residences in Poonthura are disposing wastes into river followed by Manickavilakom and Thiruvalla. The burning of wastes is reported maximum in Attukal, Nedumcadu, Kalady, Thiruvallom and Sathamangalam.

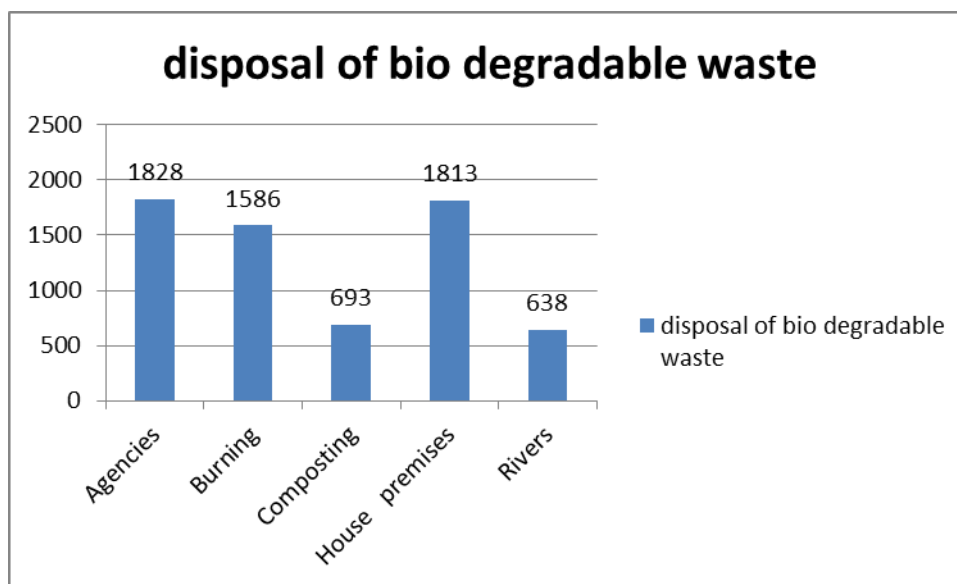


Fig. 3.9 Classification on the mode of handling of Biodegradable wastes

3.2.10 Mode of disposal of Non biodegradable wastes

- Non-biodegradable wastes from 412 residences are disposing into river. The wastes are burnt in 3017 residences. 246 residences in Poonthura are disposing wastes into river followed by Thiruvalla and Attukal. The burning of wastes is reported maximum in Thiruvallom (553) followed by Ambalathara, Vellar, Thuruthumoola, Kalady, Jagathy, Melamcode etc.
- 34 locations were identified where waste dumping was being done. Most of this is in water logged areas which homes the breeding ground of mosquitoes and these are in the proximity of the natural river.

There is urgent need to Material Collection Facility in this area for the proper collection of non-biodegradable wastes. 246 residences in Poonthura are disposing wastes into river followed by Thiruvalla and Attukal. The burning of wastes is reported maximum in Thiruvallom(553) followed by Ambalathara, Vellar, Thuruthumoola, Kalady, Jagathy, Melamcode etc.

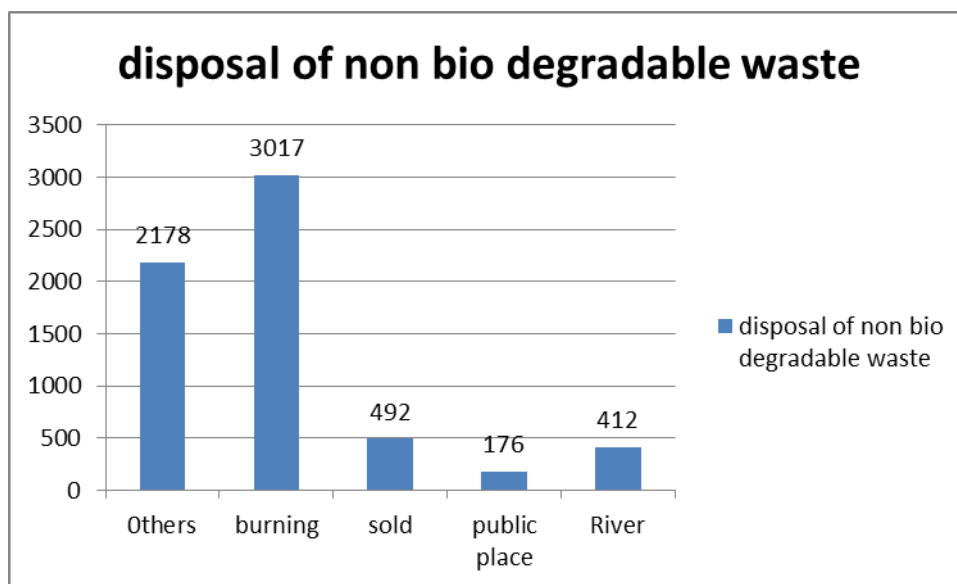


Fig. 3.10 Classification on the mode of handling of Non Biodegradable waste

3.2.11 Existing facility

Thiruvananthapuram Corporation set source level treatment of waste in wards through aerobins. Of the 100 wards, 314 bins are provided in 32 wards. The aerobins provided in the wards through which the Karaman and Killiyar flow is given in Table 2.8.

3.3 Flats

There are 32 flats in 250m of the Karamana and Killiyar river. Sewage generated in these flats are either discharged into sewer line or disposed in soak pit. Some are having only up to two flats. Consent to operate from the Kerala State Pollution Control Board is yet to be obtained by high rise building having more flats. The mode of treatment and disposal of solid wastes and sewage generated in these flats is to be closely monitored by the Kerala State Pollution Control Board and the Thiruvananthapuram Corporation. The other flats in the catchment are also to be monitored and to be brought to the consent purview.

3.4 Establishments

A total number of 706 establishments which were located in the buffer region. The establishments situated on the banks of the river include hospitals, hotels, lodges, markets, offices, shops, service stations, workshops etc. The main hospital is S.K. Hospital situated at Pangode. There are 15 hospitals, 33 hotels, 40 educational institutions, five lodges, six markets, 90 offices, 3 restaurants, 43 service stations, 323 shops, and 45 workshops situated on the bank of the river. These are to be closely monitored. The other establishments in the catchment are also to be monitored and to be brought to the consent purview.

CHAPTER IV

SANITATION SURVEY OF PARVATHIPUTHANAR

4.1 Background

The Parvathy Puthanar (T. S. Canal) and contiguous water bodies passing through the central parts of the city of Thiruvananthapuram has become highly polluted over the years, causing serious impacts on the health, sanitation, water and tourism sectors. The Kerala State Pollution Control Board entrusted Socio Economic Unit Foundation, the accredited agency of Kerala Government to carry out the sanitation survey of households 50m o the banks of canals and water bodies leading to Parvathy Puthanar. The students of Government ITI Chackai were engaged to carry out the assessment survey along with SEUF team.

The first phase of the study covered i) Canal from Chackai over bridge and adjacent areas upto Veli lake ii) Canal from over bridge up to Puthenpalam till Muttarthara iii) Ulloor thodu-portion near Kannamoola bridge iv) Puthenpalam-portion near Kannamoola bridge v) Kannamoola thodu till KIMS hospital vi) Amayizhanchan thodu near Pattoor vii) Puthenpalam till Thekkumoodu. These canal stretce=hes in ten wards of Thiruvananthapuram Corporation namely Pattom, Kunnukuzhi, Vanchiyoor, Peruthanni, Chackai, Vallakadavu, Karikkakom, Kadakompally and Kannamoola. The first pjase was implemented from October, 2012 – January 2013.

4.2 Observations of Sruvey

Sanitation of the local residents by the side of Parvathy Puthanar is to be improved considerably. Most of the households have simply kept the outlets of their toilets and latrines direct to the canal for economic reasons. The households depends on various on-site systems namely septic tanks, pit latrines, and community toilets with 8% of the population do not having access to safe sanitation disposal systems. The households in the banks of these water bodies are occupied by the weaker sections having tiny plots of land (1 cent) they are forced to discharge the liquid and solid waste to the water bodies.

4.3 Findings of Survey

The survey covered the details of sanitation facilities i.e house hold latrines, liquid waste, solid waste disposal facilities on both sides water bodies in an area of 50m the canal. 1132 households were surveyed in the first phase.

4.3.1 Toilet facilities and toilet waste disposal

Regarding house hold sanitation, 70 households completely lack toilet facilities, 176 having toilets drained directly to water bodies, 310 household have single pits, 31 households with double pits and 485 households with septic tanks, This denotes 49% of the households have unimproved latrines. Even soak pits from septic tanks are connected to canals by the households within 50m of the canal banks. But this has not been captured in the data as the people were reluctant to give correct information regarding connection to the canal. The sources of drain pipes ending in the canal could not be confirmed whether it is from 50m from the canal. Thus about 75% of latrines in the banks are unimproved latrines as per definition of WAHO/UNICEF joint monitoring programme for water supply and sanitation.

129 households are having below 2 cents and 162 families reside in puramboke area. This denotes that space constraint is most critical challenge in the urban areas for construction of latrines. Specail measures may be needed to support service improvements for the poorer sections of the community. This does not mean subsidies and awareness campaigns only but also technology options along with a proper operations and maintenance plan, which suits the local context of these communities.

The bund colonies and settlements on the purmaboke land in the banks of canals will have to be separately addressed. There is no Government land in the area for any construction purposes.

4.3.2 Liquid waste management

485 households' drain waste water in their own land premises, 252 have proper drainage, 394 drain the waste water in unscientific manner causing water pollution. Similar pattern is also observed in the case of waste water from bathrooms.

4.3.3 Solid waste management

The households along the banks of the canal only 385 (34%) households resort to some sort of segregation. 741 (65%) households that do not segregate their waste into the canal or burned. There is also the practice of segregated organic waste to burn. Only 66 families have pipe compost and one family has vermin compost. Biogas plant is installed in 13 households. Thus only 128 households have decentralized waste treatment systems. This denotes that 89% of households are practicing unscientific method in waste processing.

Thus it is seen that the solid waste management practices among the households are very poor. Segregation is reported to be practiced among 34% of households; Decentralized source level waste water treatment is practiced by 11% of the survey households only 89% resort to unscientific methods in waste processing.

4.3.4 Water borne diseases

74 cases of water borne diseases have been reported in the last six months from the households points to the prevalence of health problems. The urban informal settlements on the canal banks bear the burden of pollution of water bodies such as disease, like allergy asthma, dengue fever, foul smell, environmental pollution.

4.3.5 Drinking water supply

100% of the households reported good quality twenty four hours drinking water supply, which is very good indication of service delivery to the poor households by the Kerala water Authority.

4.3.6 Problems and perceptions of women on sanitation issues

There are 61 families residing in this bund colony of Kunnukuzhy ward. The people of the area are BPL families although APL ration card has been issued to some of them, Occupations of the family heads are auto drivers, coolies etc while the females are working as house maids, helpers in construction fields etc. They are living in the area since 1975.

The households are having kutcha or semi pucca structures. They are having single or two tiny rooms where more than one family resides. 8 of households have constructed temporary latrines in the houses, Outlets are directly connected to the canal. 50 of households do not have toilet who uses public toilets having six compartments 3

for women and three for men constructed by the municipal corporations. The people from other side of the canal (Pattom ward) is also using this public toilet. More than 300 persons are using this toilets per day. Due to over use the septic tank gets filled up often. The septage from the toilet is also discharged into the canal. Drinking water provided through four public stand posts is having 24 hours water supply.

The locals are of the opinion that canal water become polluted due to the discharge of waste water from hospitals like CosmoHospital and GG Hospital and some of the flats in the area. It is visible from drainage that joins the canal near the Anganwadi No 48. The waste water from Milma Dairy is also discharged into the canal which generates very foul smell according to the women in the colony. They women members were of the opinion that they were forced to discharge their waste and waste water into the canal as they have no other option. The affordable and affluent members of the community is discharging their waste water into the canal, throwing of solid waste in carry bags from hotels, chicken stalls is highly polluting the canal. The colony people are left without any choice. They were to be rehabilitated to an other parts of the city to completely stop the pollution of Parvathy Puthanar, Cleaning of the canal should initiated from the upper reach of the canal and through strict implementation along with complete participation of the community. Sustainable changes could be ensured through participation of all stake holders.

Vallakadavu

To discuss the issues of pollution of Parvathiputhanar a focus group discussion of women members near Vallakadavu was conducted

Twenty three families are residing in this area on the Puramboke land. They are staying in these houses for more than 25 years. Earlier canal was very clear and now it has become so dirty that the entire environment has a foul smell, most of them are suffering from different types of allergy and asthma. The doctors in the medical college used to attribute the cause to the environmental pollution near the canal.

The families having own land located on the side of Paravthy puthanar near boat pura, Vallakadavu have their own leach pit or septic tank latrines. Many of the families residing in the puramboke land also constructed latrines, but they are drained into the canal. Only one single family is not having latrine, but members are using toilet in the parental property. There is a community toilet for men in the boat pura which is used by men in the markets, auto drivers, loading workers etc., Formerly all the families used the open space for defecation which is now become

part of the airport. Liquid waste from bath area, washing is drained to the canal from all house. The quantity of solid food waste is very low and The inorganic/plastic etc are either thrown in the canal or burnt in the spaces available. They opined that affluent families, waste from hotels, hospitals are drained into the canal all through the way down its course, Ananthapuri hospital drains its waste water into the canal. It is believed that even waste from Medical college is drained into Parvathyputhanar.

People also remarked that every year Irrigation department cleans the canal, during the process all the silt from the canal is excavated and discharged in the banks of the canal which ultimately reaches the canal within 24 hours. People view this programme as measure to support the contractors. At the time there is heavy pungent smell resulting in increased incidence of Asthma and allergy in the area.

Concreted efforts from people from all walks of life, with effective pollution control measures, increased civic senses for community and active participation only changes can be initiated,

4.4 Short term recommendations to control pollution of Parvathyputhanar

Providing household latrines

Single pit conversion to bio toilet :310

Septic tank-open to canal connected to community septic tank 7

New bio toilets for no latrine households and those which are directly connected to water body
246(71+176)

Community latrines

1.. Maintenance of existing community toilet and construction of modern septic tank to 100 people at bund colony in ward Kunnukuzhy ward near thekkumoodu

2. Construction of new community toilet for 100 people at Pattom side of bund

Construction of common toilet and bathroom for three households near Thekkummoodu in Pattom ward

Connection of outlet pipes to septic tank.

Households shall be supported with funds allotted by L:SGD through Corporation

Solid waste management

Decentralized solid waste management is the best option for solid waste management in Thiruvananthapuram where all the centralized systems are encountering problems.

Ring compost and common biogas facilities are suggested for organic management

Inorganic waste management

Inorganic waste collection centers are to be established to manage inorganic wastes. The proposal for inorganic waste management involves establishment of three units comprising of sheds working capital and revolving fund.

Liquid waste other than the sewage management

Two sizes of soak pits is proposed as per the needs from the field

Soak pit (0.4m³) 71

Soak pit (0.2m³) 748

Information Education and communication, Capacity building

1. Awareness for residence association: Suchitwamission/LSGD/Corporation
2. SWM training to children, youth, Asha workers and other stake holders
3. Follow up systems
Capacity building of community groups, monitoring system and active involvement of residence association is necessary.

4.5 Long term Recommendations

1. Connecting sewers to these sewage treatment plant at Muttathara
2. Permanent solution for pollution control river is to connect outlets of latrines on the banks of the canal through a network of pipes along the canal for the final treatment at the sewage treatment plant at Muttathara.
3. The technological feasibility of this suggestion is to be explored by Kerala Water authority
4. The masons or skilled workforce should be reoriented for quality assured constructions and ensure the availability of them to people.

Enforcement of rules for proper designing and construction of septic tanks has beo be implemented. As the city corporation could not cater to all wards of the city even after the completion of the new sewage plant, desludging from septic tanks could be done. Hence regulations for scheduled desludging are required. It is necessary to identify the septage removal agencies/institutions and process or final disposal of present practice, to have information and develop monitoringsystems. To prevent pollution of canal through waste dumping, strict enforcement of rules are required after facilities are set up. Corporation has to identify space for treatment systems in decentralized ward wise arrangements and scale up promotion of agriculture, successfully implanted in some wards. Decentralized systems in SW with active participation of the community and ensure proper SWM systems

for houses on the banks of the canal. Innovative pilot projects with stakeholder participation to prevent pollution of water bodies are necessary. The role resident's association is crucial in monitoring the pollution abatement.

4.6 Limitations of the study

The study covered only houses within 50m on either sides of the canal. It is found that many households, institutions located either side of the canal drain their wastes to the canal through pvc pipes. Hence the study of households along the abks of the canal is not enough to curtail the pollution sources of the parvathy puthanar.

