ASIAN INFRASTRUCTURE INVESTMENT BANK

GOVERNMENT OF TAMIL NADU
WATER RESOURCES DEPARTMENT

ENVIRONMENTAL & SOCIAL IMPACT ASSESSMENT (ESIA) FOR EXTENSION, RENOVATION AND MODERNISATION OF GRAND ANICUT CANAL SYSTEM, TAMIL NADU

ESIA REPORT
(DRAFT)

WAPCOS LIMITED

(A GOVERNMENT OF INDIA UNDERTAKING)
MINISTRY OF JAL SHAKTI
DEPARTMENT OF WATER RESOURCES, RIVER DEVELOPMENT AND GANGA REJUVENATION

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ABBREVIATIONS

AAQ	Ambient Air Quality
ACM	Asbestos Containing Materials
AE	Assistant Engineer
AEA	Agro Ecosystem Analysis
AEE	Assistant Executive Engineer
AIIB	Asian Infrastructure Investment Bank
AoI	Area of Influence
ARP	Abbreviated Resettlement Plan
ASI	Archaeological Survey of India
BDL	Below Detection Limit
BOCW	Building and Other Construction Workers
BOD	Biochemical Oxygen Demand
BoQ	Bill of Quantity
BPH	Brown Plant Hopper
C&D	Construction and Demolition
CABI	Centre for Agriculture and Bioscience International
CBD	Convention on Biological Diversity
CBO	Community Based Organizations
CCA	Cultivable Command Area
CGWB	Central Ground Water Board
CITES	Convention on International Trade in Endangered Species of Wild Fauna and Flora
CNG	Compressed Natural Gas
COD	Chemical Oxygen Demand
CPCB	Central Pollution Control Board
CRZ	Coastal Regulation Zone
CTE	Consent to Establish
CTO	Consent to Operate
CTSI	Carlson's Trophic State Index
CWC	Central Water Commission
CWDT	Cauvery Water Dispute Tribunal
CWTSP	Canal Water Trun System Practices
DDT	Dichloro Diphenyl Trichloroet hane
DEA	Department of Economic Affairs
DL	Detection Limit
DPC	Direct Purchase Centre
DPR	Detailed Project Report
DPS	Decentralised Procurement Scheme
DRIP	Dam Rehabilitation and Improvement Project
DRO	District Revenue Officer
DSS	Decision Support System

E&S	Environment and Social
EE	Executive Engineer
EHS	Environment, Health, and Safety
EIA	Environmental Impact Assessment
EMP	Environment Management Plan
EMR	Environmental Monitoring Report/ Employee Monitoring Record
EPA	Environment Protection Act
EQM	Environmental Quality Monitoring
ERDAS	Earth Resources Data Analysis System
ERM	Extension, Renovation and Modernization
ESF	Environmental and Social Framework
ESHS	Environmental Social Health and Safety
ESIA	Environmental and Social Impact Assessment
ESMAP	Environmental and Social Monitoring Action Plan
ESMF	Environmental and Social Management Framework
ESMP	Environmental and Social Management Plan
ESMPF	Environment and Social Management Action Plan
ESP	Environmental and Social Policy
ESSs	Environmental and Social Standards
ETL	Economic Threshold Level
F.S.L	Full Supply Level
FCC	Federal Communications Commission
FFS	Farmer Field School
FGDs	Focus Group Discussions
FI	Financial Intermediary
FLFPR	Female Labor Force Participation Rate
FPO	Farmer Producer Organisation
FSD	Full Supply Depth
FYM	Framyard Manure
GA	Grand Anicut
GAC	Grand Anicut Canal
GACS	Grand Anicut Canal System
GBV	Gender Based Violence
GIS	Geographical Information System
GoI	Government of India
GoTN	Government of Tamil Nadu
GRC	Grievance Redressal Committee
GRM	Grievance Redress Mechanism
GWT	Ground Water Table
H&S	Health and Safety
IAMWARM	Irrigated Agriculture Modernisation and Waterbodies Restoration and Management
IEC	Information Educational and Communication
IGA	Income Generation Assets

IMTI	Irrigation Management Training Institute
INM	Intergration Nutrition Management
INR	Indian Rupee
IPDP	Indigenous Peoples Development Plan
IPM	Integrated Pest Management
IUCN	International Union for the Conservation of Nature
JE	Junior Engineer
LA	Land Acquisition
LCA	Lower Coleroon Anicut
LISS	Linear Imaging Self-Scanning System
LoA	Letter of Acceptance
LPG	Liquefied Petroleum Gas
M&E	Monitoring and Evaluation
NAAQS	National Ambient Air Quality Standards
NABL	National Accrediated Board Laboratory
NGO	Non-Governmental Organizations
NGT	National Green Tribunal
NOC	No Objection Certificate
NRSA	National Remote Sensing Agency
NSC	National Safety Council
NSL	Natural Supply Level
O&M	Operation and Maintenance
OHS	Occupational Health and Safety
PAFs	Project Affected Families
PAPs	Project Affected Persons
PCB	Polychloro Benzene
PCWBS	Point Calimere Wildlife and Bird Sanctuary
PHC	Primary Health Centre
PIM	Product Information Management
PIU	Programme Implementation Unit
PMC	Project Management Consultancy
PMP	Pest Management plan
PMU	Project Management Unit
PoPs	Persistent Organic Pollutants
PPC	Portland Puzzolana Cement
PPE	Personal Protective Equipment
PPM	Project affected People's Mechanism
PPVFR	Protection of Plant Variety and Farmers Right
PUC	Pollution Under Control
RAP	Resettlement Action Plan
RMC	Ready Mix Concrete
RoW	Right of Way
RP	Resettlement Plan
RPF	Resettlement Planning/Policy Framework

RTI	Right to Information
SC	Scheduled Castes
SCADA	Supervisory Control And Data Acquisition
SDT	Secchi Disc Transparency
SEAH	Sexual Exploitation, Abuse and Harassment
SHG	Self Help Group
SIA	Social Impact Assessment
SMP	Social Management Plan
SOM	Service Operational Management
SOP	Standard Operating Procedure
SOR	Schedule of Rates
SQG	Sediment Quality Guidelines
SRI	System of Rice Intensification
ST	Scheduled Tribes
SWM	Solid Waste Management
TDS	Total Dissolved Solids
TMC	Thousand Million Cubic Feet
TNAU	Tamilnadu Agricultural Unversity
TNEB	Tamilnadu Electricty Board
TNFD	Tamil Nadu Forest Department
TNPCB	Tamil Nadu Pollution Control Board
ToR	Terms of Reference
ToT	Training on Trainers
TSI	Trophic State Index
TSS	Total Suspended Solids
UNFCCC	United Nations Framework Convention on Climate Change
USD	U.S. Dollar
WHL	Women Helpline
WMP	Waste Management Plan
WPA	Wildlife Protection Act
WRD	Water Resources Department
WUAs	Water User Associations

Glossary

Term	Definition
Eri	Lake / Pond
Ayacutdarars	Farmers bearing land which is benefitted from the waterbody
Aru	River / Stream
Erikarai	Lake bund

EXECUTIVE SUMMARY

The Grand Anicut Canal System (GACS) comprises of the GA Main Canal, which traverses a length of 148.65 kms and branch channels totalling to about 1,232 kms including laterals. The Main Canal is divided into 28 reaches according to hydraulic features like Bed Width, FSD etc. The Grand Anicut (Barrage) is 328 metres long; 12.20 to 18.30 metres in width and 4.57 to 5.49 metres in height. The Main Canal passes through three administrative Districts namely Tiruchirappalli (5 kms), Thanjavur (104 kms) and Pudukkotai (39.65 kms) in the state of Tamil Nadu, India. In its course, along the alignment, the Grand Anicut Canal intercepts a right side catchment of 780 Sq. miles. The ayacut under the canal was fixed as 2, 27,472 acres under the GA Canal and 29,000 acres under the Vadavar Extension. A total of 694 Tanks in the Command Area gets benefitted through GA canal system.

The Extension, Renovation and Modernization (ERM) works of GACS shall be implemented by the WRD, GoTN. In this connection, the WRD, through the Department of Economic Affairs (DEA), Ministry of Finance, Government of India have approached the Asian Infrastructure Investment Bank (AIIB) for part financing of ERM of GACS. Currently, DEA has requested AIIB to provide a loan facility of INR 1,609.125 Crores (USD 229.87 Million) which is 70% of Project Cost of INR 2,639.15 Crores (USD Million 377.02) at price level 2014-15. The balance amount of INR 689.625 Crores (USD 98.52 Million) will be the share of GoTN.

The Project components include Extension, Renovation and Modernization (ERM) works of the following.

Particulars	Unit	Existing	Proposed (ERM)
Bed and Side Lining	km	1,323.32	364.030
Regulators	Nos	45	26
Syphons	Nos	102	66
Well Syphons	Nos	132	15
Canal Syphons	Nos	76	25
Aqueducts	Nos	72	7
Under Tunnel	Nos	131	58
Drops	Nos	966	245
Head Sluices	Nos	293	169
Direct Sluices	Nos	358	283
Rear Channel Sluices	Nos	8	-
Pipe Sluices	Nos	2,146	609
Bridges	Nos	184	3
Gauging Bridges	Nos	10	0
Tanks	Nos	694	33
Buildings	Nos	116	74

Particulars	Unit	Existing	Proposed (ERM)
Roads	km	452	31.56
End Dams	Nos	127	8
Bank Strengthening	km	619	744.094
Steps & Ramps	Nos	721	418
SCADA	-	-	Entire Project

Due to the proposed project activities, the likely impacts and its extent on various environmental and social parameters have been studied by assessing the baseline environmental status of the area and estimations were made as how this will change with commencement of project activity. The potential environmental and social impacts due to the project has been studied for different phases of the project, i.e., pre-construction phase, construction phase and operation phase.

In the evaluation process, the severity of impacts is assigned to each project activities on a cogent basis and are classified as C.1, C.2 & C.3 based on high, moderate and low / negligible impacts respectively. The screening of environmental and social impacts is given below.

S. No	Activities	Purpose	Anticipated Impacts	Impact Cat.	Remarks / Significance
	Pre-Construction Phase				
1	Felling of trees	Required for ERM activities such as embankment strengthening, renovation / reconstruction, storage area, side lining, service road etc.	change in landscape	Negative (C.1)	• Felling of 23,183 trees outside forest area. WRD – 14,015 trees Forests* – 9,168 trees *These are planted on WRD land as part of social forestry initiatives by Forest Dept., GoTN • Impact would be direct, long term and

S. No	Activities	Purpose	Anticipated Impacts	Impact Cat.	Remarks / Significance
					irreversible in nature; • Compliance to Management Plan
2	Demolition / shifting of social infrastructure such as electrical utilities	Required for ERM activities such as embankment strengthening, storage area, side lining, service road	Impact on religious aspects and public utilities	Negative (C.2)	• Direct, short-term impact • Medium severity • Reversible impacts • Compliance to Management Plan
	Construction Phase				
3.	Establishment of Labour Camps	Housing of labours for construction works	• Loss of trees for fuelwood; • Hygiene and health of labours • Waste disposal • Labour Influx • Host communities	Negative (C.2)	• Direct, short-term impact • Low severity • Reversible impacts
4	Operation of Heavy Machinery	Levelling of canal bed and compaction of embankment.	• Air and Noise pollution • Oil Spillage	Negative (C.2)	• Direct and short-term impact • Low severity • Implementation of mitigation measures

S. No	Activities	Purpose	Anticipated Impacts	Impact Cat.	Remarks / Significance
5	Vehicular Movement	Transport of Construction materials and Haulage of heavy machinery	• Increased Traffic • Air and Noise pollution, • Exposure of local habitations	Negative (C.2)	• Direct and short-term impact • Low to Medium severity • Implementation of mitigation measures
6	Material Handling and Storage	Stacking of different construction materials; Storage of construction material and C&D waste and Sheds for equipment & construction materials	• Water and Soil pollution • Exposure of workers	Negative (C.2)	• Direct and short-term impact • Low severity • Implementation of mitigation measures
7	Operation of Batching Plants and Hot Mix plant	Concrete mix for construction works i.e., side and bed lining, reconstruction works etc. Bitumen topping of roads	Air, Noise and Soil Pollution	Negative (C.1)	• Direct and short-term impact • Low severity • Implementation of mitigation measures
8	Generation of Construction and Demolition (C&D) Waste	Demolition of existing structures Renovation / Reconstruction of cross drainage works and bridges Construction of Regulator across Canal Lining of Canals Compaction of embankments	• Landscape degradation • Air and water Pollution	Negative (C.3)	• Direct and short-term impact • Low severity • Implementation of mitigation measures
Operation Phase					
9	Use of agro-chemicals	To boost crop yields	Reduces soil fertility, Pest	Negative (C.2)	• Long term impact

S. No	Activities	Purpose	Anticipated Impacts	Impact Cat.	Remarks / Significance
			Resistance towards insecticides, Creating Health and Environmental risks		• Moderate severity • Implementation of Integrated Pest Management Plan • Organic Farming
10	Trapped Silt	To prevent silt being carried to the downstream and tailend portion of the canal	Risks to environment and human health if the silt is contaminated and not properly stored or disposed	Negative (C.2)	• Long term impact • Moderate severity • Implementation of silt management plan.

Based on the project details and the baseline environmental status, potential impacts that are expected to occur as a result of the execution and operation of the proposed project, the ERM GACS project falls under Category-B which has a limited number of potentially adverse environmental and social impacts. Thus, it requires conducting an Environmental and Social Impact Assessment (ESIA) including preparation of an Environmental and Social Management Plan (ESMP) in accordance with the AIIB's Environmental and Social Policy (ESP), under the Environmental and Social Framework (ESF, 2019). Some of the management / mitigation measures are suggested as detailed below.

Top Soil: Mitigation Measures:

1. The top soil will be stored separately and will be reused for landscaping, grass turfing and site restoration works
2. The top soil will be stripped to a specified depth of 6-8 inches and stored in stockpiles of height not exceeding 2 – 4 m and should be stored away from waterways. The heap of the top soil will be covered with tarpaulin cover to minimize air pollution.
3. The stored topsoil will be spread in order to maintain the physio-chemical and biological activity of the soil and will be used for restoration of sites in landscaping and plantation as per compensatory plantation plan.

Soil Contamination: Mitigation Measures:

1. Fuel storage and refilling locations should be kept away from water sources / water bodies and water supply sources and shall be stored in containers and kept in raised impervious platforms, however the spillover fuel from the primary containers will be stored in a secondary container.
2. All spoils shall be disposed-off and the site shall be maintained clean.
3. Designated storage site with proper signage's for oil, lubricants and similar products shall be maintained.