The study in the first phase covered only 1132 housholds in selected stretches of Parvathy puthanar and other water bodies as suggested by KSPCB. There should be a second phase to cover all houses existing in the canal banks to have an overview of the pollution of water bodies and to suggest pollution abtement measures.

There were some households which were looked at the time survey could not be covered. However efforts were taken to cover the informal settlements in colonies

The house numbers and ward numbers were recorded differently as respondents could not give correct numbers, Ward numbers changed many times, house numbers census numbers etc were reported wrongly. Efforts were taken to correct thesame in consultation with ward councilors.

The outflow from septic tank could not be captured in the study as people are reluctant to given information about the same.

The outflow of drain pipes is drained to canal through underground pipes. The grown of thick grass in the area forbids taking the actual number of drain pipes to the canal.

CHAPTER V

STATUS OF SURFACE WATER/GROUND WATER QUALITY

5.1 General

The river Karamana is the second longest river (68 km) passing through the Thiruvananthapuram district. Of which 21 km of the river flows through the Thiruvananthapuram city which is located downstream of the river. Its main tributary is River Killiyar (33km) which meets the River Karamana at Pallathukadavu. Before joining the River Karamana, the Killiyar travels through a distance of 14 km through the Thiruvananthapuram City. Parvathiputhanar (portion of T.S. Canal passing through Thiruvannanthapuram City) is located parallel to the sea shore and meets the River Karamana at Moonnattumukku.

5.2 Assessment of River Water Quality Data

The Kerala State Pollution Control Board is conducting the monitoring of the River Karamana monthly. The location of the sampling stations are as follows:

Table .5.1 Location of sampling stations

No.	Sampling station	Peculiarity of the station
1.	Peppara	Located in the upstream portion of the River Karamana Reservoir for water supply of Thiruvananthapuram city
2	Aruvikkara	Located in the upstream portion of the River Karamana Reservoir for water supply of Thiruvananthapuram city
3.	Mangattukadavu	Located before entering the Thiruvananthapuram city
4.	Pallathukadavu	Killiyar meets the River Karamana at Pallathukadavu Before joining River Karamana, Killiyar passes through the Thiruvananthapuram city
5.	Thiruvallom	This station is located downstream of Pallathukadavu
6.	Moonnattumukku	Parvathiputhanar meets the River Karamana at Moonnattumukku

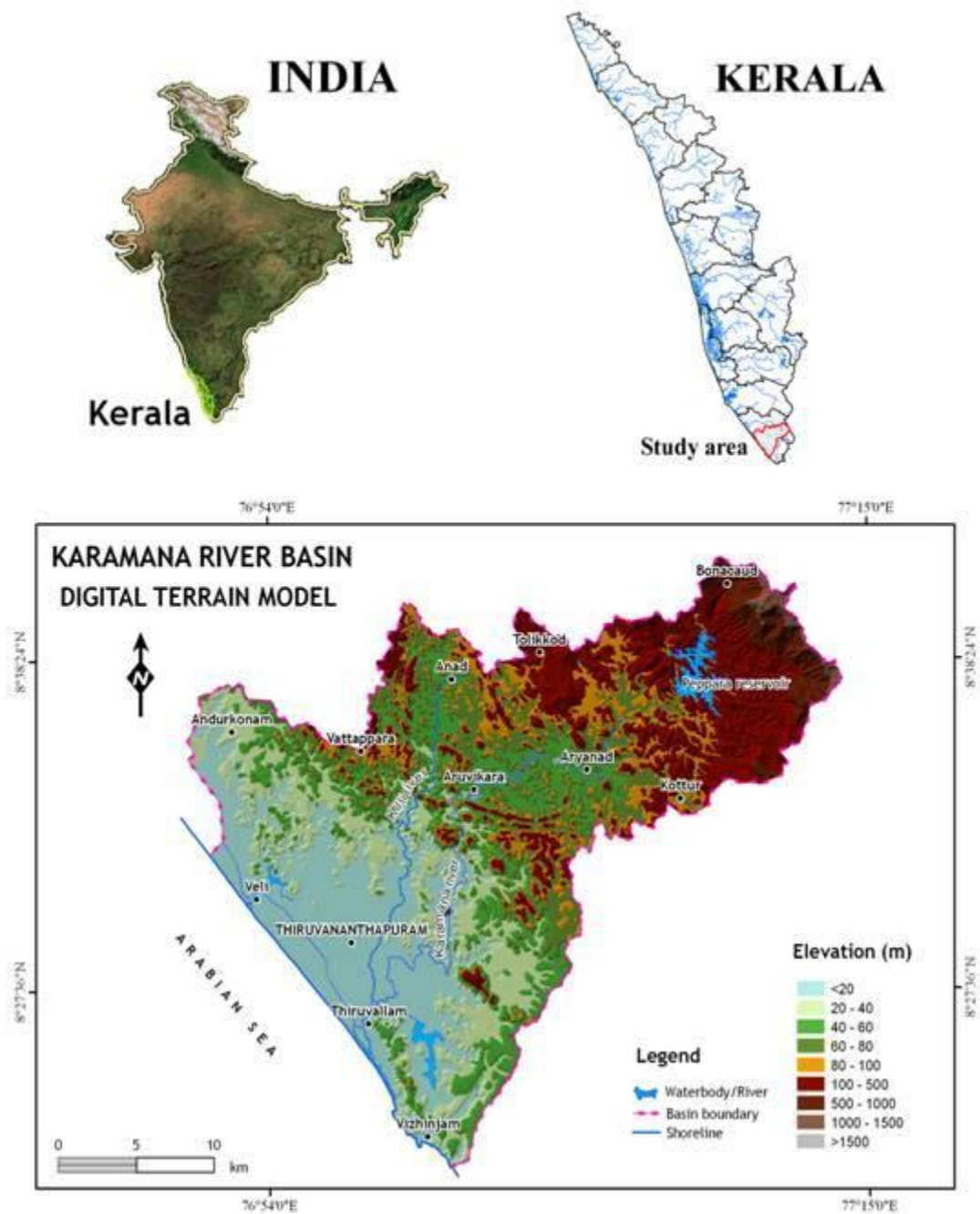


Fig. 5.1 Karamana Killiyar

The reduction in water quality with respect to dissolved oxygen was observed in Thiruvallom and Moonnattumukku. The rise in BOD can also be observed in these stations, The reduction in dissolved oxygen was more during monsoon when compared to other seasons. The rise in BOD was high during premonsoon when compared to other seasons.

Variation of Dissolved Oxygen in Karamana River during 2018

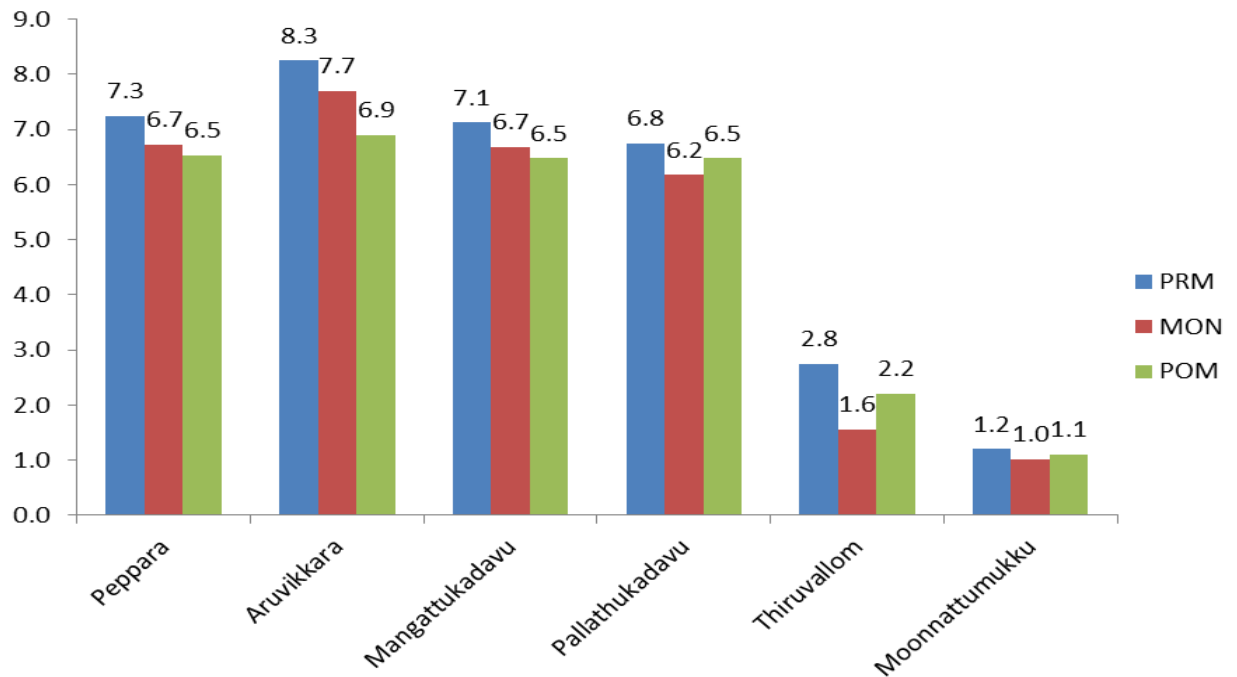


Fig 5.2 Variation of Dissolved Oxygen in karamana river during 2018

Variation of Biochemical Oxygen in Karamana River during 2018

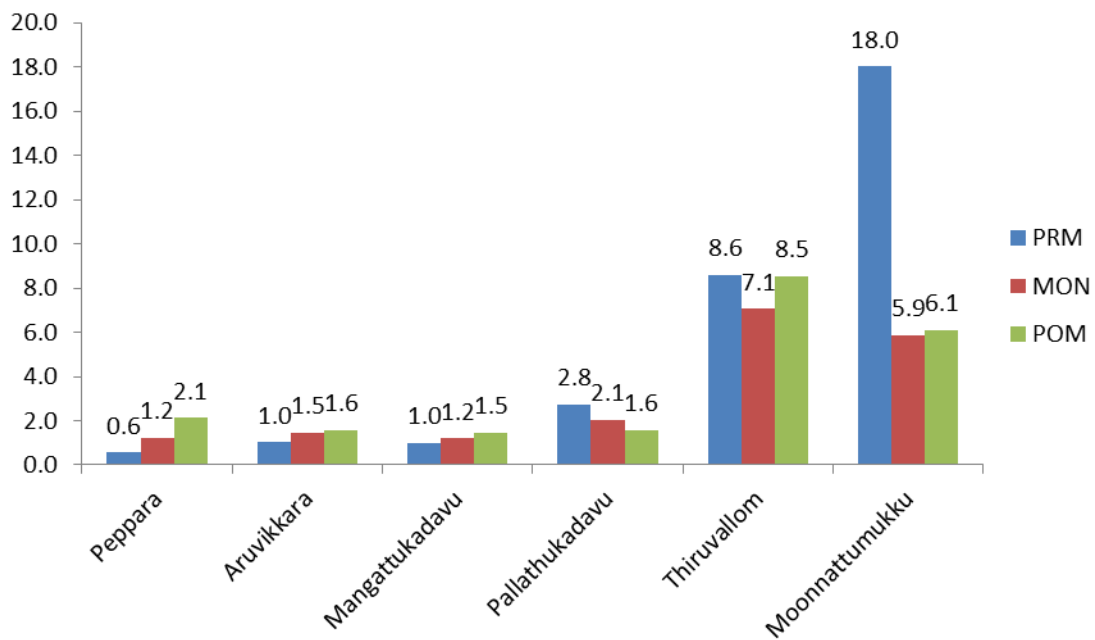


Fig 5.3 Variation of Bio Chemical Oxygen in karamana river during 2018

During all seasons, a very high level of both total coliform and fecal coliform was observed in Pallathukadavu, Thiruvallom and Moonnattumukku. The level of total coliform was high during monsoon whereas the fecal coliform level was comparatively high during monsoon. This confirms the contamination of river water due to sewage generated in the Thiruvananthapuram City.

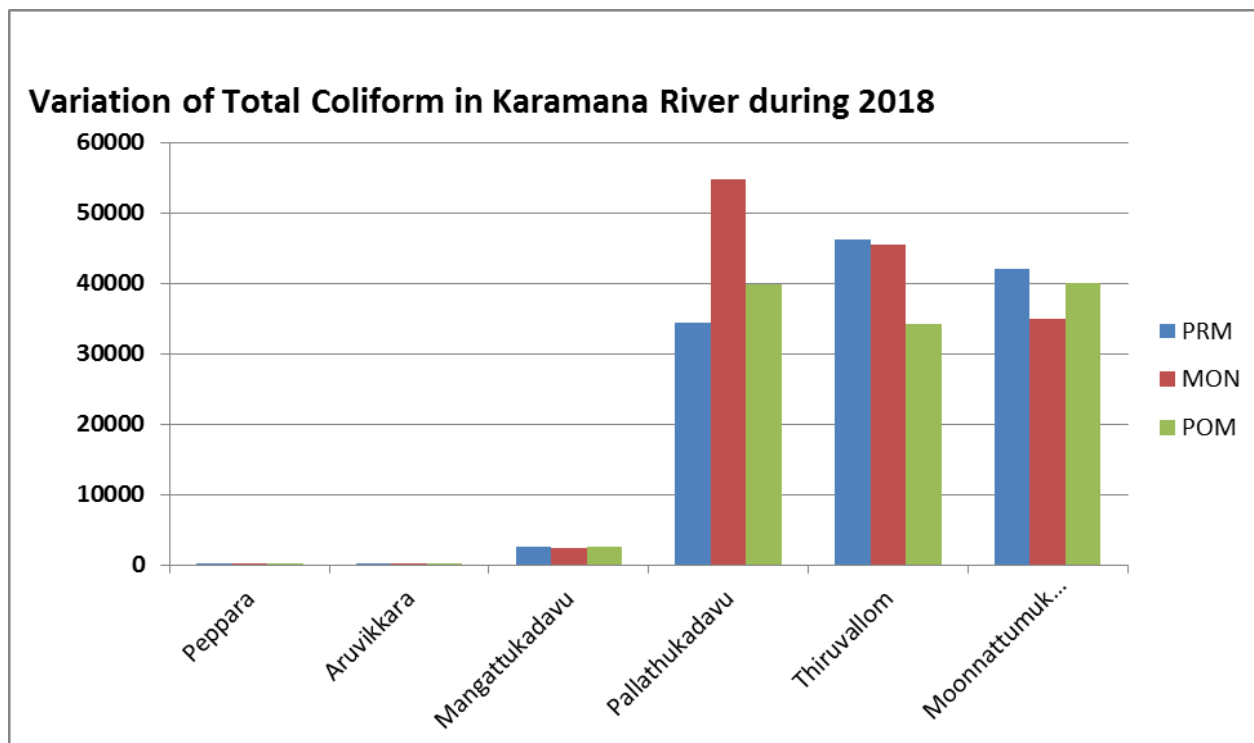


Fig 5.4 Variation of Total coliform in karamana river during 2018

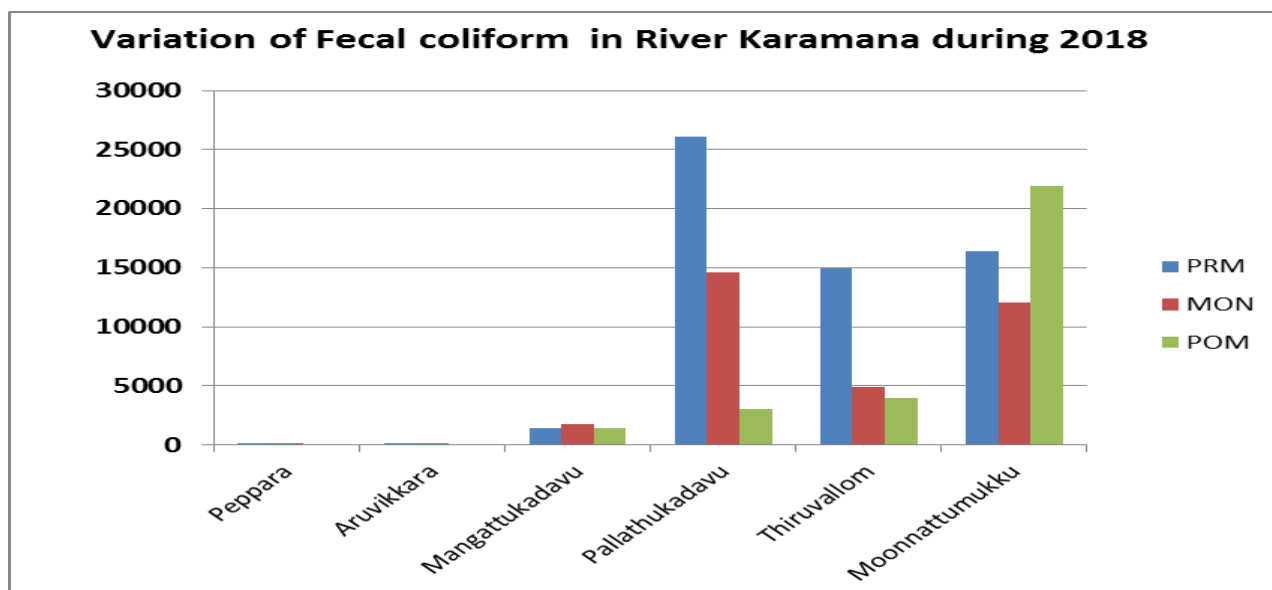


Fig 5.5 Variation of Fecal coliform in karamana river during 2018

5.3 Analysis of water quality of other drains

There are many drains passing through Thiruvananthapuram city. A part of the drainage in the City reaches the Karamana river (Southern part of the City) through Killiyar, and Parvathiputhanar through Thekkanakkara canal. Some more polluted drains namely Kannettumukku drain, Kuriyathi drain etc are also joining Karamana river. The remaining part of drainage reaches the Akkulam Veli lake through the drains namely Ulloor drain, Pattom drain, Amayizhanchan drain, Kannammola drain. Ulloor drain, Pattom drain and Amayizhanchan drain join to form Kannammoola stream and its joins the Akkulam-Veli lake in its upstream portion (Northern part of the City) and thereby making the entire lake polluted. The latest analysis report of these drains is as follows