Water Quality: Mitigation Measures:

1. Construction activities in the canal will be carried out only during non-monsoon period
2. The Contractor will take all precautionary measures to prevent the wastewater generated during construction works from entering into water bodies viz. Wash water from batching plant and RMC shall be collected in settling tank and used for dust suppression.
3. No construction materials / spoils will be stored along the water bodies and adequate provision will be made for preventing spillage of materials into these water bodies.
4. Water quality to be monitored periodically, as per the monitoring plan.

Ambient Air Quality : Mitigation Measures:

1. Water will be sprayed frequently during construction phase, in construction sites and batching plant sites for suppressing fugitive dust. Extra precautions will be taken when working near sensitive areas like schools, hospitals etc.
2. The construction equipment will be fitted with appropriate dust suppression devices
3. Pollution Under Control (PUC) certificates will be mandatory for all vehicles / equipment / machinery to be used for the construction works
4. The sediment/soil / shoal, debris, and construction materials during construction will be covered with tarpaulin cover
5. Mandatory provision of Personal Protective Equipment (PPE) for workers at the batching plant and other construction sites to reduce the chances of ill effect of emissions
6. Periodic monitoring of particulate matter i.e., PM_{10}, $PM_{2.5}$, SO_2 and NO_2 will be carried out as per environmental monitoring plan.

Ambient Noise Level : Mitigation Measures

1. All construction equipment's and batching plants used for construction shall strictly conform to the CPCB ambient noise level standards
2. Any kind of demolition or other heavy noise generating activity will not be permitted within 100 m radius of sensitive areas / silence zone during active

working hours (10 AM to 5 PM); work in sensitive areas / silence zones shall preferably be carried out on weekend and holiday or between 6 AM to 10 AM and 5 PM to 9 PM of other weekdays.

3. Vehicles and equipment used will be fitted with silencer/ noise barrier and maintained as per the regulation
4. All the workers working in the construction sites where heavy machineries are used shall be provided with earplugs to avoid any ill impacts on their health.
5. Noise levels to be monitored as per monitoring plan and if the noise level at any time found to be higher than immediate measure to reduce noise in that area will be ensured.

Ecological Resources : Mitigation Measures:

1. No tree felling will be allowed beyond the identified working zone;
2. All the trees located in labour camps, storage areas, disposal sites and other allied sites will be conserved
3. The C&D materials will be stored at a safe distance from trees located in such areas to avoid any damage to the trees
4. In case of felling of trees, prior permission from Forests Dept. shall be obtained and compensatory afforestation at 1:10 ratio shall be done
5. In case of finding of any fauna during construction, safeguard measures will be taken like i.e., (1) no harm to any fauna by the construction workers, (2) care by the construction vehicles to avoid accidents to fauna, (3) information to Forests Dept. in case of any encounter takes place with wild animals
6. The project activities shall be restricted to day time hours and construction activities shall not be carried out during migratory season.

At project level GRM will be in place for addressing social, environmental and project related grievances. The GRM will have multi-level structures and processes. At the grassroot level the committee is made up of Assistant Engineer (PIU), Assistant Executive Engineer (PIU) this committee meets on weekly basis. This committee will look after the grievances related to implementation of the mitigation measures, construction practices and issues related to project. It will resolve disputes relating to resource use that may arise between communities, the grievances that may arise with planning measures, or the actual implementation of the project activities. At the next level the Executive Engineer (PIU) convenes the meetings fortnightly ones. The third level is the Superintending Engineer, Executive Engineer (PMU) at the District level. The committee organize meetings once in every month.

The project GRM notwithstanding, an aggrieved person shall have access to the country's legal system at any stage. In the event that the established GRM is not in a position to resolve the issue, the affected persons can also use the AIIBs Project-affected People's Mechanism (PPM) by directly contacting (in writing) the complaint receiving officer at AIIB

headquarters (https://www.aiib.org/en/policies-strategies/operational-policies/policy-on-the-project-affected-mechanism.html) . Meaningful consultations and awareness programs will be undertaken with the affected persons, the communities in the project area and civil society soon after the resettlement planning framework is approved. Consultation will be continuous throughout the project area, including all the distribution canals during the implementation of the project. The project implementation unit (PIU) and the implementation support NGO will be responsible for conducting these consultations. The PIU will ensure that groups and individuals consulted are informed about the outcome of the decision-making process, and confirm how their views were incorporated. The consultation process established for the project will employ a range of formal and informal consultative methods. Different techniques of consultation with stakeholders are proposed during project implementation, such as in-depth interviews, public meetings, and group discussions.

There is a Resettlement Policy Framework which has been framed for the project to cover all likely impacts on affected persons including land acquisition. This ESIA report covers the social impact assessment and due diligence covered to assesses any impacts on livelihood, impacted structures, etc. Based on the census and transect walk survey no affected persons were identified.

As part of the ESIA study, based on the anticipated impacts and suggested mitigation / management measures, a budgetary provision for Implementation of ESMP has been earmarked for an amount of Rs.48.65 Cr which includes cost for obtaining Regulatory Clearances, Tree felling and compensatory Afforestation, Workers Safety and Labour Camp Management, Environmental Quality Monitoring, Conducting Capacity Building and Awareness Campaigns programs and Preparation of Reports.

CHAPTER 1: INTRODUCTION

1.1 PROJECT OVERVIEW

Modernization of any Irrigation Project includes Extension, Renovation and Modernization (ERM) components of the existing project to optimize the benefits in view of the technical advancement and to rectify the deficiencies experienced in operation and maintenance of the project over the past years.

The Grand Anicut Canal System (GACS) comprises of the GA Main Canal, which traverses a length of 148.65 kms and branch channels totalling to about 1,232 kms which including laterals. The Main Canal is divided into 28 reaches according to hydraulic features like Bed Width, FSD etc. The Grand Anicut (Barrage) is 328 metres long; 12.20 to 18.30 metres in width and 4.57 to 5.49 metres in height. The Main Canal passes through three administrative Districts namely Tiruchirappalli (5 kms), Thanjavur (104 kms) and Pudukkotai (39.65 kms) in the state of Tamil Nadu, India.

In its course, along the alignment, the Grand Anicut Canal intercepts a right-side catchment of 780 Sq. miles. The ayacut under the canal was fixed as 2, 27,472 acres under the GA Canal and 29000 acres under the Vadavar Extension. A total of 694 Tanks in the Command Area gets benefitted through GA canal system.

The Water Resources Department (WRD), Government of Tamil Nadu (GoTN), have identified components of GACS, which need reconstruction, rehabilitation, repair and new components, which are necessary for equitable distribution, maintaining hydraulic profile and for discharge control in GACS, through preparation of Detailed Project Report by WAPCOS Limited, A Government of India (GoI) Enterprise under the aegis of the Union Ministry of Jal Shakti.

The ERM Works of GACS shall be implemented by the WRD, GoTN. In this connection, the WRD, through the Department of Economic Affairs (DEA), Ministry of Finance, and Government of India have approached the Asian Infrastructure Investment Bank (AIIB) for part financing of ERM of GACS. Currently, DEA has requested AIIB to provide a loan facility of INR 1,609.125 Crores (USD 229.87 Million) which is 70% of Project Cost of INR 2,639.15 Crores (USD Million 377.02) at price level of 2014-15. The balance amount of INR 689.625 Crores (USD 98.52 Million) will be the share of GoTN. The Project Area Map of GACS is shown in Figure 1.

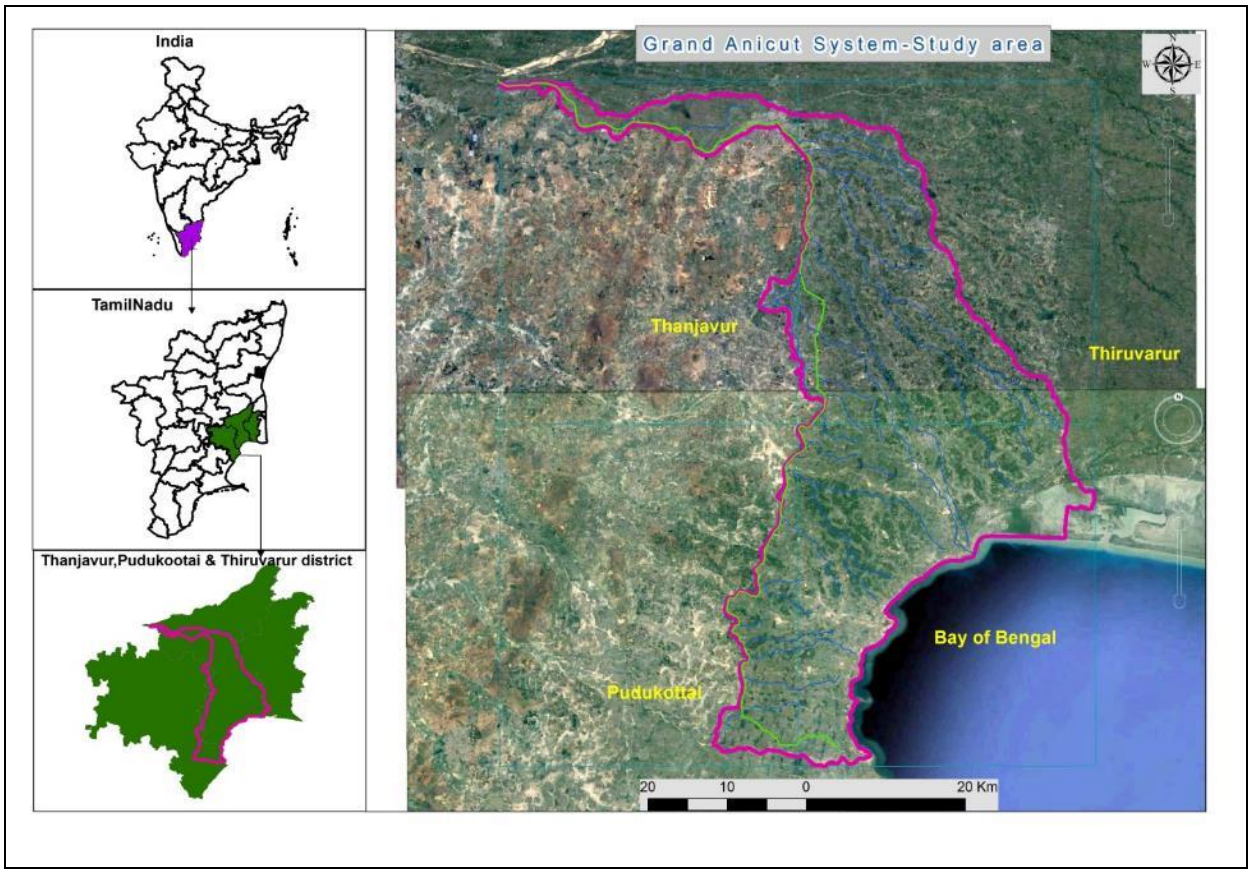


Figure 1: Project Area Map of GACS

1.2 NEED FOR THE PROJECT

The GACS was constructed during the 1930's according to the prevailing standards practiced then. Over the period of time, GACS components have seen several defects which have lead to breakage in the canal lining etc. which has led to reduction in conveyance efficiency. Some of the major issues identified which need to be addressed during ERM Works of GACS are as follows:

- Loss of Irrigation Efficiency due to seepage which has led to reduction in overall efficiency to 33.86%
- Obstruction in the Canal Bed leading to the reduction in free board, due to rising of the Natural Supply Level (NSL). This leads to water scarcity in the tail end area every year even though adequate availability of water in Mettur Dam.
- The old lining in the canal section in some reaches in the main canal and its branches has deteriorated over time and due to this, heavy transmission losses and percolation losses

are experienced, which prevents the water from reaching the tail end areas even when full supply is drawn from the Grand Anicut Head.

- Several regulating structures are old and in deteriorated conditions, which need to be replaced and/or repaired.
- Absence of proper drainage courses in some canal reaches lead to inundation of tail end area, ayacut area and village habitations during torrential rainfall.
- Existing obstructions in the drainage channels leading to stagnation of the drainage water causing inundation in the ayacut area on both sides and damages to nearby habitation.

1.3 PROJECT AREA OF INFLUENCE

The direct and indirect project Area of Influence (AoI) for impact assessment has been considered as 10 m and 500 m respectively due to the following reasons:

- The impacts due to the ERM activities like side and bed lining, repair and reconstruction of irrigation infrastructure etc., will have insignificant impacts considering the project size, intensity and duration and localised nature. The project shall also deploy labour force.
- The population density in the project area where project activities shall take place is very less with less human habitations. The major stretch of the GA Main Canal traverses through rural areas where the population density is very less while only few kms of the GA Main Canal traverses through urban areas.

The assessment criteria are presented in the Table 1.

Table 1 : Assessment Criteria

S.No.	Area of influence (m)	Assessment Aspects
1	10	Encroachers/squatter, public utilities like electric poles, transformers, trees, schools, financial institutions, post offices etc.
2	500	• Presence of Archaeological sites • Sensitive areas like school, colleges, religious places, hospitals etc, • Presence of Pisci culture / fisheries resources auction in and around the canal, land under lease for agriculture • Biodiversity hotspots and Eco sensitive zones.

1.4 OBJECTIVES OF THE ESIA STUDY

The overall objective of carrying out the ESIA study is to fulfil the requirements of the ESP in order to safeguard the environment while ensuring that the project meets the objectives for sustainable development. The key objective of the study is to recommend technically feasible and

to suggest management measures to minimise the negative impacts as well as improving the positive impacts during the project construction and operation phase. The report also covers social safeguard requirements. The specific objectives of the study are as follows:

- To ensure the Project is assessed and implemented in conformity with the regulatory requirements and policies of GoI, GoTN, as well as the AIIB's ESP and Environmental and Social Standards (ESSs).
- Identify, analyse and evaluate the type and extent of likely positive and negative impacts of the project on the environment and social aspects and to assess the capacity of the institutions responsible for management and mitigation of these impacts;
- Ensuring appropriate compensation for the Project Affected Persons (PAP) / Project Affected Families (PAF) irrespective of legal status with a view to provide suitable options that enable the affected people to improve or at least restore their standard of living in the post impact period.
- Protecting marginalized and vulnerable groups in the communities, including the economically and socially disadvantaged (vulnerable PAF) sections through additional support.
- To develop Environmental and Social Management Plan (ESMP) to identify mitigation measures that will address the concerns associated with the proposed project and provide details needed to implement the plan.
- To conduct socio economic, cultural and institutional analysis of the communities in the project area and also the major social problems related to the project.

As per the EIA Notification, 2006 and its subsequent amendments, any project which has probable impact on the environment is listed under 43 categories which are required to take prior environmental clearance after identifying /occupying the land for particular use.

As per the notification Schedule it is included in Sl. No 4, Irrigation projects. As the project activities involves extension, rehabilitation, and modernization of River channel infrastructure including de-silting of Riverbed, providing of new structures, etc. without any increase in command area, thus the project does not fall under the purview of EIA notification and its subsequent amendments and does not require Environmental Clearance.