Table5.2 Analysis report for the month of December, 2018

No.	Stream	Sampling Station	pH	Condu ctivity	Dissolved oxygen	BOD	Total coliform	Fecal coliform
1.	Kannettumukku stream	Kuthirasena	7.2	34	2.9	0.9	2200	1200
2.	Parvathiputhanar	Parvathiputhanar	7.9	58	4.6	1.1	1800	1500
		S M Lock	8.4	56	2.7	1.6	2000	1600
3.	Thottumbhagam stream	Thottumbhagam	6.9	52	2.8	1.6	1900	1600
4.	Kuriyathi stream	Kuriyathi						
5.	Thekkekkara canal							
6.	Ulloor stream	Ulloor bridge	7.5	25	1.5	3.9	1400	1200
		Cosmo before	7.4	24	1.8	2.7	1100	900
		Cosmo after	6.9	26	3.9	2.1	1200	1100
7.	Pattom stream	Kuravankonam	7.3	48	4.8	0.9	1600	1400
		Plamoodu	7	35	2.3	2.1	1900	1800
		Thekkummoodu	7.5	36	1.9	2.4	1600	1400
8.	Amayizhanchan stream	Bakery junction	7.3	24	3.8	2.7	1400	1100
		Thampanoor						
		Pattoor	7.5	35	4	1.3	1900	1500
9.	Kannammoola stream	After joining (Pattoor)	7.5	35	4	1.3	1900	1500
		Kannammoola bridge	7.6	24	4.9	2.6	1900	1700
10.	Akkulam boat club	Akkulam	7.5	69	3.8	2.4	2600	2200
11.	Veli boat club	Veli	7.6	79	4.6	1.4	2100	2000
12.	Thettiyar stream	Thettiyar stream	6.8	49	3.9	1.5	1800	1400

5.4 Flow Details- MARUTHANKUZH I STATION ON 2016

Day	Jun		Jul		Aug		Sep		Oct		Nov		Dec		Jan		Feb		Mar		Apr		May	
	W.L	Q	W.L	Q	W.L	Q	W.L	Q	W.L	Q	W.L	Q	W.L	Q	W.L	Q	W.L	Q	W.L	Q	W.L	Q	W.L	Q
1	6.289	1.212	6.359	2.701	6.259	0.785	6.239	0.473	6.239	0.473	6.239	0.473	6.279	1.012	6.239	2.091	6.219	1.323	6.209	1.068	6.199	0.911	6.189	0.717
2	6.279	1.012	6.339	2.113	6.259	0.785	6.239	0.473	6.239	0.473	6.239	0.473	6.279	1.012	6.239	2.091	6.219	1.323	6.209	1.068	6.199	0.911	6.219	1.323
3	6.279	1.012	6.339	2.113	6.259	0.785	6.239	0.473	6.239	0.473	6.299	1.292	6.279	1.012	6.239	2.091	6.219	1.323	6.209	1.068	6.199	0.911	6.199	0.911
4	6.279	1.012	6.339	2.113	6.279	1.012	6.219	0.303	6.239	0.473	6.279	1.012	6.299	1.292	6.239	2.091	6.219	1.323	6.209	1.068	6.199	0.911	6.199	0.911
5	6.259	0.785	6.299	1.292	6.279	1.012	6.219	0.303	6.239	0.473	6.279	1.012	6.299	1.292	6.239	2.091	6.219	1.323	6.209	1.068	6.189	0.830	6.199	0.911
6	6.259	0.785	6.299	1.292	6.279	1.012	6.219	0.303	6.239	0.473	6.259	0.785	6.279	1.012	6.239	2.091	6.219	1.323	6.259	2.883	6.189	0.830	6.199	0.911
7	6.559	11.84	6.279	1.012	6.259	0.785	6.219	0.303	6.239	0.473	6.239	0.473	6.279	1.012	6.229	1.926	6.219	1.323	6.209	1.068	6.189	0.830	6.199	0.911
8	7.589	76.81	6.299	1.292	6.259	0.785	6.219	0.303	6.239	0.473	6.239	0.473	6.279	1.012	6.229	1.926	6.219	1.323	6.209	1.068	6.189	0.830	6.219	1.323
9	6.739	20.17	6.299	1.292	6.259	0.785	6.219	0.303	6.239	0.473	6.239	0.473	6.279	1.012	6.229	1.926	6.219	1.323	6.209	1.068	6.189	0.830	6.199	0.911
10	6.639	15.39	6.299	1.292	6.239	0.473	6.219	0.303	6.239	0.473	6.239	0.473	6.279	1.012	6.229	1.926	6.219	1.323	6.209	1.068	6.189	0.830	6.199	0.911
11	6.939	30.87	6.299	1.292	6.239	0.473	6.239	0.473	6.239	0.473	6.239	0.473	6.259	0.785	6.229	1.926	6.209	1.068	6.209	1.068	6.189	0.830	6.339	4.523
12	6.739	20.17	6.319	1.655	6.239	0.473	6.239	0.473	6.239	0.473	6.239	0.473	6.239	0.473	6.229	1.926	6.219	1.323	6.199	0.911	6.199	0.911	6.259	3.204
13	6.739	20.17	6.339	2.113	6.239	0.473	6.239	0.473	6.239	0.473	6.239	0.473	6.239	0.473	6.229	1.926	6.219	1.323	6.199	0.911	6.239	2.091	6.259	3.204
14	6.539	10.99	6.299	1.292	6.239	0.473	6.239	0.473	6.299	1.292	6.239	0.473	6.239	0.473	6.219	1.512	6.219	1.323	6.199	0.911	6.339	5.654	6.219	1.323
15	6.439	6.000	6.299	1.292	6.239	0.473	6.239	0.473	6.239	0.473	6.239	0.473	6.239	0.473	6.219	1.512	6.219	1.323	6.199	0.911	6.239	2.281	6.199	0.911
16	6.419	4.977	6.339	2.113	6.239	0.473	6.239	0.473	6.319	1.655	6.239	0.473	6.239	0.473	6.219	1.512	6.219	1.323	6.239	2.083	6.239	2.281	6.199	0.911
17	6.379	3.301	6.299	1.292	6.239	0.473	6.239	0.473	6.259	0.785	6.239	0.473	6.239	0.473	6.219	1.512	6.219	1.323	6.219	1.628	6.239	2.281	6.199	0.911
18	6.419	4.977	6.299	1.292	6.239	0.473	6.239	0.473	6.239	0.473	6.239	0.473	6.239	0.473	6.219	1.512	6.209	1.068	6.219	1.628	6.199	0.911	6.199	1.266
19	6.389	3.621	6.299	1.292	6.239	0.473	6.239	0.473	6.239	0.473	6.259	0.785	6.279	1.012	6.219	1.512	6.209	1.068	6.199	0.911	6.199	0.911	6.339	5.026
20	6.339	2.113	6.279	1.012	6.219	0.303	6.239	0.473	6.239	0.473	6.239	0.473	6.279	1.012	6.219	1.512	6.209	1.068	6.199	0.911	6.199	0.911	6.239	2.091
21	6.389	3.621	6.279	1.012	6.219	0.303	6.239	0.473	6.359	2.701	6.239	0.473	6.259	0.785	6.239	2.091	6.209	1.065	6.199	0.911	6.199	0.911	6.239	2.091
22	6.359	2.701	6.279	1.012	6.219	0.303	6.239	0.473	6.339	2.113	6.239	0.473	6.259	0.785	6.219	1.323	6.209	1.068	6.219	1.176	6.189	0.789	6.219	1.323
23	6.339	2.113	6.279	1.012	6.219	0.303	6.239	0.473	6.279	1.012	6.239	0.473	6.239	0.473	6.219	1.323	6.209	1.068	6.219	0.911	6.189	0.789	6.219	1.323
24	6.319	1.655	6.299	1.292	6.219	0.303	6.239	0.473	6.239	0.473	6.239	0.473	6.259	0.785	6.219	1.323	6.209	1.068	6.199	0.911	6.189	0.789	6.199	0.911
25	6.319	1.655	6.299	1.292	6.219	0.303	6.259	0.785	6.239	0.473	6.239	0.473	6.239	0.473	6.219	1.323	6.209	1.068	6.199	0.911	6.189	0.789	6.199	0.911
26	6.289	1.212	6.279	1.012	6.219	0.303	6.259	0.785	6.239	0.473	6.239	0.473	6.239	0.473	6.219	1.323	6.209	1.068	6.199	0.911	6.189	0.789	6.199	0.911
27	6.319	1.655	6.259	0.785	6.219	0.303	6.259	0.785	6.239	0.473	6.279	1.012	6.239	0.473	6.219	1.323	6.209	1.068	6.199	0.911	6.189	0.789	6.199	0.911
28	6.289	1.212	6.299	1.292	6.219	0.303	6.239	0.473	6.219	0.303	6.279	1.012	6.239	0.473	6.219	1.288	6.209	1.068	6.199	0.911	6.189	0.717	6.199	0.911
29	6.339	2.113	6.279	1.012	6.219	0.303	6.239	0.473	6.219	0.303	6.279	1.012	6.239	0.473	6.219	1.323			6.209	1.068	6.189	0.717	6.239	2.091

30	6.389	3.621	6.279	1.012	6.219	0.303	6.239	0.473	6.219	0.303	6.279	1.012	6.239	0.473	6.219	1.323			6.199	0.911	6.189	0.717	6.419	8.796
31			6.259	0.785	6.219	0.303			6.259	0.785			6.239	0.473	6.219	1.323			6.199	0.911			6.359	6.179
Ten-Daily Mean																								
I Ten-Daily	6.52	13.00	6.315	1.651	6.263	0.822	6.225	0.354	6.239	0.473	6.255	0.694	6.283	1.068	6.235	2.025	6.219	1.323	6.214	1.250	6.193	0.863	6.202	0.974
II Ten-Daily	6.53	10.72	6.307	1.465	6.237	0.456	6.239	0.473	6.255	0.704	6.241	0.504	6.249	0.612	6.222	1.636	6.215	1.221	6.208	1.188	6.228	1.906	6.245	2.337
III Ten-Daily	6.34	2.156	6.281	1.047	6.219	0.303	6.245	0.567	6.259	0.856	6.255	0.689	6.244	0.558	6.221	1.389	6.209	1.068	6.204	0.950	6.190	0.780	6.244	2.396
Monthly																								
Min.	6.26	0.785	6.259	0.785	6.219	0.303	6.219	0.303	6.219	0.303	6.239	0.473	6.239	0.473	6.219	1.288	6.209	1.065	6.199	0.911	6.189	0.717	6.189	0.717
Max.	7.59	76.81	6.359	2.701	6.279	1.012	6.259	0.785	6.359	2.701	6.299	1.292	6.299	1.292	6.239	2.091	6.219	1.323	6.259	2.883	6.339	5.654	6.419	8.796
Mean	6.46	8.626	6.300	1.377	6.239	0.520	6.236	0.465	6.251	0.683	6.250	0.629	6.258	0.740	6.226	1.674	6.215	1.214	6.208	1.123	6.204	1.183	6.231	1.918

Annual Runoff (MCM) = 53 Annual Runoff (mm) =

Peak Observed Discharge = 8.796 on 30/05/2017 Corres. Water Level :6.419

Lowest Observed Discharge = 0.717 on 28/04/2017 Corres. Water Level :6.189

5.5 Ground water quality

The ground water quality collected from the Central Ground Water Board is given as Table 1, 2, 3, and 4. The sampling stations are at Aruvikkara, Nedumangad, Vellanand, Thiruvananthapuram and Poonthura. The analysis reports reveal that ground water quality is within the limits except for nitrate at Poonthura. The nitrate level exceeds the permissible standard of 100mg/l.

Table 5.3 Ground Water Quality at Aruvikkara Station

Characteristics	Unit	2012	2013	Limiting standards
pH		-	7.65	6.5-8.5
Electrical conductivity	us/cm	70	64	-
Total hardness	mg/l	8	10	300
Calcium	mg/l	3.2	3.2	75
Magnesium	mg/l	0	0.49	30
Chloride	mg/l	11	7.1	250
Fluoride	mg/l	0.22	0.15	1
Nitrate	mg/l	0.5	0.51	45(desirable) 100 (Permissible)

Table 5.4 Ground Water Quality at Vellanad Station

Characteristics	2013	Limiting standards
pH	7.56	6.5-8.5
EC in micro siemen/cm	57	-
Total hardness in mg/l	12	300
Calcium in mg/l	3.2	75
Magnesium in mg/l	0.97	30
Chloride in mg/l	9.9	250
Fluoride in mg/l	0.06	1
Nitrate in mg/l	1.2	45(desirable) 100 (Permissible)

Table 5.5 Ground Water Quality at Nedumangad station

Characteristics	Unit	2012	2014	2015	Limiting standards
pH		7.7	7.12	6.83	6.5-8.5
Electrical conductivity	us/cm	200	72	154	-
Total hardness	mg/l	22	18	12	300
Calcium	mg/l	4.8	6.4	1.6	75
Magnesium	mg/l	2.4	0.49	2	30
Chloride	mg/l	50	1.4	33	250
Fluoride	mg/l	0	0.42	0.15	1
Nitrate	mg/l	5.0	0.94	6.8	45(desirable) 100 (Permissible)
Sodium	mg/l	-	3.4	18	
Potassium	mg/l	-	1.4	5.2	
Carbonate	mg/l	-	0	0	
Bicarbonate	mg/l	-	29	17	
Sulphate	mg/l	-	2.5	0	200

Table 5.6 Ground Water Quality Characteristics at Thiruvananthapuram

Characterisitcs	2015	2016	Limiting standards
pH	7.13	7.11	6.5-8.5
Electrical conductivity	240	280	
Total hardness in mg/l	30	24	300
Calcium in mg/l	5.6	5.6	75
Magnesium in mg/l	3.9	2.4	30
Sodium in mg/l	24	40	
Potassium in mg/l	5.3	2.7	
Carbonate in mg/l	0	0	
Bicarbonate in mg/l	15	4.8	
Sulphate in mg/l	traces	2	200
Chloride in mg/l	37	57	250
Fluoride in mg/l	0.3	0.12	1
Nitrate in mg/l	37	38	45(desirable) 100 (Permissible)

Table 5.7 Ground Water Quality at Poonthura station

Charcteristics	Unit	2013	2016	2017	Limiting standards
pH		--	6.34	7.27	6.5-8.5
Electrical conductivity	us/cm	510	159	780	
Total hardness	mg/l	142	20	225	300
Calcium	mg/l	46	3.2	68	75
Magnesium	mg/l	6.8	2.9	13	30
Chloride	mg/l	71	30	89	250
Fluoride	mg/l	0.12	0.08	0.21	1
Nitrate	mg/l	39	27	107	45(desirable) 100 (Permissible)
Sodium	mg/l	-	20	53	
Potassium	mg/l	-	4.6	4.7	
Carbonate	mg/l	-	0	0	
Bicarbonate	mg/l	-	7.3	165	
Sulphate	mg/l	-	2.5	36	200

CHAPTER VI

INVENTORY OF SOURCES OF POLLUTION AND GAP IDENTIFICATION

The degradation of water bodies in the City is mainly caused by the discharge of sewage, sullage, and garbage into the water bodies. The generation, treatment and disposal of these wastes in the Thiruvananthapuram Corporation area and Panchayaths are discussed here.