1.5 SCOPE OF THE ESIA STUDY

In order to assess the impacts due to the proposed project an ESIA study was conducted, further, the project falls under Category-B which has a limited number of potentially adverse environmental and social impacts. Thus, it requires conducting an Environmental and Social Impact Assessment (ESIA) including preparation of an Environmental and Social Management Plan (ESMP) in accordance with the AIIB's Environmental and Social Policy (ESP), under the Environmental and Social Framework (ESF, 2019). In this regard, WAPCOS Limited has been appointed by the

WRD, GoTN to undertake the ESIA Study for the proposed ERM works of GACS. The ESIA Study of the proposed ERM works of GACS was undertaken to identify the possible positive and negative impacts on the social and biophysical environment during the construction and operation phases. The activities undertaken as part of the assignment includes the following

- Carried out review of literature on the Cauvery River Basin and GACS including literature on the biophysical environment as well as the cultural, social, economic aspects of the GACS;
- Carried out baseline assessments of the project's area of influence through scoping and in-depth study and analysis of the proposed ERM works of GACS;
- Predicted and assessed the magnitude and significance of positive and negative environmental and social impacts of the proposed project activities;
- Developed measures for mitigation of impacts during project implementation;
- Conducting stakeholder and public consultations;
- Preparation of ESMP;
- Preparation of RPF for the Project;

These activities had been undertaken within the framework and policies of AIIB i.e., ESSs, legal framework of GoI and GoTN. The ESIA team interacted with the DPR team in order to document the existing social, cultural, biological and physio-chemical components of the existing environment in the project's area of influence (AoI). The Consultant has used AIIB's Environmental and Social Framework (ESF, 2019) including ESP and ESSs in conducting the ESIA study as well as for the preparation of the ESMP and RPF. The ESIA report cover the review of the Bank's ESP and determines which policies have been triggered by the proposed project activities and recommends mitigation and monitoring measures consistent with these policies. The deliverables are as follows:

- ESIA with ESMP
- Resettlement Planning Framework (RPF) for the Project

1.6 METHODOLOGY OF THE ESIA STUDY

The methodologies used to perform the ESIA study are as follows:

Review of literature

A kick-off meeting was undertaken, with the WRD officials, after award of the work for conducting the ESIA study. The DPR along with the data available with WRD were collected and various project objectives were discussed during the kick-off meeting. The Terms of Reference (ToR) as given by AIIB for conducting the ESIA study was discussed with the client and the DPR Team. Besides, different stakeholders associated with this project were identified in consultation with WRD and the DPR Team for the ERM Works of GACS Project.

Reconnaissance Study

A desktop study of the project area using available Landuse classification maps, Satellite Imageries, Basin maps, Canal Network system and the Chainage Maps were used to know the areas of project influence to identify the anticipated impacts.

WAPCOS multi-disciplinary team along with the WRD officials had conducted the reconnaissance survey for the entire stretch of the Main Canal starting from the Headwork's at Kallanai, Tiruchirappalli District and traversing through the Thanjavur District till the tail end of the Canal at Mumbalai Tank, Pudukkottai District and the network of branch canals. During the consultations, participatory methods were adopted to collect the information and details about the different aspects related to canal and tank irrigation and management.

Participatory Methods for ESIA study

The different participatory methods were adopted during the initial stage of the ESIA study, which includes Transect walk along the canals and tanks, Focus Group Discussion (FGD), Semi structured interviews with the key informants Viz. well-informed farmers, representatives of Water User Associations (WUAs) and Department heads. Rapid Environmental Impact Assessment was conducted for all category- 2 project activities.

Relevant secondary information on the socio-economic, demographic and environmental aspects were reviewed. The data collected from the secondary sources has been complemented by information gathered through field level consultations conducted by a multidisciplinary team using participatory methods with the different sections of the communities. Semi structured interviews have been conducted with the officials of line departments and Open-ended interviews with the representatives of the local bodies and Water User Associations (WUAs), Focus Group Discussions (FGDs) with the men and women farmers, Women Self-Help Groups (WSHGs). The visiting teams conducted transect walks in the project sites such as along the canal and tank area swith the guidance of WRD and local communities. A detailed check list of points while conducting semi structured interviews and FGD has been prepared before going to the field for consultations.

Field consultations has been organised in three stages. The first stage has been with a range of stakeholders like the officials of line departments, technical experts and leaders of Community Based Organisations (CBO), local bodies, WUAs and NGOs. During the consultations the scope of the work, objectives and the methodology has been shared with the stakeholders, suggestions and opinions were collected from the stakeholders.

The second stage focused on the farming communities; a wide range of topics related to environment and social aspects has been covered. During the visits conducted FGD, transect walks and also semi structured interviews, an exhaustive check list was prepared by the team to

conduct the consultations with different social groups like men and women farmers, members and leader of WUAs, SHGs, local bodies, NGOs, and officials of line departments.

The third stage is the public disclosure of the findings of ESIA report, RPF and mitigation measures to get public opinion / feedback of the project.

Monitoring of Environmental Parameters

The various environmental parameters for Ambient Air and Noise quality, Surface and Groundwater quality and Soil quality was monitored and analysed by NABL accredited environmental laboratory. Ground water data of project area Districts were obtained from the District groundwater brochures of the Central Ground Water Board (CGWB). The presence of environmentally sensitive location, critically polluted area, forest areas, protected area, migratory routes, nearby towns etc. on which project may have potential adverse impacts were identified in consultation with stakeholders' departments and local communities.

Impact Prediction and Management Plan

The primary and secondary data / information collected were analysed to ascertain the baseline environmental and social conditions. The impacts due to the project activities were identified and mitigation measures along with management plan are proposed for each identified adverse impact.

1.7 STRUCTURE OF THE ESIA REPORT

The ESIA report is presented based on the following structure:

- Chapter 1: Introduction
- Chapter 2: Description of Project
- Chapter 3: Legal and Regulatory Framework
- Chapter 4: Environmental and Social Baseline Status
- Chapter 5: Analysis of Alternatives
- Chapter 6: Social Impact Assessment
- Chapter 7: Potential Environmental and Social Impacts and Mitigation
- Chapter 8: Environmental and Social Management Plan
- Chapter 9: Environmental and Social Monitoring Action Plan
- Chapter 10: Stakeholder Consultations
- Chapter 11: Capacity Building
- Chapter 12: Grievance Redressal Mechanism
- Chapter 13: Institutional Arrangement for Implementation of ESMP

CHAPTER 2: DESCRIPTION OF PROJECT

2.1 PROJECT BACKGROUND

The Grand Anicut Canal (GAC) takes off from the Cauvery at Grand Anicut (Barrage) located downstream of Stanley reservoir, popularly known as Kallanai which is one of the oldest irrigation barrage in the world built around 2,000 years ago and was considered the largest in Asia at the time of its construction. The Barrage was built across the River Cauvery by the Chola King, Karikal Valavan with the objective of diverting the Cauvery water for irrigation in the Thanjavur delta. The barrage is in good condition built on a strong foundation and solid structure and is used as a major irrigation system in the state of Tamil Nadu.

The GACS project, as formulated by the British Engineer Col. W.M. Ellis was sanctioned for construction of a reservoir of 93.5 TMC capacity across Cauvery at Mettur and extension of irrigation to new area of 3.01 Lakh acres, comprising of 2.71 Lakh acres, under a new canal taking off from the Grand Anicut and 0.30 Lakh acres, by extension of the Vadavar canal of Vennar. An additional 20,000 acres has been envisaged as second crop under this canal. This new irrigated area under this canal is located adjacent to the Cauvery Delta in Thanjavur and Pudukottai Districts.