6.1 Sewage

In the City, people mostly depend on piped water supply. About 80-85% of the water consumed is returned to public drainage system as waste water as sullage and sewage. Sewerage system was commissioned in 1945. The execution and maintenance of sewerage schemes are vested with the Kerala Water Authority (KWA). The details of the sewage generated as well as the existing sewerage scheme is given in Table 5.1. The four lift up stations at Mudavanmugal, Arannoor, Thaliyal and Sathamangalam discharge the sewage in to the main pumping station at Kuriyathi. A fifth lift up station at the Medical college campus pumps the sewage into the main pumping station at Kannammoola. The sewage from the main pumping stations namely Kuriyathy, Pattoor, Eanchakkal and Kannammoola is pumped to the stilling chamber at Valiyathura and is disposed through common sewage treatment plant of 107MLD capacity and the treated effluent is discharged into the T. S.Canal.

Thiruvananthapuram Municipal Corporation presently comprises an area of 141.74 km² of which about 30% is covered by piped sewerage system. The system was designed in such a way that the overflow, i.e. excess sewage above the holding capacity in the pumping stations due to pumping breakdown caused by power failure, break down of pump sets etc., should reach the nearest canal/rivers. 30% of the city area is only covered under the sewerage scheme. Now the population and the number of houses in the City have increased many folds and the inflow into the sewage pumping stations also has increased. The system has exceeded its designed capacity resulting in the discharge of a large quantity of raw sewage as overflow into the Karamana river through the Killiyar, the Akkulam-Veli lake through the Amayizhanchan stream, the ThekkanankaraCanal and the T.S.Canal.

Present coverage status of Thiruvananthapuram corporation area

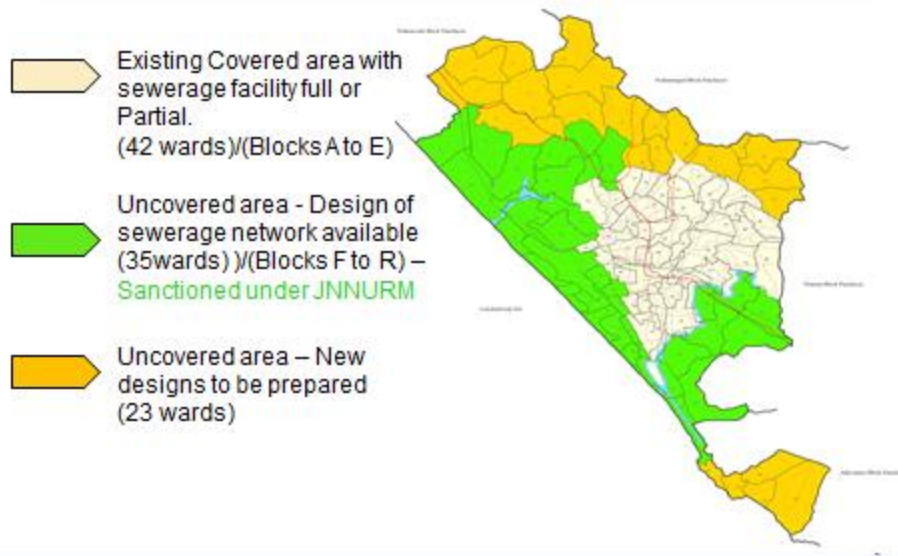


Fig .6.1 Present coverage status of Thiruvananthapuram corporation area

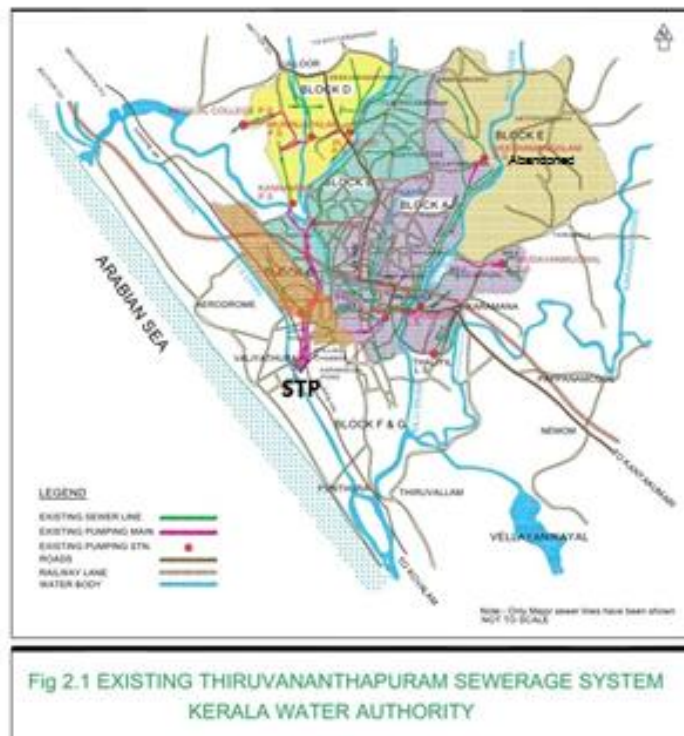


Fig 6.2 Existing Thiruvananthapuram Sewerage System Kerala Water Athority

A large quantity of rain/seepage enters the system during rainy season although the sewerage scheme is designed for disposal of sewage and sullage. Considerable quantity of sewage as overflow at many places such as through manholes, sump wells in the pumping stations reaches either the Killiyar and Karamana river or Akkulam-Veli lake through the Amayizhanchan stream and the T.S.Canal due to the inadequacy of the existing system and negligence of some of the pump operators.

There is more chance for the disposal of wastes from these slums into the streams. The details of slums in Thiruvananthapuram city is given in Table 6.2.

Table 6.1 Generation of Sewage in the Thiruvananthapuram City

No.	Particulars	Unit	Quantity
1.	Area of the ThiruvananthapuramCity*	km ²	214
2.	Population(2011 census)*	No.	9,86,578
3.	Quantity of water supplied to the city°	Mld	160
4.	Total number of households*	No.	2,07,460
5.	Quantity of sewage generated in the City•	Mld	128
6.	Area of the City comes under the sewerage system	km ²	27.01
7.	Number of households under sewerage scheme of KWA	No.	80000
8.	Number of households under sewerage scheme in the Karamana-Killiyar basin	No.	35900
9.	Number of households under sewerage scheme in the AV lake basin	No.	44100
10.	Number of sewerage connections	No.	68000
11.	Population under sewerage scheme	No.	343000
12.	Quantity of sewage collected through sewerage connections	Mld	50

* District Census Handbook, 2001

° Quantity of water required per head per day is assumed as 180 l.

- Quantity of sewage generated per head per day is as
- sumed as 80% of average quantity of water required per head per day

Table 6.2 Details of Slums

(Source - Corporation of Thiruvananthapuram)

No.	Name sub-basin	Name of Slum	Area(ha)	Total Population
1	Killiyar basin			
2	Amayizhanchan basin	Chirakkulam colony	0.5	430
		Poundukulam colony	1.1	803
		Rajajinagar colony		
3.	Pattom basin	Ambedkar colony, Thekkumoodu	1.8	289
		Barton Hill, Kunnukuzhy	5.16	1256
		Kunnukuzy R. C. Street	1.3	1055
		Plamood thottuvarambu	0.4	204
		Thekkumoodu bund colony	0.3	381
4.	Ulloor basin	Murinjalapam bund colony	0.06	107
		Vayyamoola, Gowreesapattom	0.47	178
5.	TS Canal basin	Colony opposite to Airport	3	2454
		Fishermen settlement from Veli to Shankumugam	10	4269
		Kannanthura colony	1.5	882
		Karimadom colony	2.8	1815
		Poonthura pamboor	0.61	1825
		PriyadarsininagarAirport	0.3	343
		Sewage farm	0.5	890
		Slum near Kuriyathi	0.08	75
		St. Mary's colony near wireless station	44.52	1226
		Uppidamoodu palam I & II	0.15	86

		Vallakkadavu Puthen road milk colony	1.2	265
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6.2 SOLID WASTES INCLUDING BIODEGRADABLE AND NON BIODEGRADABLE WASTE

In Kerala, decentralized treatment system is adopted for the treatment of biodegradable and non-biodegradable wastes. Composting units are placed at community level, institutional level, and house hold level. Material collection facilities were also constructed for the collection of non biodegradable wastes like plastic, etc. Resource recovery facility comprising of shredding plant and bailing plant is also setup in the Corporation. The details of solid waste disposal in Thiruvananthapuram Corporation are given below:

Table 6.3 Solid waste disposal in Thiruvananthapuram Corporation area

Total quantity of solid waste	TPD	300-350
Number of wards		100
Decentralized facilities	No.	Pipe compost: 87000 Biogas plant: 1850 Bio composter kitchen bin: 8600
Facilities at Household level		97450 houses
Facilities in establishments at community level		Community level biogas plants in 50 establishments
Facilities in markets, schools at community level		Biogas plants at 28 places (Total 42T) 114 aerobins at 18 places
Proposal		Submitted proposal for solid waste management of Rs. 33,84,25,000 for decentralized solid waste management facilities

6.3 INDUSTRIES & ESTABLISHMENTS

There are two major industrial units namely Hindustan Latex Limited, Peroordada and Thiruvananthapuram Dairy located near to the River Karamana. M/s. Hindustan Latex Limited, Peroordada is a public sector company which is engaged in the production of health care products, including: condoms, contraceptive pills, , blood bags and Pharma products. This factory is having effluent treatment plant for the treatment of effluent generated there. The treated effluent is discharged into a drain leading to Killiyar. Thiruvananthapuram Dairy is located near to a drain leading to Parvathiputhanar. It is a company owned by the State Government. It is engaged in the production of dairy products. The

factory is having own effluent treatment plant. The effluent after treatment is led to a drain leading to Parvathiputhanar.

These units have obtained Board's Consent to Operate for operating the industry. The details are given below:

Pappanamcode Industrial Estate is situated near the River Karamana. No major industrial units are located in this Industrial estate

No.		Hindustan Latex Limited, Peroorkada	Thiruvananthapuram Dairy, Ambalathara
1	Name and quantity of products	3.7 million pieces of male contraceptives/day	7500 kl Dairy products
2	Quantity of water consumption	787 KLD	472 KLD
3	Quantity of treated effluent	265 KLD	150 KLD
4	Treatment system	ETP	ETP
5	Mode of utilization	Gardening and balance to drains	Irrigation and balance to drains

Central Works, Pappanamcode is also located near the river.

SL.NO	NAME OF UNIT	STATUS OF WASTE WATER/EFFLUENT TREATMENT	REMARKS
1	HINDUSTHAN LATEX,PEROORKADA	ETP is provided and is working	Maximum reuse of treated water balance to public drain.
2	S.A.P CAMP, PEROORKADA	Septic tank provided for Sewage at the quarters. No treatment for sullage.	Directions issued to provide village treatment plant. Reminder sent and received information that work is in progress
3	ARAFA AUDITORIUM, VALLAKADAVU	Septic tank & soak pit provided for waste water treatment. Biogas provided for garbage disposal	Direction issued to remove the solid waste stagnated at the waterbed near the unit.
4	KAIRALI FORD,TRIVANDRUM	ETP with reuse facility provided	Direction is issued for safe storage & disposal of solid waste
5	S.K HOSPITAL, IDAPPAZINJI	Revamping STP is progressing	Direction issued for implementation of STP
6	MALABAR MALL, CHACKAI	STP provided with provision for Reuse of treated water	
7	AIRPORT AUTHORITY OF INDIA, CHACKAI	Sewage disposal directly to Muttathara common STP	Direction issued to AAI for arrangements for solid waste

8	K.S.R.T.C, PAPPANAMCODE	Primary Treatment facility provided	Direction issued for the storage waste oil and discharge of waste water
9	INTERNATIONAL POWER LAUNDRY,KANJIRAMPARA		
10	S.F.S WIBLETON FLAT,GOLF LINKS,KOWDIAR	Primary treatment provided but was not properly functioning. Discharge through sewer connection.	Direction issued to function primary treatment properly & to provide Garbage disposal facility
11	SKYLINE GOLF LINKS APPARTMENTS, KOWDIAR	Primary treatment provided and then to sewer line. Biobin provided.	Direction issued to function primary treatment properly
12	KINGS VILLA CORDON APPARTMENT,KOWDIAR	Primary tank provided and then to sewer line	Direction issued to provide biogas plant/ Biobin
13	ASSET HOMES BUILDERS APPARTMENTS, SASTHAMANGALAM	Primary tank provided and then to sewer line. Bio composter provided	
14	ANANTHAPURI HOSPITAL, CHACKAI	STP provided	
15	MILMA, AMBALATHARA	ETP provided	Direction issued to provide function sludge management system properly.
16	ARADHANA HOSPITAL, CHALAI		
17	MEDICAL COLLEGE HOSPITAL	Screens & filters and then to sewer connection	
18	GOVT.AYURVEDHA COLLEGE	Not obtained consent/Authorisation under BMW rule	Notice issued
19	COSMOPOLITAN HOSPITAL	Primary treatment provided and then to sewer connection. STP proposal submitted. Incinerator for solid waste disposal provided	STP provided, Notice issued, sewer connection
20	CREDENCE HOSPITAL, ULLOOR	STP with soak pits provided.	
21	S.I PROPERTIES, JAGATHY		
22	SREEDHANYA, ILAMKULAM,SREEKARYAM	STP provided. Dispersion trenches provided	
23	POTHYS, AYURVEDHA COLLEGE JUNCTION	Primary treatment & then to sewer line.	
24	INDIAN COFFEE HOUSE, THAMPANOOR	Primary tank provided and then to sewer line.	
25	APOLLO DIMORO HOTEL, THAMPANOOR	STP with reuse facility provided. Bio – Composter provided.	
26	K.S.R.T.C , THAMPANOOR		
27	HEERA FLAT, M.P APPAN ROAD	STP with soak pits provided	Direction to be given to provide additional soak pits.
28	CHAITHRAM HOTEL, THAMPANOOR	Sewage through sewer line. Holding tanks provided is not adequate for primary treatment	
29	D.R.M OFFICE(RAILWAY), METTUKADA,THYCAUD		
30	GOWREESA HOSPITAL,GOWREESAPATTOM		
31	NIRMALA	Septic Tank – Soak Pit provided	69

	HOSPITAL,MEDICAL COLLEGE		
32	BEACON GREENVILLA, MEDAMUKKU,THIRUMALA		

CHAPTER VII

ACTION PLAN FOR POLLUTION ABATEMENT OF KARAMANA-KILLIYAR

The action plan is prepared by the departments namely Kerala State Pollution Control Board, Kerala Water Authority, Irrigation department, and Thiruvananthapuram Corporation for the abatement of pollution of River Karamana and Killiyar. The preparation of the action plan is based on concept plan approved by the Chief Secretary.

7.1 ACTION PLAN BY KERALA STATE POLLUTION CONTROL BOARD

Sl. No.	Project		Proposed action	Agency	Target date	Per unit	No.	Total budget	Remarks
1.	Sanitation	1.1	Providing of toilets to 320 residences (35+9+16+246+3) with treatment and disposal system for sewage and sullage-DEWATS	Thiruvananthapuram Corporation	Three months				As per survey on Karamana and Killiyar and also that on Parvathiputhana r, there are residences which are having no toilets.
2.	Toilet waste disposal	2.1	Providing of community/individual DEWATS systems for sewage and grey water for the 8150 (7000+1132) residences having discharge into rivers, soak pit. Grey water is also to be diverted to the above DEWATS system in the unsewered area Or Provide	Thiruvananthapuram Corporation Kerala Water Authority Revenue department Irrigation department and Local Self Government is to allocate the space	Three months for DEWATS or Two years for sewer line and pumping stations				The discharge from septic tank is also to be diverted to DEWATS

			sewerline with pumping station						
3.	Community toilets	3.1	Construction of new community toilets with treatment system	Thiruvananthapuram Corporation Kerala Water Authority Suchitwa Mission Revenue department Irrigation department and Local Self Government is to allocate the space	Six months				In the sanitation survey of Parvathyputhanar, construction of new community toilet from 100 people at Pattom side of bund was proposed by SEUF.
		3.2	Maintenance of existing community toilets and providing of treatment system	Thiruvananthapuram Corporation Suchitwa Mission	Three months				Maintenance of existing community toilets and construction of modern septic tank to 100 people at bund colony in ward Kunnukuzhy ward near Thekkummoodu
4.	Sewered area	4.1	Frequent block, back flow to toilets identified in the survey are to be rectified Temporary measures such as bucket cleaning	Kerala Water Authority	Temporary measures- 3 months				1861 residences are connected to sewer in the area near to river Poojappura, Jagathy, Valiyasala, Chalai, Karamana, Nedumcaud,
		4.2	Permanent solution to prevent overflow through manholes,	Kerala Water Authority	Augmentation of pipeline –one year				Proposal of Kerala Water Authority is to be as per concept plan

			pipelines and pumping stations						
		4.3	Stop the overflow of sewage into drains, and rivers and alternate mechanism is to be in place for stopping the overflow. Ascertain the adequacy of existing old sewer pumping lines, mainlines, sub lines/manholes in the area especially in blocks A, B, and C of sewerage network and revamp it. Adequacy of sewer line in Block B in Thampanoor and East Fort is to be checked. The quantity of water consumption in this area and the quantity of sewage reaching common STP is to be ascertained	Kerala Water Authority	One month				
		4.4	KWA is to do systematic analysis of sewer line blockage date and find out source and probable entry	Kerala Water Authority	One month				

			points of solid wastes into the sewer system. With this information Corporation, and PCB to conduct inspection						
		4.5	Silt trap to prevent the entry of sediment to sewer system	Kerala Water Authority Thiruvananthapuram Corporation					
		4.6	Entry of rain water into the sewer system is to be stopped	Thiruvananthapuram Corporation and Kerala Water Authority	One year				
		4.7	Rain water harvesting/ground water recharge is to be provided wherever possible	State Ground Water Department Thiruvananthapuram Corporation	One year				
		4.8	Entry of solid wastes including sanitary napkin is to be prevented By inspections and by providing facilities such as Modular type incinerator for sanitary disposal facility in hostels, hotels, flat, hospitals, establishments	Thiruvananthapuram Corporation Kerala Water Authority	Six months				
		4.9	Septage	Thiruvananthapuram Corporation					

			treatment facility is to be in place as reported. Septage collection and disposal of private parties is to be regularized. Online system shall be implemented to ensure disposal of septage at treatment plant. Revenue shall be shared with Corporation and water authority	uram Corporation Thiruvananthapuram Corporation	Sixmonths				
5	Solid wastes	5.1	Awareness is to be created in the ward for the segregation, treatment and disposal of solid wastes as per Solid Wastes Management Rules, 2016.	Thiruvananthapuram Corporation Pollution Control Board Health Department	Three months				
		5.2	Aero composting and Material Collection Facility in all 45 wards near river bank	Thiruvananthapuram Corporation	Three months		45	225 lakh	The setting of each aero composting and material collection facility will cost 5 lakh including setting up of shed, leveling of land etc.
		5.3	Aero composting and Material Collection Facility in other areas of all 45 wards	Thiruvananthapuram Corporation	Three months		180	900 lakh	
		5.4	Aero composting and Material	Thiruvananthapuram Corporation	Three months		275	1375 lakhs	

			Collection Facility in other areas of all 55 wards						
		5.5	Adequate number of kitchen bins shall be provided	Thiruvananthapuram Corporation	Three months				
6.	Market		Providing proper waste handling facility for waste water and solid wastes Kannettumukku Pangode	Thiruvananthapuram Corporation	Six months				
7.	Rendering plant		Rendering plant for poultry wastes	Thiruvananthapuram Corporation	Six months				
8.	Slaughter house and rendering plant		Slaughter house	Thiruvananthapuram Corporation	Six months				
10.	Flats and establishments		Strict monitoring of waste disposal (sewage, sullage, bio-degradable waste, non-biodegradable waste) in flats, offices, educational institutions, shops, lodges, auditoriums in surveyed area and also in the catchment of the river i) Verify whether consent to operate of the Board exists	Pollution Control Board, District Office, Thiruvananthapuram Thiruvananthapuram Corporation	Once in three months				

			ii) Verify on compliance of consent conditions in the consent to operate iii) Treated sample should be taken from the flats/establishments once in a month. iv) Ensure proper treatment and disposal facility for sewage, sullage and garbage in the flats and establishments v) Monthly progress report is to be submitted by the District Office to Head Office						
11.	Establishments namely service station, workshops		Strict monitoring of waste disposal (effluent, waste oil and solid wastes) in service station, workshops in surveyed area and also in the catchment of the river i) Verify whether consent to operate of the Board exists	Pollution Control Board, District Office, Thiruvananthapuram Thiruvananthapuram Corporation	Once in three months				

			ii) Verify on compliance of consent conditions in the consent to operate iii) Treated sample should be taken from the flats/establishments once in a month. iv) Ensure proper treatment and disposal facility for waste water in the establishments v) Monthly progress report is to be submitted by the District Office to Head Office						
12	Industrial units namely Hindustan Latex Limited, Thiruvananthapuram Dairy, K.S.R.T.C , Central works Pappanam code, Popular vehicles and services ltd, Killipalam		Strict monitoring of waste disposal (effluent, solid wastes, sludge) in industrial units in surveyed area and also in the catchment of the river i) Verify whether consent to operate of the Board exists ii) Verify on compliance of	Pollution Control Board, District Office, Thiruvananthapuram	Once in three months				

			consent conditions in the consent to operate iii) Treated sample should be taken from the flats/establishments once in a month. iv) Quantity of treated water generated and the quantity of water reused) iv) Ensure proper treatment and disposal facility for waste water in the establishments v) Monthly progress report is to be submitted by the District Office to Head Office						
13.	Sanitation survey is to be done for Neduman gad town		Sanitation survey is to be conducted for 100m on either sides of the Nedumangad town and of 10 m on either sides of polluted streams if any located near Killiyar	Pollution Control Board, District Office, Thiruvananthapuram	Three months				
14,	Sanitation survey is to be done beyond other parts		Sanitation survey is to be conducted for 100m on either sides of the	Pollution Control Board, District Office, Thiruvananthapuram	Three months				

	of the city		other parts of streams namely Ulloor stream, Pattom stream, Kannamoola stream, Thekkanankara canal and Parvathy Puthanar and of 10 m on either sides of polluted streams if any located nearby						
15.	Water quality monitoring of Karamana and Killiyar		Water quality monitoring of different stations of Karamana and Killiyar, and its streams and submission of water quality report once in four months	Pollution Control Board, District Office, Thiruvananthapuram	Once in four months				
16.	Awareness		Awareness for residence association:	Suchitwamission/LSGD/Corporation	Once in a month				
17	Training on solid waste and liquid waste management		Training to children, youth, Asha workers and other stakeholders	Suchitwamission/LSGD/Corporation	Once in a month				
18.	Capacity building		Capacity building of community groups, monitoring system and active involvement of residence association is necessary		Once in a month				

7.2 ACTION PLAN OF KERALA WATER AUTHORITY

Pollution abatement of Karamana – Killi river Action Plan of Kerala Water Authority

Preventing Overflow from pumping stations

- Installation of additional pumpset at Kannammoola pump house. Work awarded – Target 15.02.2019
- Installation of additional pumpset at Murinjapalam pump house. Work awarded – Target 15.02.2019
- Installation of additional pumpset at Plammood pump house . Work awarded – Target 15.02.2019
- Installation of additional pumpset at Pattoor pump house. Work awarded – Target 15.02.2019

Pollution abatement of Karamana – Killi river Action Plan of Kerala Water Authority

Preventing Overflow from pumping stations

- Providing new pumping main from Mudavanmughal pump house to Jagathy junction – Work awarded, Tar cut sanction pending - Target 31.10.2019
- **Installation of new pump sets at Mudavanmughal (2 No.)**
Estimated Amount – Rs.13,00,000/-
(Proposed Under State Plan -Target 31.12.2019)
- **Installation of new pump sets at Enchakkal (1No.)**
Estimated Amount – Rs.10,00,000/-
(Proposed Under State Plan -Target 31.12.2019)

Pollution abatement of Karamana – Killi river
Action Plan of Kerala Water Authority

Preventing Overflow from pumping stations

Upgradation of Pump House

- Upgradation of Thaliyal pump house (Estimate :160 lakhs)-
– **Proposed under State Plan - Target 31.12.2019**
- Upgradation of Aranoor pump house(Estimate : 77 lakhs)
– **Proposed under State Plan - Target 31.12.2019**

Pollution abatement of Karamana – Killi river
Action Plan of Kerala Water Authority

Preventing Overflow into streams/ drains

Laying of new pumping line

- Providing new pumping main from Mudavanmughal pump house to Jagathy junction – Work awarded. Tar cut sanction pending. Target 31.12.2019
- Extending Pumping Main from Stilling Chamber at Muttathara to Sewage Treatment Plant (AS :343 lakhs). Work held up for want of sanction from BSF. Target 31.03.2019.

Pollution abatement of Karamana – Killi river
Action Plan of Kerala Water Authority

Preventing Overflow into streams/ drains

Medical College Sewage Treatment Plant.

- Installation of 5 MLD treatment. Target 31.3.2020

Pollution abatement of Karamana – Killi river
Action Plan of Kerala Water Authority

Preventing Overflow into streams/ drains

- Rehabilitation of sewer line near Thaliyal pump house (Estimate :103 lakhs) – **Proposed under State Plan - Target 31.12.2019**
- Rehabilitation of sewer line in Sreedevinagar (Estimate :29 lakhs) –**Proposed under State Plan - Target 31.12.2019**

Pollution abatement of Karamana – Killi river
Action Plan of Kerala Water Authority

Preventing Overflow into streams/ drains

Abstract of various works undertaken by KWA during the last 3 years

Nature of Work	Work Completed (In Rs. Lakhs)	Work In progress (In Rs. Lakhs)	Estimation / Tendering In progress (In Rs. Lakhs)	Total
Extension of Sewer Network	1110	5385	7945	14440
Rehabilitataion of Existing Pumping System	160	163	53	375
Rehabilitataion of Existing Sewer Network	635	741	1190	2567
New STP at Medical College			1916	1916
Total	1905	6289	11104	19298

Pollution abatement of Karamana – Killi river
Action Plan of Kerala Water Authority

Solution for uncovered areas - Septage Management



- o Since no networks are available the ground water pollution/dischage into streams has to be controlled. So the usage of septic tank has to be made mandatory
- o Collection tankers to be arranged by Corporation
- o Construction of septage treatment plant is completed at Muttathara and is ready to receive septage

Pollution abatement of Karamana – Killi river
Action Plan of Kerala Water Authority

New coverages – Block F to R



- o Work in progress in blocks F,I,J,K,L
Target - 31.12.2019
- o For other uncovered areas septage management is the option

Pollution abatement of Karamana – Killi river
Action Plan of Kerala Water Authority

Other General Measures

- Developing database in GIS platform engaging Kerala State Remote Sensing Agency (Rs. 10 lakhs)
(Proposed under State Plan-Target 30.9.2019)
- Awareness programmes are to be conducted through Suchitwa mission/ Corporation to residents not to dispose solid waste into the sewer system and also not to connect rain water to sewer system.

7.3 ACTION BY THIRUVANANTHAPURAM CORPORATION AS PER ACTION PLAN AS ON 23-2-2019

Sl.No.	Project		Proposed action	Agency	Target date	<u>Action taken by Thiruvananthapuram corporation</u>	Remarks
1.	Sanitation	1.1	Providing of toilets to 320 residences (35+9+16+246+3) with treatment and disposal system for sewage and sullage-DEWATS	Thiruvananthapuram Corporation	Three months	Portable toilets are proposed in parvathiputhanar residents having no toilet units.40 units are proposed	As per survey on Karamana and Killiyar and also that on Parvathiputhanar there are residences which are having no toilets.
2.	Toilet waste disposal	2.1	Providing of community/individual DEWATS systems for sewage and grey water for the 8150 (7000+1132) residences having discharge into rivers, soak pit. Grey water is also to be diverted to the above DEWATS system in the unsewered area Or Provide sewerline with pumping station	Thiruvananthapuram Corporation Kerala Water Authority Revenue department Irrigation department and Local Self Government is to allocate the space	Three months for DEWATS or Two years for sewer line and Pumping stations		The discharge from septic tank is also to be diverted to DEWATS

3.	Community toilets	3.1	Construction of new community toilets with treatment system	Thiruvananthapuram Corporation Kerala Water Authority Suchitwa Mission Revenue department Irrigation department and Local Self Government is to allocate the space	Six months	Pattom Thekkummodu bund CT constructed, Rajaji nagar CT constd. New projects are proposed at Putharik andam and medical college. Work in progress at medical college site.	In the sanitation survey of Parvathyputhanna, construction of new community toilet for 100 people at Pattom side of bund was proposed by SEUF.
		3.2	Maintenance of existing community toilets and providing of treatment system	Thiruvananthapuram Corporation Suchitwa Mission	Three months	Project for maintenance of Kunnukuzhy CT ongoing. Jagathy, Edappazham, Karamana, Manacaud, Poojappura, Eastfort, Perorkada, Kodungoor etc PT work ongoing.	Maintenance of existing community toilets, and construction of modern septic tank for 100 people at bund colony in ward Kunnukuzhy near Thekkummodu
			Systematic analysis of sewerline, blockage date, and find out source and find out probable entry points of solid wastes into the sewer system. With this information, Corporation and PCB to conduct inspection.				

		4.5	Silt trap to prevent the entry of sediment to sewer system	Kerala Water Authority Thiruvananthapuram Corporation			
		4.6	Entry of rain water into the sewer system is to be stopped	Thiruvananthapuram Corporation and Kerala Water Authority	One year		
		4.7	Rain water harvesting/ground water recharge is to be provided wherever possible	State Ground Water Department Thiruvananthapuram Corporation	One year	Done according to KMBR	
		4.8	Entry of solid wastes including sanitary napkin is to be prevented By inspections and by providing facilities such as Modular type incinerator for sanitary disposal facility in hostels, hotels, flat, hospitals, establishments	Thiruvananthapuram Corporation Kerala Water Authority	Six months	Napkin incinerators are provided in various schools	
		4.9	Septage treatment facility is to be in place as reported. Septage collection and disposal of private parties is to be regularized.	Thiruvananthapuram Corporation		Purchasing sucking machine with vehicles with different capacities are proposed project under process	

			Online system shall be implemented to ensure disposal of septage at treatment plant. Revenue shall be shared with Corporation and water authority	Thiruvananthapuram Corporation	Six months		
5.	Solid wastes	5.1	Awareness is to be created in the ward for the segregation, treatment and disposal of solid wastes as per Solid Wastes Management Rules, 2016.	Thiruvananthapuram Corporation Pollution Control Board Health Department	Three months		
		5.2	Aero composting and Material Collection Facility in all 45 wards near river bank	Thiruvananthapuram Corporation	Three months	Aerobin and mcf are proposed in 100 ward of Tvpm corporation Poojappura, karamana ,kunjalummoodu ,manacaud thamalam,ambal athra etc constructed .balance ward works are starting stage	The setting of each aero composting and material collection facility will cost 5 lakh including setting up of shed, leveling of land etc.
		5.3	Aero composting and Material Collection Facility in other areas of all 45 wards	Thiruvananthapuram Corporation	Three months	Projects proposed in 100 wards dpc approval accorded. Estimate for same under preparation	
		5.4	Aero composting	Thiruvananthapuram Corporation	Three months	Projects proposed in 100 wards dpc approval accorded. Estimate for same under	

			and Material Collection Facility in other areas of all 55 wards	hapuram Corporation	months	preparation	
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		5.5	Adequate number of kitchen bins shall be provided	Thiruvananthapuram Corporation	Three months		
6.	Market		Providing proper waste handling facility for waste water and solid wastes Kannettumukku Pangode	Thiruvananthapuram Corporation	Six months	SWM projects aerobin proposed in various market	
7.	Rendering plant		Rendering plant for poultry wastes	Thiruvananthapuram Corporation	Six months	Site may be made available	
8.	Slaughter house and rendering plant		Slaughter house	Thiruvananthapuram Corporation	Six months	NOC awaited from PCB	
10.	Flats and establishments		Strict monitoring of waste disposal (sewage, sullage, bio-degradable waste, non-biodegradable waste) in flats, offices, educational institutions, shops, lodges, auditoriums in surveyed area and also in the catchment of the river i) Verify whether consent to operate of the Board exists ii) Verify on compliance of consent conditions in the consent to operate iii) Treated sample	Pollution Control Board, District Office, Thiruvananthapuram Thiruvananthapuram Corporation	Once in three months		

			should be taken from the flats/establishments once in a month. iv) Ensure proper treatment and disposal facility for sewage, sullage and garbage in the flats and establishments v) Monthly progress report is to be submitted by the District Office to Head Office				
11.	Establishments namely service station, workshops		Strict monitoring of waste disposal (effluent, waste oil and solid wastes) in service station, workshops in surveyed area and also in the catchment of the river i) Verify whether consent to operate of the Board exists ii) Verify on compliance of consent conditions in the consent to operate iii) Treated sample should be taken from the flats/establishments once in a month. iv) Ensure proper treatment and disposal facility for	Pollution Control Board, District Office, Thiruvananthapuram Thiruvananthapuram Corporation	Once in three months		

			waste water in the establishments v) Monthly progress report is to be submitted by the District Office to Head Office				
12	Industrial units namely Hindustran Latex Limited, Thiruvananthapuram Dairy, K.S.R.T.C , Central works Pappanam code, Popular vehicles and services ltd, Killipalam		Strict monitoring of waste disposal (effluent, solid wastes, sludge) in industrial units in surveyed area and also in the catchment of the river i) Verify whether consent to operate of the Board exists ii) Verify on compliance of consent conditions in the consent to operate iii) Treated sample should be taken from the flats/establishments once in a month. iv) Quantity of treated water generated and the quantity of water reused) iv) Ensure proper treatment and disposal facility for waste water in the establishments v) Monthly progress	Pollution Control Board, District Office, Thiruvananthapuram	Once in three months		

			report is to be submitted by the District Office to Head Office				
16.	Awareness		Awareness for residence association:	Suchitwamission/LSGD/Corporation	Once in a month		
17	Training on solid waste and liquid waste		Training to children, youth, Asha workers and other stakeholders	Suchitwamission/LSGD/Corporation	Once in a month		

	managem ent						
18.	Capacity building		Capacity building of community groups, monitoring system and active involvement of residence association is necessary		Once in a month		