The construction of GACS was started in the year 1925, as per the 1924 Agreement as part of the Cauvery Mettur Project and was completed by 1934 and was inaugurated in the same year by the then Governor of Madras, Sir George Frederick Stanley and the Reservoir has been named after him in his honour. The GAC traverses through three Districts of Tamil Nadu namely Tiruchirapalli, Thanjavur and Pudukkottai.

The WRD, GoTN, has identified components of GACS, through WAPCOS which need reconstruction, rehabilitation and repair besides identifying new components, which are essential for equitable distribution, maintaining hydraulic profile and for discharge control in GACS.

2.1.1 Cauvery River Basin and its Drainage System

The Cauvery River originates in Brahmagiri range of hills of the Western Ghats at an elevation of 1341 m above MSL in Madikeri District of the state of Karnataka. The total drainage area of the Cauvery River basin is 81,155 Sq. km i.e., 2.5% of the total geographical area of the country. About 42% lies in Karnataka, 54% in Tamil Nadu, 3.5% in Kerala and the balance basin area lies in Karaikkal region of Puducherry. The maps showing the portion of the basin lying in Tamil Nadu and the sub-basins of Cauvery is given in Figure 2 and 3 respectively.

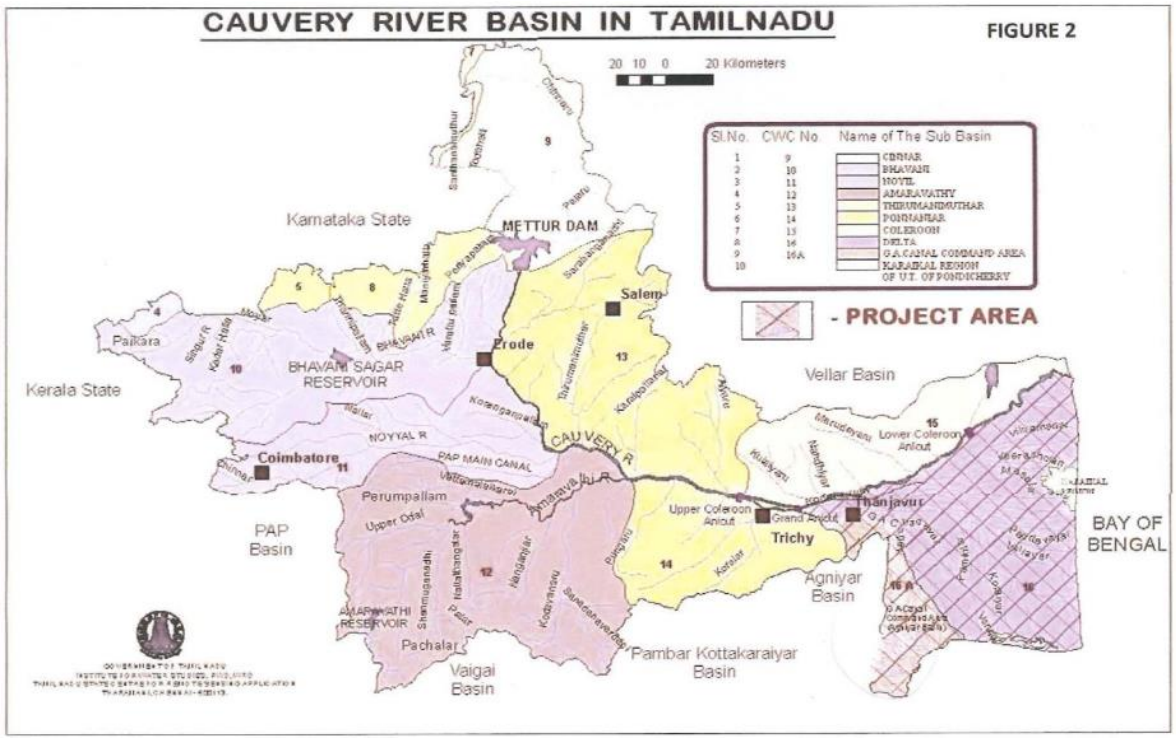


Figure 2 Map of Cauvery River Basin in Tamil Nadu

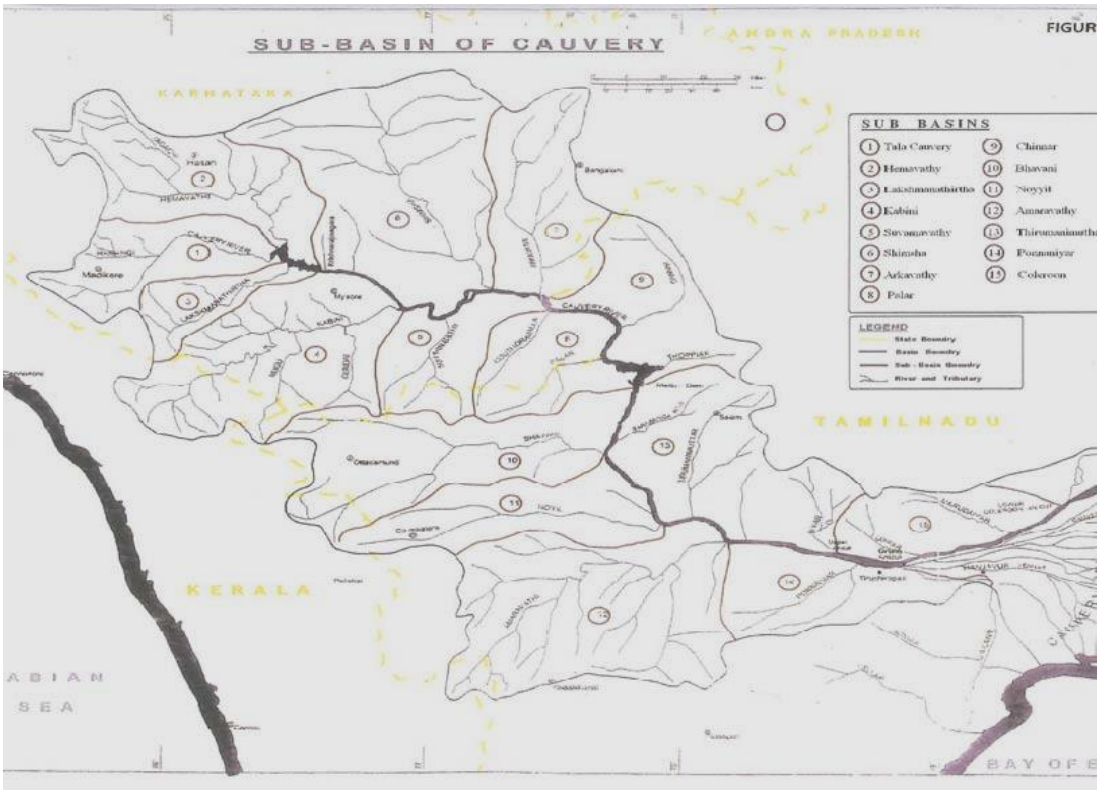


Figure 3 Sub-Basin Map of Cauvery River Basin

It is estimated that more than 50% of the area irrigated in Cauvery River basin in Tamil Nadu lies under the Cauvery Delta region. The total area is 5,60,000 Ha with four canal systems which are as detailed in Table-2.