7.4 ACTION PLAN BY IRRIGATION DEPARTMENT

REJUVANATION MEASURES IN KARAMANA-KILLI RIVER

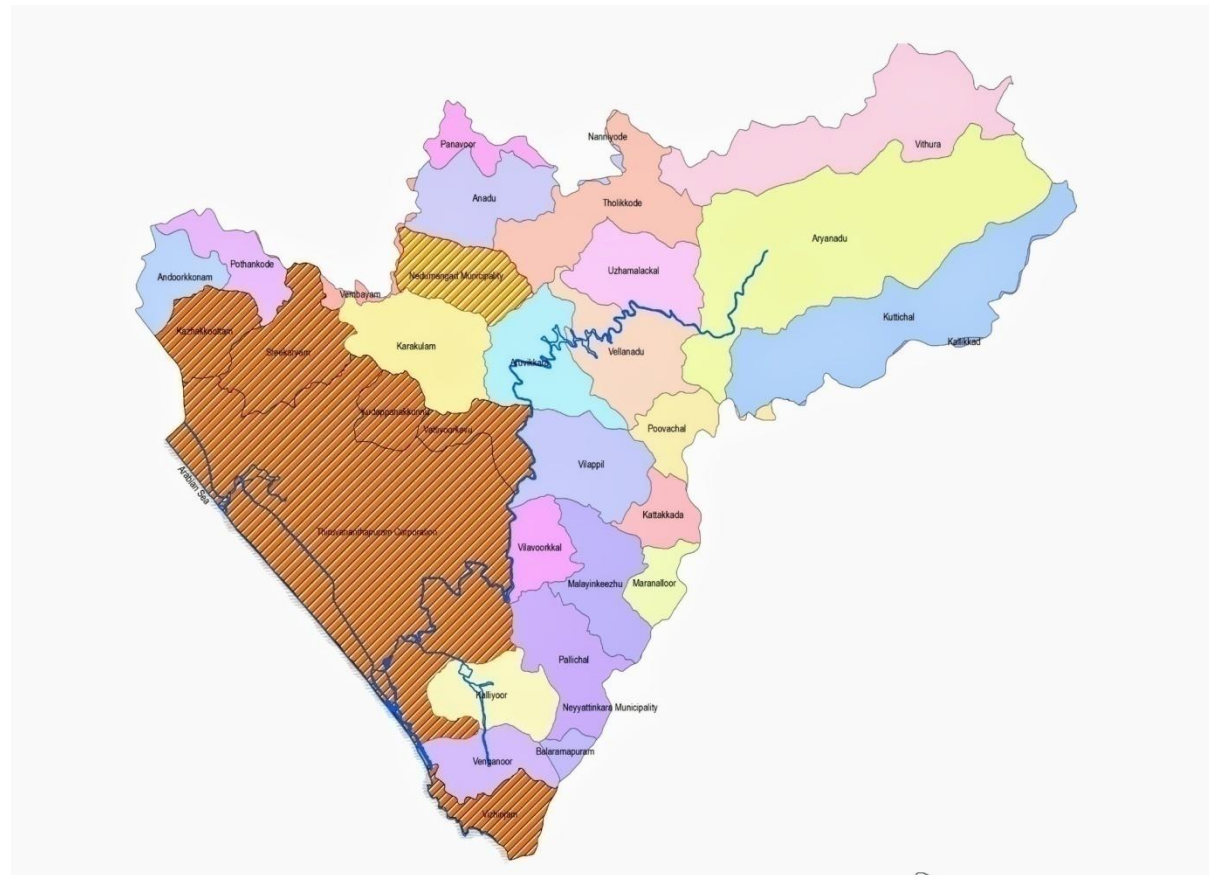
1. Introduction

The pollution in the rivers is on the rise due to fast urbanization and industrialization, lack of sanitation and waste management services. Karamana and Killi river in Thiruvananthapuram are among the polluted rivers. Pollution in Karamana and Killi river is increasing significantly especially due to discharge of effluents, domestic waste, dumping of

solid waste and biomedical wastes etc into the river. Also the stretch of Karamana river at Moonnattumukku has been classified in the polluted river in India by Central Pollution Control Board (CPCB)

Thiruvananthapuram city people are facing problems of flooding frequently and pollution of the river continuously hence; there is urgent need for measures to be taken for flood mitigation and pollution abatement for Killi and Karamana rivers. The impact of pollution and flood creates nuisance for the people residing along the river side. It affects the aquatic life and the marine ecology. Use of river water for bathing and other domestic purposes is not suitable and leads to spread of water borne diseases. In view of above, pollution abatement measures need to be adopted.

2.Karamana River Basin



Length of Karamana river 74 km

Catchment area 690 sq km

Average annual rain fall 2850mm

Annual yield 860Mm³

Karamana river originates from the vicinity of the Agasthiarkoodam about 1600 m above the sea level and has a length of 66 km .Its upper tributary rivers are the Kaaviyaar, Attayaar, Vaiyappadyaar and Thodayaar. The river flows in a south - south west direction before flowing into the Arabian Sea.

The largest tributary of the Karamana is the Killiyar, which flows for a distance of 24 kilometres. It has five [anicut](#)s on it which regulates the flow of water. Part of the water is diverted into the Kochar channel which in turn feeds the Padmatheertham pond outside the [Padmanabhaswamy Temple](#). There are several temples located along the Killiyar's banks, the most famous of which is the Attukal Temple. The Killiyar drains the [Nedumangad](#) forest and its basin is rich in avian fauna.

water on the western side of the island is blocked due to heavy silting at Munnattumukku and accretion of sea sand at Kunnumanal. During high tide, seawater from the estuary surges up to Thiruvallam through the eastern side of Edayar. When the tide ebbs, the dirty water from the Parvathy Puthanar rushes in, covering the upstream portions up to Thiruvallam and beyond

2.1 Main Drains in Thiruvananthapuram Corporation

The main drains in Thiruvananthapuram corporation in Karamana basin are Pazhavangadi Thodu, Pattom thodu, Ulloor thodu, Kannammoola thodu (Amayizhanjan thodu), Kariyil thodu, Choozhampala thodu, Ananthanthodu thodu, Edanada thodu, Arayalloor thodu, Ela thodu, Thiruvallom thodu, Pallathukadavu thodu, Azhankal thodu, and Koori thodu. Thekkenakkara canal and Parvathy Puthanar. Due to steady increase in population, the needs for housing complexes and colonies have also increased. The overall development activities intruded with the drainage system and new storm water drains have become the imperative need of the day.

2.1.1 Pazhavangadi thodu

Pzhavangadi thodu starts from observatory hills and KWA water treatment plant area and merges with Amayizhanjan thodu near Kannammoola and has a length of about 5.4km. It is the main discharge canal of Thiruvananthapuram Municipal Corporation and traverses through the important areas of the city such as Thampanoor, Pazhavangadi, Thakaraparambu, Vanchiyoore and Pattoor. The width of the thodu varies from 3 to 6m. Many road side drains make discharge into this thodu. Periodic de-silting of the thodu is essential as the disposal of solid material into the thodu continues unabated.

2.1.2 Ulloor thodu

Ulloor thodu originates from pothencodu area and enters the TMC area at Edavakode and passes through the northern part of the city such as Mannanthala, Ulloor, Chalakuzhy and Murinjapalam and reaches Kannammoola where it joins with the Amayizhanjan thodu. From Edavakode to Kannammoola the Ulloor thodu has a length of about 8km and a width of 10 to 15m. Dhobis in the city used to wash cloths in this thodu. Some portion of thodu is noticed to be highly contaminated and the flow is stagnant in several reaches. Several natural drains join with this thodu bringing silt and debris to Kannammoola thodu. Due to solid wastes disposal and silt deposit inside the thodu the cross sectional area reduces leading to over flow of the thodu during rainy season resulting in flooding in the low lying areas on both sides of the thodu. Further it is observed that sewage and sullage from the houses on the banks of thodu are directly diverted into this canal making the water contaminated.

2.1.3 Pattom thodu

Pattom thodu is a natural drain with an average width of 3to6m and length of about 6.5km. It starts from the upper reaches of Kudappanakunnu, on the eastern part of the city. Pattom thodu finally discharges into Amayizhanjan thodu at Kannanmmola . Pattom thodu is silted up resulting in overflow and flooding of nearby areas of the city. There is encroachment on the silted area of the canal, which in turn, reduces the carrying capacity of the canal. Pattom thodu is to be de-silted and adequate side protection has to be given to prevent further encroachment and to maintain its carrying capacity.

2.1.4 Kannammoola thodu

Kannanmoola thodu also called Aamayizhanjan thodu starts at about 0.7km upstream of Kannanmoola bridge. Before joining Akkulam lake Ulloor thodu and Pattom thodu joins with Kannanmoola thodu. The Kannanmoola thodu has a width of 20 to 30m and a length of about 5.7km. The Pazhavangadi thodu joins at about 0.25km below the Ulloor and Pattom thodu confluence. As in the case of other canals in the city, Kannanmoola thodu is also in a very poor condition with low carrying capacity as a result of deposition of silt and debris, vegetation, formation of delta at the upstream and down streams of the foot bridges, poor maintenance, bank erosion and low velocity. Unless the condition is scientifically improved, possibility of flooding in this area cannot be controlled.

2.1.5 Thekkenakkara canal

The Thekkenakkara canal is one of the main flood water canals which starts from Karimadom colony southeast of East fort and passes through the most populous areas like East fort, Padmanabhaswamy temple, Sreevaraham, Muttathara, NH bye-pass, and ends in Parvathy Puthanar near Puthenpalam. The entire stretch of the thodu is now choked with silt and debris. About half of the length of the thodu is covered with slab, and desilting is very tedious in this stretch. Thekkenakkara canal has a width of 3m and length of 2.5km. Several small drains join with this canal in various portions, and in many places these canals are to be reconstructed.

2.1.6 Parvathy Puthanar

The major man-made drain in the city is Parvathy Puthanar (Travancore Shoranur canal T S canal) with Edayar at south end and Aakkulam lake at the north. 36 small drains from the city area discharge into this canal. Parvathy Puthanar runs parallel to the sea shore through the coastal belt of Thiruvananthapuram city. Some of the reaches of the canal are badly damaged and so need to be protected.

Besides the above, there are a number of drains and leading drains in the city area like Tettiyar thodu, Pangappara thodu, Kaimanam Azhamkal thodu, Amathara thodu, Koori thodu, Vattakkayal Thodu. Other important drains contributing to storm water drainage to the city canals are Choozhampala thodu, Anathana thodu, Edanada thodu, Arayalloor Ela thodu and Thiruvallom Pallathukadavu thodu.

The thodus mentioned above originate within the city limits flows through thickly populated areas and ultimately discharge into the sea through Poonthura estuary and Veli estuary / Akkulam Lake.

An In-depth study of the present status of the drains, their carrying capacity, anticipated flood discharge and the probable routing / rerouting may be devised and implemented for restoring / enhancing the status of drainage network inside the city to solve the issue to a significant extent was done by RITES Ltd. and suggestions to tackle the situation were included in the report.

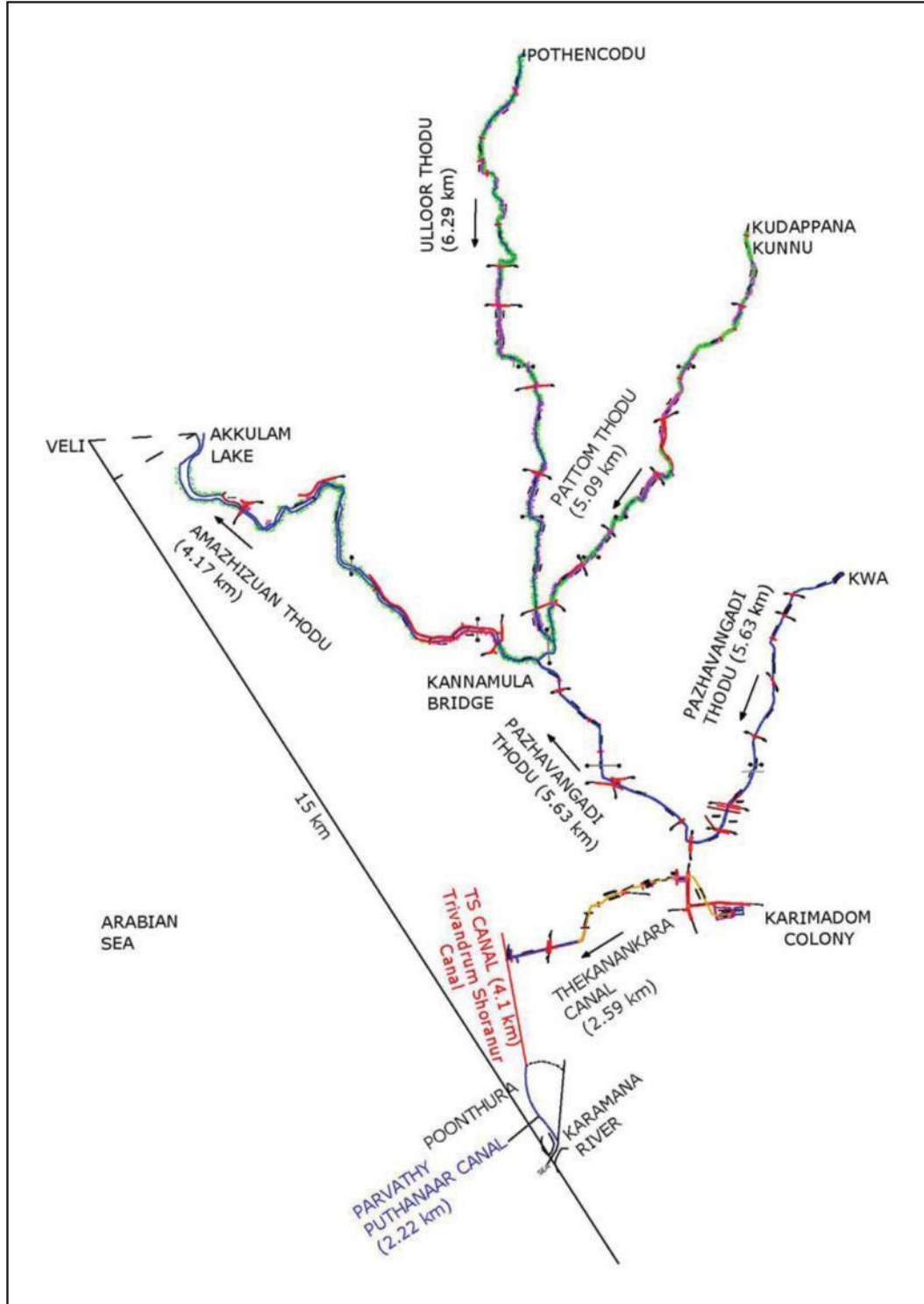
3.Gap Analysis

1. The average flow of water in Karamana River is 50 to 60 cumecs but as RITES study the estimate 1 in 25 yr flood in Karamana river is 830 cumecs and in Killi river the average flow is 10 to 20 cumecs but as per RITES study the estimate 1 in 25 yr flood in Killi river is 189 cumecs. Considering this study the stage of the rivers at different cross sections along the river in the city limit is analysed so that the top level of the embankments is fixed on the adjacent sides of the river inside the city limit to accommodate the design flood. To meet this situation bank heights to be increased at an average height 2.5 m on some locations .
2. Suitable bund sections and protective measures along the different cross section of the rivers in the city limit are to be proposed
3. Suitable shutter arrangements are to be provided to stop reverse flow into the drains reaching these rivers.
4. Flood mitigation pollution abatement in Karimadom and adjoining colony area by adopting suitable solutions.
5. Control of pollution in Karamana river and Killi river for bathing purpose

6. Suitable mechanism for the free flow of flood waters to the Arabian sea from the rivers and thodus in the city limit.
7. Control of Saline intrusion to the rivers Karamana and Killi during tidal effect.
8. Control the Encroachment in the banks of the rivers.