Table 2 : Command Area of Canal System under Cauvery River

S. No.	Canal System	Command Area (Ha.)
1	Lower Coleroon Anicut (LCA)	77,557.00
2	Cauvery	1,89,328.00
3	Vennar	2,01,058.00
4	Grand Anicut	92,057.00

The Kattalai Irrigation schemes of Lower Bhavani is around 90,000 Ha this is the other schemes under the efficient water management of Cauvery River system in Tamil Nadu.

The Cauvery River enters the state of Tamil Nadu where Mettur dam impounds 95.6 TMC of water for use in the Cauvery Delta area. At upper Anicut, about 177 kms from Mettur dam, the River splits into two branches i.e., Northern Branch, a flood carrier called the Coleroon, and the Southern Branch is the main Cauvery which carries water for irrigation. At the Grand Anicut (Barrage), the River Cauvery splits into two branches i.e., Cauvery and Vennar.

The Cauvery and Vennar Rivers act as the main irrigation canals through regulators provided on both the Rivers and they further, distribute into branches and field channels, which forms the network in the delta region. These channels also carry the drainage water and act as irrigation cum drainage channels in the lower delta with around 177 major drains and 519 minor drains.

The northern branch of Cauvery namely the Coleroon bifurcates at the upper Anicut from the Cauvery which act as main flood carrier and it continues to flow in north-easterly direction to enter the Bay of Bengal south of Porto Novo at the confluence of Vellar River in the north. The Lower Coleroon Anicut (LCA) which is the last point of utilization of Cauvery water, is located about 110 km below the upper Anicut.

2.2 PROJECT LOCATION

The Main Canal of GACS traverses a total length of 148.65 kms through the three Districts i.e., Tiruchirappalli (5 kms), Thanjavur (104 kms) and Pudukkotai (39.65 kms) in the state of Tamil Nadu, India. The GACS and its command area is shown in Figure 4.

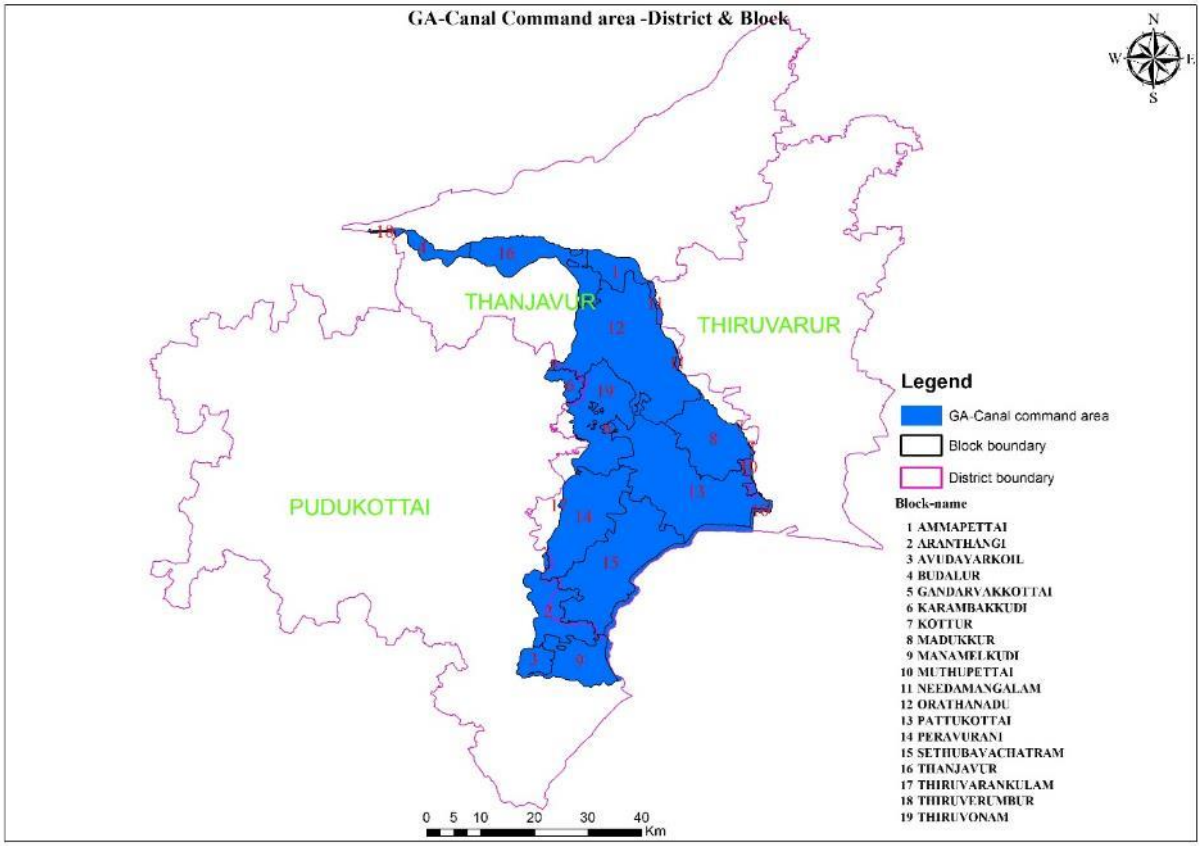


Figure 4: Command Area Map of GACS

2.1.2 Grand Anicut Canal System

The Grand Anicut canal takes off from the Grand Anicut head on the right side of the Cauvery immediately above the right flank of the Vennar Regulator.

The upland drainage course of old Vennar River emptied into GA canal below the construction of New Canal Head and served as source for the GA canal.

The old Vennar serving as an upland drainage course which formerly emptied into Vennar below the site of the new canal head was diverted and allowed to fall into the pool upstream of the new canal. The head sluice of the canal which also carries a road over it consists of 6 Vents each of 30 feet width fitted with radial shutters, and operated through electrical motors. Work on the canal system was started in 1926 and completed by 1935.

The Grand Anicut main canal traverses a length of 148.654 kms and passes through three Districts viz. Trichy / Thanjavur / Pudukkottai. The initial length of 5 kms falls in Trichy District, 104 kms falls in Thanjavur District and balance 39.654 km falls in Pudukkottai District. Originally the main canal was constructed for a length of 109.160 km, and then subsequently, one extension channel, two main channels and a feeder channel were constructed.

The canal is designed for an ayacut of 2,56,000 acres requiring a full supply discharge of 3,500 Cusecs at a duty of 73. However, for purposes of flushing and for filling up tanks when supplies are available, the canal as designed to provide for a maximum supply of 4,100 Cusecs, or 600 Cusecs in excess of the full supply discharge. The general slope of the country is from North West to South East. The distributing channels taking off from the canal are all on the left. The branch channels are carried generally on the ridges so as to command the lands lying on either side between the top of the ridges and the bottom of the valleys coming between.

The bed width of the canal at head is 54.860 m or 180 feet with F.S depth of 2.135 m or 7ft. the capacity of the canal is gradually reduced to suit the ayacut to be served. The bed fall however is gradually increased from 0.15 / 1000 at the head reaches to 0.25 / 1000 at the tail end to keep the velocities as high as practicable. The canal is 67.83 (109.160 km) miles in length from head to RD 35 / 81, where it takes the name as Grand Anicut extension channel and beyond this as Narasinga Cauvery Extension, (New Main Channel). The left bank of the canal is maintained throughout to serve as a bank road motorable in fair weather for inspection by officers.