As per the sanitation survey conducted by the Pollution Control Board the households on the banks of the river are directly or indirectly discharging sewage to the river. About 35 residences are having no toilets. The sewerage system is subjected to frequent blocks, overflows and leakage.

The Pollution Control Board along with Corporation and Water Authority has to address these problems by separating storm water from sewage pipes, revamping the pumping system and providing community toilets for residences having no toilets.



Drainage net work Thiruvananthapuram city

4. Long term flood mitigation measures

The causes for flooding of Killi and Karamana rivers have been investigated and main reasons are as follows:

1. Height of the river bunds are low and not adequate to meet even normal flood
2. The river bunds are damaged at several places all along the river reaches
3. Breaches to the river bunds at several locations along the river stretches
4. The river channels are choked due to siltation in the river bed
5. Obstructions to the free flow of river channel due to presence of boulders debris, garbage in the river
6. Restrictions to the free flow of river due to jungle growth on the retaining walls of the bund
7. Back flow through the out fall drains / culvers into the rivers due to damage of the shutters
8. Encroachments to the river bund by adjacent construction activities
9. Encroachments to the river bund by local habitation
10. Obstruction to the river drainage system at sea mouth due to formation of sand bar at Poonthura pozhi

The flood mitigation measures suggested for Karamana and Killi rivers are broadly classified as

- (i) Structural measures and
- (ii) Non structural measures

4.1 Structural measures suggested

- Increase of height of the river bunds on either side

- Strengthening of river bunds
- Capping of breached river bunds
- Repair of damaged sections of river bunds
- Provide shutters to drains outfall in to the river
- Construction of breakwater at Poonthura Pozhi
- Suitable structures for saline water intrusion

4.2 Non structural Measures

- De-siltation of silt up material on the river bed
- Removal of rock outcrops on the river bed
- Removal of garbage and debris
- Cutting and removal of weeds, jungle growth etc grown on the side walls of river bunds
- Evacuation of encroachments alongside the river bunds and rehabilitation

5. 1Flood mitigation of the Killi and Karamana River

- The average flow of water in Karamana River is 50 to 60 cumecs but as RITES study the estimate 1 in 25 yr flood in Karamana river is 830 cumecs and in Killi river the average flow is 10 to 20 cumecs but as per RITES study the estimate 1 in 25 yr flood in Killi river is 189 cumecs. Karamana and Killi river, the banks of the rivers are not high enough. Considering the above, the sections are designed at various identified points and bunds are to be raised to 2.5m height at various locations. The detailed chart is attached showing the flow levels and height of the bunds.

Geo textile can be used in earthen bunds at various locations which will stabilize the slope of the bund. In heavily damaged locations, concrete/rubbles bunds are proposed. Financial aspects are arrived for an amount of Rs.2217.11lacks

- Along the Killi and Karamana river several side drains outfall into the river. 37 drain outlets are in Killi river and 27 drain outlets are in Karamana river, all these are taken for the flood gate design. The provision is provided for the shutters for an amount comes to Rs.64lacks

Non structural measures suggested are:

The condition of existing rivers as natural drainage for storm water is deteriorating day by day. Dumping of domestic wastes and non domestic waste from houses, markets, hotels, etc., discharge of sewages directly into the rivers and unscientific and indiscriminate methods of sand mining are resulting in the erosion of river bed and its banks. Due to reduced cross sectional area of rivers, flash floods have become common during downpour. Hence the blockages in the rivers have to be cleared to allow the storm water to flow free without any obstructions.

5.2Flood mitigation measures of Karimadom colony

The reclamation of water bodies and low lying areas or encroachments for development is the main reason for water logging. Most of the flood moderation zones inside the city have already been converted into concrete dwellings and apartments resulting in excessive run off. Karimadom colony being a low lying area is water logged during rains. The situation will be worse during the periods of heavy rains in the city. Lack of proper storm water drainage is a serious problem.

There are two drainage channels draining the storm water from Karimadom colony one drain is flowing towards eastern side and joins with Killi River and other drain is flowing towards western side and joins with Parvathi Puthanar through Thekkanakara canal. Besides the above drainage channels, there is a Karimadom tank which was designed as a flood cushion during flooding. Under normal rainfall conditions, surface runoff within the low lying area of Karimadom colony would drain by gravity via the internal drains to the floodwater storage pond of Karimadom tank for storage and subsequent disposal to the Thikkanakara canal. The Karimadom tank is silted up over the years and lost its capacity and could not able to store the drain water.

A detailed study on Karimadom colony, is done by RITES to arrive at a reasonable quantification of water accumulated at the colony due to a flood of 1 in 25 years has been carried out. The 25 year flood depth map for Karimadom area has been prepared. The amount of water that can be accumulated in and near Karimadom colony due to a flood of 1 in 25 year intensity has been assessed. Based on this study Structural measures Repairing /strengthening of damaged on both sides of bund of Thekkanakara canal is proposed

- 1. Increase of bund on both side of Thekkanakara canal by 50cm (h) x50cm (w)**
- 2. Providing 3m height fencing on both sides of the bund**
- 3. Providing shutter in the drain near Killi palam bridge to stop reverse flow of water**
- 4. Providing small drains from Karimadom colony to outfall into Thekkanakara**

canal

5. Rejuvenation of Karimadom Tank by constructing a sheet pile storage tank

6. Providing culvert between Chala dumping yard and Karimadom tank

5.3 Rejuvenation of Karimadom tank

The Karimadom tank is one of the detention storage tank located in Thiruvananthapuram city to discharge storm water from the adjoining lowing areas. In order to improve the Karimadom tank and make the tank to serve its purpose for a longer time period, it is proposed to construct a compound wall with gates around the Karimadom Colony Tank. For rejuvenation of Karimadom tank, it is proposed to make a tank of 70 m x 80 m. The tank will be desilted up to 3 m. Beautification will be done surrounded the area. Considering the site condition it is proposed to provide steel sheet pile surrounded the tank. Above the steel sheet pile, 3 m fencing will be provided to prevent throwing of garbage into the tank.

5.4 Improvement measures suggested to drains / thodus

All the 5 identified thodus viz Aamayizhanjan thodu (Kannamoola thodu), Pazhavangadi thodu, Pattom thodu, Ulloor thodu and Thekkanamkara canal are passing through thickly populated areas of Thiruvananthapuram city and are silted up heavily due to poor maintenance lead to drastic reduction in water carrying capacity. The following improvement measures are suggested after the detailed surveys and studies carried out on the drains.

Long Term Structural Measures

- 1. Increase of height of the side walls / bunds by 50 cm on either side**
- 2. Strengthening canal / thodu walls / bunds with RR masonry**
- 3. Fencing of the canals / thodus on either side.**

Non structural measures

- 1. Desiltation**
- 2. Removal of garbage, debris**

3.Cutting and removal of weeds, jungle growth etc grown on the side walls of thodus

4.Evacuation of encroachments and rehabilitation

5.5 Development of Parvathy Puthnar canal

Parvathy puthannai one of main source of pollution to Karamna and Killi river.As per the report on City Development Plan, Thiruvananthapuram by Thiruvananthapuram Municipal Corporation & Local Self Government Department, Government of Kerala under Jawaharlal Nehru National Urban Renewal Mission (JNNURM), protection works are required at Kovalam to Panathura, Moonnattumukku to SM lock, Vazhavila to Akkulam, fencing the canal to prevent pollution and Renovation of Poonthura to Akkulam reach of Parvathy Puthanar for development of Parvathy Puthanar canal. This will help for free flow of flood water from Thekkanakara canal to the sea at Poonthura Pozhi. This work has to be taken up as per the recommendations of JNNURM study in conjunction with the present drainage improvement works suggested.Now the Improvements to the Parvathy Puthanar is started . Government has set aside an amount of 150 crore for improving Parvathy Puthanar . This project includes cleaning of Parvathy Puthanar rehabilitation and widening the canal to a width of 25 m with 5m supply line area on either side. Necessary land acquisition in this rgard is also included in this project.

5.6 Structural measures for sea opening at poonthura

It is necessary to construct two breakwaters at Poonthura to prevent the formation of the sandbar at the estuary and keep the river mouth open so as to ensure continuous discharge into the sea. The annual sand bar formation at the river mouth prevents the free flow of storm water into the sea and leads to water stagnation in the lake that is responsible for the pollution of the water and flooding and water logging in the upstream areas up to Thampanoor and beyond in the city. The breakwaters suggested at the sea mouth will prevent the formation of sand bar and keep the mouth open round the year to evacuate the storm water freely.

The proposed construction of breakwaters at Poonthura to keep the mouth open always together with other measures proposed for Storm Water Drainage in Thiruvananthapuram city will reduce the flooding in the low lying area in the city. For this detailed scientific study by CWPRS/IIT

6. Action taken

Projects were proposed both to address the solid and liquid waste management and also for the awareness campaign against pollution. As per the study of RITES, detailed discussions were made on pollution abatement of Killi and Karamana river with technical members. In this regard the following works were done in Killi and Karamana River

1. Providing fencing GI-chain linked fencing both sides of various bridges upstream and downstream along Killi and Karamana River and Thiruvallam Thodu

Amount:- 211 lakhs

Pollution in Karamana and Killi river is increasing significantly discharging of effluents, domestic waste dumping of solid waste, bio-medical waste into the river. This pollution creates nuisances for the people residing along the river side and also affect the aquatic life of the river as well as marine ecology. In view of above, pollution abatement measures need to be adopted. Hence fencing are provided in bridges within the city area of Killi and Karamana river for minimizing pollution in the river

2. Bio diversity Park at Karamana, Walk way at Azhankal bund

Amount: 200.16 lakhs

Clean and beautiful river creates a healthy and attractive environment for recreation and tourism. The beautification works by providing landscaping synergistic with the natural condition and local tradition. Bio-diversity park is one of the best solution which not only reduces air pollution but also prevent soil erosion and people can realize the responsibility of maintaining the natural environment of river as clean as possible. Therefore bio-diversity park was proposed at right bank of Karamana river down stream of Karamana NH 47 road bridge. The local residents association and the people representatives has come forward with the project. This area is highly enriched in the soil fertility and various types of plants and shrubs. This park will act as a leisure place for local residents as well as nearby residents.

3. Constructing a check dam in Karamana river at Kalady

Amount:- 61.6 lakhs

Karamana river is the major river which passes near to the capital city to Thiruvananthapuram and reach to the Arabian Sea through Poonthura Pozhi, many infiltration galleries of Kerala Water Authority and for local drinking water projects and so many Balikadavus and bathing ghats situated on both sides of Karamana river. There are many temples and four existing kadavus in this area and experiences scarcity of water during drought season. In addition the salt water and sewage from the lower stretches comes to the upper stretches up to 11 km during high tides. Therefore this check dam is proposed for an about 350m down stream of Karamana NH road bridge.

3. An integrated solid waste management at Thiruvallom Balikadavu including bio-gas plant and An integrated solid waste management at Thiruvallom thodu branch of Karamana river
Amount:-131.45 lakhs

Thousands of devotees visiting the temple are exposed to health hazards caused by the heavy pollution of the down stream stretches of the Karamana river especially on Thiruvallom Thodu which is a branch of Karamana river. The stagnant water and accompanying stretch at the bathing ghats put off even the most determined devotee from taking the customary bath. The devotees immerse themselves in this polluted water hence the Devesom Board had to install pipe water showers at the bathing ghats. In Karamana river, joins the Killi river near pallathukadavu, highly polluted Parvathy Puthanar joins the Karamana at Munnattumukku. When the heavy tides, these polluted water and sea water enters into these Thiruvallam thodu and kadavus. For minimize the Intensity of pollution the above work was proposed.

4. Dhobi ghat in Karamana river at Kaladi
Amt:-10 lakhs

There are number of dabhies whose livelihood depends on the business of washing the clothes. They wash the clothes in the nearby water body. Other infrastructure like toilet blocks also needs to be developed and maintain the good sanitation at the ghats. So many dobhi ghats are existing along the both banks of the Karamana river. Most of the dhobi ghats are dilapidated conditions. Hence the maintenance of the dobhi ghats are became most necessary. Hence this project was proposed right bank near Kaladi about 350 m down stream of NH road bridge and this was used many dhabies daily.

Table: Bund section required in Killi River

CS No	Chainage (inm)	Right Bank Level (in m)	Left Bank Level (in m)	25 Flood Level (in m)	Diff floodlevel (m)		Bund To beraised (m)	
					Right Bank	Left Bank	Right Bank	Left Bank
1	0.00	4.411	3.533	5.7	1.289	2.167	2	2.5
2	125.03	2.783	4.153	5.7	2.917	1.547	3.5	2.5
3	264.67	4.332	3.646	5.7	1.368	2.054	2	2.5
4	394.70	5.553	4.201	5.7	0.147	1.499	0.5	2
5	500.00	4.593	6.113	5.7	1.107	0.413	2	0
6	605.35	4.366	2.366	5.7	1.334	3.334	2	3.5
7	716.93	4.539	3.164	5.7	1.161	2.536	2	3
8	828.70	4.219	4.375	5.71	1.491	1.335	2	2
9	933.94	4.218	1.281	5.73	1.512	4.449	2	5
10	1035.13	3.087	2.778	5.74	2.653	2.962	3	3.5
11	1136.23	4.103	2.566	5.74	1.637	3.174	2	3.5
12	1240.16	4.511	4.112	5.74	1.229	1.628	2	2
13	1343.96	4.322	2.934	5.74	1.418	2.806	2	3.5
14	1451.43	3.653	5.31	5.77	2.117	0.46	2.5	1
15	1554.72	2.786	3.033	5.78	2.994	2.747	3	3
16	1654.14	3.702	3.211	5.79	2.088	2.579	2.5	3
17	1749.80	2.876	2.791	5.79	2.914	2.999	3	3.5
18	1849.14	3.577	4.912	5.79	2.213	0.878	3	1
19	1954.44	3.433	3.877	5.79	2.357	1.913	3	2.5
20	2049.20	6.103	5.222	5.80	0.303	0.578	0	1
21	2148.32	3.683	5.194	5.79	2.107	0.596	2.5	1
22	2256.41	3.897	3.128	5.76	1.863	2.632	2.5	3
23	2355.45	4.788	3.612	6.15	1.362	2.538	2.5	3
24	2440.75	5.911	7.638	6.14	0.229	1.498	0.5	0
25	2541.63	5.736	7.311	6.14	0.404	1.171	0.5	0
26	2638.33	4.662	5.986	6.14	1.478	0.154	2	1
27	2735.25	4.063	6.122	6.56	2.497	0.438	3	1
28	2829.63	3.792	5.993	6.70	2.908	0.707	3	1
29	2936.55	6.211	6.299	6.66	0.449	0.361	1	1
30	3037.06	5.877	6.633	6.64	0.763	0.007	1	1
31	3142.04	6.305	6.234	6.74	0.435	0.506	1	1
32	3235.77	5.511	6.894	6.74	1.229	0.154	1.5	0
33	3328.03	4.223	6.744	6.68	2.457	0.064	3	0
34	3436.36	4.118	7.043	6.44	2.322	0.603	3	0
35	3537.98	6.912	5.932	7.35	0.438	1.418	1	2
36	3630.02	6.921	7.003	7.87	0.949	0.867	1	1
37	3729.85	6.401	6.271	7.97	1.569	1.699	2	2
38	3834.33	7.167	8.012	7.97	0.803	0.042	1.5	0.5
39	3931.34	10.232	6.975	7.97	2.262	0.995	0	1.5
40	4027.21	6.821	6.613	7.97	1.149	1.357	2	1.5
41	4129.62	7.647	7.211	7.98	0.333	0.769	1	2
42	4233.26	5.877	6.744	7.91	2.033	1.166	3	2
43	4334.05	5.11	6.122	8.01	2.9	1.888	3	2
44	4433.93	6.432	6.543	8.02	1.588	1.477	2	2
45	4529.37	6.02	5.627	8.02	2	2.393	3	3
46	4628.60	5.71	7.032	8.08	2.37	1.048	3	1.5
47	4730.04	4.877	6.856	8.14	3.263	1.284	3.5	1.5
48	4823.32	5.673	7.033	8.25	2.577	1.217	3	1.5

49	4928.42	5.877	7.033	8.24	2.363	1.207	3	1.5
CS No	Chainage (in	Right Bank Level (in m)	Left Bank Level (in m)	25 Flood Level (in m)	Diff Flood level (m)		Bund To be raised (m)	
					Right Bank	Left Bank	Right Bank	Left Bank
50	5017.88	7.633	7.94	8.35	0.717	0.41	1	1
51	5139.22	9.342	8.06	8.35	0.992	0.29	1	1
52	5234.05	8.265	8.854	8.35	0.085	0.504	1	0
53	5335.62	9.154	10.553	8.40	0.754	2.153	1	0
54	5435.71	8.518	9.286	8.50	0.018	0.786	0.5	0
55	5534.58	8.778	7.544	8.50	0.278	0.956	0.5	1.5
56	5625.97	8.884	7.554	8.58	0.304	1.026	0.5	1.5
57	5732.15	8.817	8.174	8.97	0.153	0.796	1	1.5
58	5833.85	9.004	7.893	8.97	0.034	1.077	1	1.5
59	5919.41	8.873	8.339	8.97	0.097	0.631	1	1
60	6020.31	8.673	8.21	9.05	0.377	0.84	1	1
61	6116.93	9.192	8.554	9.21	0.018	0.656	1	1
62	6212.60	9.634	9.195	9.26	0.374	0.065	0.5	1
63	6322.27	9.721	9.783	9.57	0.151	0.213	0.5	0.5
64	6412.82	10.184	9.778	9.57	0.614	0.208	0	0.5
65	6506.46	10.564	9.674	9.57	0.994	0.104	0	0.5
66	6606.90	10.182	9.734	9.58	0.602	0.154	0	0.5
67	6704.20	9.783	9.845	9.68	0.103	0.165	0	0.5
68	6800.00	10.142	9.645	9.77	0.372	0.125	0	0.5
69	6907.90	10.734	11.324	9.92	0.814	1.404	0	0
70	7008.23	10.566	11.011	9.92	0.646	1.091	0	0
71	7103.94	11.228	11.119	9.92	1.308	1.199	0	0
72	7206.15	11.428	11.186	10.32	1.108	0.866	0	0
73	7310.01	11.038	10.884	10.32	0.718	0.564	0	0
74	7395.84	11.284	10.849	10.33	0.954	0.519	0	0
75	7503.32	11.582	11.154	10.50	1.082	0.654	0	0
76	7603.54	11.221	10.768	10.88	0.341	0.112	0	0.5
77	7695.93	11.184	11.035	10.89	0.294	0.145	0	0.5
78	7796.22	10.899	11.539	11.02	0.121	0.519	0.5	0.5
79	7904.11	13.011	10.657	11.02	1.991	0.363	0	0.5
80	8018.88	14.216	13.433	11.04	3.176	2.393	0	0
81	8097.56	12.897	14.354	11.11	1.787	3.244	0	0
82	8200.69	13.512	14.038	11.36	2.152	2.678	0	0
83	8298.93	14.562	13.893	12.78	1.782	1.113	0	0
84	8405.86	12.609	13.638	12.78	0.171	0.858	0.5	0
85	8516.55	13.645	13.733	12.78	0.865	0.953	0	0
86	8606.14	15.594	15.278	12.78	2.814	2.498	0	0
87	8708.59	15.745	15.675	12.78	2.965	2.895	0	0
88	8807.06	15.973	14.719	12.78	3.193	1.939	0	0
89	8905.08	15.524	14.983	12.81	2.714	2.173	0	0
90	9000.00	14.219	14.177	12.83	1.389	1.347	0	0
91	9102.12	14.219	14.099	13.22	0.999	0.879	0	0
92	9200.00	14.711	14.289	13.92	0.791	0.369	0	0
93	9311.63	14.228	15.571	14.56	0.332	1.011	1	0

94	9408.49	14.736	14.526	14.46	0.276	0.066	0	0
95	9507.30	14.211	14.115	14.58	0.369	0.465	1	0
96	9588.95	14.267	13.855	14.59	0.323	0.735	1	1
97	9702.90	13.548	13.944	14.85	1.302	0.906	2	1.5
98	9789.53	13.811	14.321	14.87	1.059	0.549	2	1.5
99	9892.44	14.928	14.428	15.70	0.772	1.272	1	1.5
CS No	Chainage (inm)	Right Bank Level (in m)	Left Bank Level (in m)	25 Flood Level (in m)	Diff flood level (m)		Bund To be raised (m)	
					Right Bank	Left Bank	Right Bank	Left Bank
100	9993.23	15.365	14.847	15.71	0.345	0.863	1	1.5
101	10081.98	15.218	15.088	15.75	0.532	0.662	1	1.5
102	10182.87	15.339	14.788	15.79	0.451	1.002	1	1.5
103	10282.89	15.173	15.219	15.88	0.707	0.661	1.5	1.5
104	10386.29	14.672	14.671	15.93	1.258	1.259	1.5	1.5
105	10487.08	15.395	15.514	15.99	0.595	0.476	1	1
106	10575.93	15.219	15.066	15.99	0.771	0.924	1	1
107	10680.41	14.784	14.784	15.98	1.196	1.196	1.5	1.5
108	10778.50	15.109	14.891	15.99	0.881	1.099	1.5	1.5
109	10879.14	14.987	15.165	16.15	1.163	0.985	1.5	1.5
110	10982.61	15.552	15.854	16.15	0.598	0.296	1	0.5
111	11082.33	15.22	14.675	16.16	0.94	1.485	1.5	1.5
112	11172.92	14.655	15.111	16.28	1.625	1.169	2	1.5
113	11269.32	14.305	14.622	16.28	1.975	1.658	2.5	2
114	11368.69	15.165	15.332	16.28	1.115	0.948	2.5	1.5
115	11471.55	14.822	15.744	16.52	1.698	0.776	2.5	1.5
116	11567.09	16.365	16.326	16.52	0.155	0.194	0.5	0.5
117	11666.60	16.477	16.544	16.52	0.043	0.024	0.5	0.5
118	11771.40	16.132	17.227	16.52	0.388	0.707	0.5	0.5
119	11869.64	16.533	16.565	16.68	0.147	0.115	0.5	0.5
120	11976.12	16.687	17.007	16.69	0.003	0.317	0.5	0.5
121	12073.60	16.711	17.307	16.69	0.021	0.617	0	0.5
122	12171.00	16.966	16.855	16.70	0.266	0.155	0	0.5
123	12273.12	17.216	17.211	16.79	0.426	0.421	0	0.5
124	12372.07	17.788	16.033	16.79	0.998	0.757	0	1
125	12466.38	18.276	16.911	17.20	1.076	0.289	0	0.5
126	12569.35	18.733	17.065	17.40	1.333	0.335	0	0.5
127	12660.79	18.554	17.326	17.58	0.974	0.254	0	0.5
128	12757.79	18.833	17.587	17.59	1.243	0.003	0	0.5
129	12856.47	19.101	17.944	17.59	1.511	0.354	0	0.5
130	12962.38	16.784	18.655	17.89	1.106	0.765	1.5	0.5
131	13062.33	18.744	14.577	17.89	0.854	3.313	0	4
132	13164.81	19.211	18.322	17.89	1.321	0.432	0	0
133	13264.75	19.788	20.224	17.89	1.898	2.334	0	0
134	13360.18	17.231	16.956	17.89	0.659	0.934	1	1.5

135	13454.75	19.957	18.344	17.93	2.027	0.414	0	0
136	13567.29	20.329	19.645	18.08	2.249	1.565	0	0
137	13662.43	20.452	20.118	18.14	2.312	1.978	0	0
138	13769.82	16.784	18.655	18.16	1.376	0.495	1.5	0
139	13860.22	18.744	14.577	18.17	0.574	3.593	0	4
140	13959.33	19.211	18.322	18.31	0.901	0.012	0	0.5
141	14050.96	19.788	20.224	18.31	1.478	1.914	0	0

Table: Bund section required in Karamana River

CS No	Chainage (inm)	Right Bank Level (inm)	Left Bank Level (inm)	25 Flood Level (inm)	Diff in floodlevel (m)		Bund To be raised (m)	
					Right Bank	Left Bank	Right Bank	Left bank
1	0.00	0.768	0.745	0.77	0.002	0.025	0	0
2	267.42	1.065	1.651	0.77	0.295	0.881	0	0
3	518.63	1.135	0.937	0.77	0.365	0.167	0	0
4	750.57	0.823	1.056	1.15	0.327	0.094	0.5	0.5
5	1039.04	0.844	0.754	1.70	0.856	0.946	1	1
6	1283.72	0.722	1.556	1.89	1.168	0.334	1.5	0.5
7	1535.48	1.022	1.182	1.91	0.888	0.728	1	1
8	1792.02	1.255	0.967	1.96	0.705	0.993	1	1
9	2055.93	1.401	2.562	2.68	1.279	0.118	1.5	0.5
10	2300.00	2.611	0.955	2.90	0.289	1.945	0.5	2
11	2512.40	0.955	0.711	3.07	2.115	2.359	2.5	2.5
12	2753.50	0.756	1.513	3.13	2.374	1.617	2.5	2
13	3018.89	1.219	1.561	4.08	2.861	2.519	3	3
14	3275.23	1.102	1.132	4.10	2.998	2.968	3	3
15	3526.60	2.231	1.543	4.09	1.859	2.547	2	3
16	3776.76	2.543	1.143	5.29	2.747	4.147	3	5
17	3967.69	1.434	2.117	5.66	4.226	3.543	5	4
18	4240.61	2.174	3.885	5.73	3.556	1.845	4	2
19	4512.75	2.163	3.231	5.73	3.567	2.499	4	2.5
20	4748.96	2.673	2.893	5.71	3.037	2.817	3	3
21	4988.47	3.219	3.037	5.91	2.691	2.873	3	3
22	5287.91	4.123	4.436	5.84	1.717	1.404	2	2
23	5549.36	4.110	4.232	5.94	1.830	1.708	2	2
24	5738.33	2.873	1.232	5.93	3.057	4.698	3.5	5
25	5990.21	5.342	4.452	5.93	0.588	1.478	1	1.5
26	6240.80	4.217	5.325	6.05	1.833	0.725	2	1.5
27	6503.82	5.232	7.340	6.04	0.808	1.300	1	0
28	6766.88	3.121	4.321	6.06	2.939	1.739	3.5	2
29	7003.58	4.117	5.211	6.04	1.923	0.829	2.5	1.5
30	7267.97	3.932	4.163	6.20	2.268	2.037	2.5	2.5
31	7554.31	4.132	5.342	6.21	2.078	0.868	2.5	1.5
32	7942.33	4.415	5.342	6.66	2.245	1.318	2.5	1.5
33	8178.81	6.573	6.873	6.65	0.077	0.223	0.5	0
34	8433.74	4.132	5.326	6.65	2.518	1.324	3	1.5

35	8674.55	5.132	7.232	6.30	1.168	0.932	1.5	0
36	8925.26	5.232	7.153	6.64	1.408	0.513	1.5	0
37	9161.26	6.734	7.534	6.62	0.114	0.914	0	0
38	9419.52	5.453	7.912	6.80	1.347	1.112	2	0
39	9671.87	5.290	5.019	6.84	1.550	1.821	2	2
40	9919.94	7.213	6.847	7.02	0.193	0.173	0	0.5
41	10153.57	5.487	6.748	6.93	1.443	0.182	1.5	0.5
42	10403.59	6.184	5.184	7.26	1.076	2.076	1.5	2.5
43	10654.93	6.288	5.733	7.32	1.032	1.587	1.5	2
44	10905.97	6.219	5.691	7.30	1.081	1.609	1.5	2
45	11166.20	6.032	5.429	7.41	1.378	1.981	1.5	2.5
46	11436.71	4.592	5.483	7.54	2.948	2.057	3.5	2.5
47	11692.49	4.182	5.038	7.68	3.498	2.642	3.5	3
48	11919.45	6.523	5.210	7.69	1.167	2.480	1.5	3
49	12162.85	6.818	5.672	7.68	0.862	2.008	1.5	2.5

CS No	Chainage (inm)	Right Bank Level (in m)	Left Bank Level (in m)	25 Flood Level (inm)	Diff Flood level (m)		Bund To beraised (m)	
					Right Bank	Left Bank	Right Bank	Left Bank
50	12411.37	7.189	6.521	7.66	0.471	1.139	1	1.5
51	12687.12	8.102	6.534	7.88	0.222	1.346	0	1.5
52	12900.00	3.921	7.082	7.90	3.979	0.818	4	1.5
53	13136.81	6.210	3.542	7.87	1.660	4.328	2	5
54	13386.44	5.439	5.439	7.90	2.461	2.461	3	3
55	13627.54	2.730	3.148	7.89	5.160	4.742	5	5
56	13834.92	3.453	3.328	7.98	4.527	4.652	5	5
57	14040.61	2.453	3.165	7.98	5.527	4.815	6	5
58	14289.73	3.563	4.722	7.98	4.417	3.258	3.5	3.5
59	14539.70	2.564	2.321	7.98	5.416	5.659	6	6
60	14789.87	5.324	10.283	7.98	2.656	2.303	3	0
61	15039.87	4.432	3.675	7.98	3.548	4.305	4	5
62	15286.61	4.254	4.183	8.00	3.746	3.817	4	4.5
63	15539.86	3.262	4.674	8.04	4.778	3.366	5	4
64	15789.87	2.768	4.103	8.08	5.312	3.977	6	4
65	16039.84	4.452	4.675	8.07	3.618	3.395	4	4
66	16289.86	6.448	2.768	8.07	1.622	5.302	2	6
67	16539.73	8.757	2.758	8.07	0.687	5.312	0	6
68	16787.93	6.253	3.564	8.10	1.847	4.536	2	5
69	17039.80	8.142	3.562	8.11	0.032	4.548	0	5
70	17289.75	6.354	5.785	8.09	1.736	2.305	2	2.5
71	17539.56	8.102	5.884	8.10	0.002	2.216	0	2.5
72	17789.00	4.563	9.164	8.06	3.497	1.104	3.5	0

73	18039.85	5.273	9.453	8.20	2.927	1.253	3	0
74	18289.69	10.342	4.534	8.30	2.042	3.766	0	4
75	18539.84	9.364	4.564	8.27	1.094	3.706	0	4
76	18789.85	8.783	10.219	8.40	0.383	1.819	0	0
77	19039.82	6.773	10.182	8.27	1.497	1.912	1.5	0
78	19289.84	8.553	7.232	8.53	0.023	1.298	0	1.5
79	19539.83	5.874	6.775	8.62	2.746	1.845	3	2
80	19789.82	5.153	7.456	8.78	3.627	1.324	4	2
81	20040.07	5.884	5.054	8.79	2.906	3.736	3	4
82	20289.84	8.173	10.486	9.57	1.397	0.916	1.5	0
83	20539.74	7.445	7.734	9.60	2.155	1.866	2.5	2
84	20789.87	7.153	11.534	9.70	2.547	1.834	3	0

7.Financial aspect of the Project

Sl No	Description of items	Amount (in Lakhs)
1	Development works for Karamana River including raising of bund height to contain floods and strengthening of damaged bunds	1862.00
2	Development works for Killi River including raising of bund height to contain floods and strengthening of damaged bunds	355.00
3	Improvements to Thekkanakara canal such as de-silting	50.00
4	De-siltation of Thodus in Karamana Basin	677.00
5	Improvements to Karimadom tank-de-silting, sheet piling, providing fencing	450.00
6	Improvements to Poonthura pozhi- Break water construction, trench cut in the sea bed for bidding layer	2922.00
7	Culvert along Attakulangara bye-pass road	120.00

8.	Shutter to side drains	64.00
9	Parvathy Puthanar (KIIFB)	15000.00
	Total	21500

Rupees Two hundred and fifteen crores only

8. Conclusion

In order to have a safe habitat along the sides of rivers of Karamana and Killi, flood mitigation measures as envisaged in the report such as increasing bank height wherever necessary, flood routing works by enhancing the capacity of thodus and tanks, facilitating flood discharge to sea through Poonthura pozhi etc. are to be carried out.

In pollution abatement plan, the coli form level of the rivers is to be maintained below 500 MPN which is the preferable standard for bathing. The capacity of the Sewage treatment Plant has to be increased to meet the requirements of the city. The clean and clear water flowing through the city will increase the hygiene and beauty of the city.