The canal passes through the Thanjavur Town in cutting which practically begins at RD 12 / 9899 and extends to RD 14 / 8865, a distance of nearly 6.5 km. The approach to the town is in deep cutting (26 feet) but through the Town itself the depth of cutting is such as to keep to full supply level as far as possible below ground level.

The canal in this reach is taken with reduced bed width of 80 feet and full supply depth of 10 feet by suitably increasing the slope of the canal with suitable transitions. As a protective measure against scour, the whole course of the canal within the town has been protected with revetment.

One important aspect is the change in alignment of the canal made during execution, from RD 20 / 4750; the canal is taken in an entirely new alignment. As originally aligned, the canal was to pass through the eastern portion of the old Pudukkottai State for the irrigation of certain lands in the State, but in view of difficulties that cropped up later regarding the control of irrigation supplies, the collection of revenue by staff authorities and the administrative control over the canal zones in that native State territory, that course had to be abandoned and it was found necessary to realign the canal so as to run entirely within the Madras territory. An area of 20,000 acres of the naturally commandable extent has been thrown out of the ayacut, due to the shifting of the canal. However, after the merger of Pudukkottai State with the Indian Union and on the several representations of the Pudukkottai Ryots, a scheme for giving irrigation for a portion of the ayacut that would have been benefited under the original alignment of the canal has been executed by improving and extending the Olavayal branch channel. The height of the embankments crossing the valleys of the Maharaja Samudram, the Agniyar and other important drainages had to be increased as the canal had to cross them at a sufficiently high level to command the lands lower down. Besides these, the canal bed had to be dropped by 27 feet in a series of drops to enable the crossing of the valleys to be affected at practicable levels.

In its course, along the alignment, the Grand Anicut Canal intercepts a right-side catchment of 780 Sq. miles, which can create a combined potential flood of over 80,000 Cusecs. The streams crossed vary in size from quite insignificant ones to big streams like Agniyar, which is capable of carrying a discharge as high as 58,300 Cusecs. The most practicable and necessary alternative of crossing the drainages was to exclude the water in cross drainages altogether by means of aqueducts. Forty-three such cross drainage works (Aqueducts, Syphon Aqueducts / Syphons) have been constructed in the course of the canal. By this means, the design of the canal has been much simplified, as its capacity at any point is restricted to the requirements of irrigation alone.

All the head sluices of the branch canals, channels and distributaries taking off from the canal are provided with screw gearing shutters for regulation and are designed to carry the F.S.L discharge even when the canal carries half supply discharges.

Since the development of the ayacut under the G.A. Canal did not reach the eligible extent of 3,01,000 acres as per 1924 agreement, the ayacut under the canal was fixed as 2,27,472 acres under the GA Canal and 29,000 acres under the Vadavar Extension. To make good the shortfall of 45,000 acres, the Mettur canal scheme with a new canal taking off directly on the right flank of the River from Mettur dam was executed in 1958.

The details of the GACS are summarised as follows:

- Originally the Main Canal was constructed for a length of 109.16 km, and subsequently, one extension channel, two main channels and a feeder channel were constructed.
- There are 16 branch canals offtaking from G.A. main canal from Ch: 00 km to 148.081 km with a length of 288.495 km**.** Among the Branch Canals, Kalyana Odai Branch Canal is the largest canal and Rajamudaram Branch canal is the second largest canal. From the Branch canals, several channels / open head channels are offtaking.
- There are 40 distributaries offtaking from G.A. main canal with a total length of 79.722 km.
- There are 263 laterals offtaking from various branch canals and distributaries, with a total length of 626.445 km.
- The details are given in Table 3 to 6 respectively.

Table 3 : Details of the G.A. Main Canal

No.	Name of the Canal	Chainage (km)	Length (km)	District
1.	G.A. Main Canal	0.00 to 109.16	109.16	Tiruchirappalli / Thanjavur
2.	G.A. Extension Channel	109.16 to 126.83	17.67	Pudukottai
3.	G.A. New Main Channel	126.83 to 135.90	9.07	Pudukottai
4.	Mahaganapathipuram	135.90 to 144.43	8.53	Pudukottai

	Main Channel			
5.	Mahaganapathipuram Feeder Channel	144.43 to 147.28	2.85	Pudukottai
6.	Mumpalai Tank Distributary		1.37	Pudukottai
Total			**148.65**	

Table 4 : Details of G.A. Branch Canal

No	Branch Canal	Parent Canal / Channel	Off taking Chainage (km)	Length (km)	District
1.	Chakkra Channel	G.A. main canal	27.61	6.23	Thanjavur
2.	Neivasal Thenpathy Channel	G.A. main canal	45.28	18.10	Thanjavur
3.	Vattacheri Channel	G.A. main canal	48.12	16.77	Thanjavur
4.	Kalyana Odai Branch Channel	G.A. main canal	48.80	48.19	Thanjavur
5.	Rajamadam Branch Channel	G.A. main canal	58.66	42.87	Thanjavur
6.	Olavayal Branch Canal	G.A. main canal	62.62	27.77	Thanjavur / Pudukottai
7.	Alivalam Main Canal	G.A. main canal	77.67	12.26	Thanjavur
8.	Kayavur Channel	G.A. main canal	82.98	6.63	Thanjavur
9.	Pannavayal Channel	G.A. main canal	88.84	8.30	Thanjavur
10	Puduppattinam Branch Canal	G.A. main canal	93.29	24.08	Thanjavur
11	Ananthapuram Channel	G.A. main canal	99.50	14.37	Thanjavur
12	Kalanivasal Channel	G.A. main canal	101.82	11.57	Thanjavur
13	Anavayal Branch canal	G.A. extension channel	121.85	12.75	Thanjavur
14	Ammanichadram Branch Canal	G.A. extension channel	123.37	16.00	Thanjavur
15	Thiruvappady Main Channel	G.A. extension channel	126.79	13.23	Thanjavur
16	Kalakkamanagalam Channel	G.A. new main channel	131.36	9.34	Thanjavur
Total				**288.49**	

Table 5 : Details of G.A. Canal Distributaries

No.	Distributaries	Parent Canal / Channel	Off taking Chainage (km)	Length (km)	District
1.	Rear Channel	G.A. main canal	5.10	1.34	Thanjavur
2.	G.A.No. 1A Rear Channel	G.A. main canal	8.12	1.64	Thanjavur
3.	G.A.No.1B Channel	G.A. main canal	9.65	1.67	Thanjavur
4.	Rear Channel	G.A. main canal	9.68	1.68	Thanjavur
5.	G.A.No.1 Channel	G.A. main canal	12.03	1.71	Thanjavur
6.	Palayeevayal Channel	G.A. main canal	20.34	1.70	Thanjavur
7.	Rear Channel	G.A. main canal	20.37	1.62	Thanjavur
8.	Rear Channel	G.A. main canal	22.06	1.20	Thanjavur
9.	Rear Channel H.S.	G.A. main canal	23.15	0.91	Thanjavur
10.	Head sluice rear channel	G.A. main canal	24.09	2.61	Thanjavur
11.	G.A.No.2 Rear Channel	G.A. main canal	24.67	0.93	Thanjavur
12.	G.A No.3 Channel	G.A. main canal	29.83	2.32	Thanjavur
13.	G.A No.4 Channel	G.A. main canal	33.58	1.32	Thanjavur
14.	G.A No.5 Channel	G.A. main canal	35.88	0.43	Thanjavur
15.	G.A No.5A Channel	G.A. main canal	36.36	1.40	Thanjavur
16.	Rear Channel	G.A. main canal	39.19	1.29	Thanjavur
17.	G.A No.6 Channel	G.A. main canal	51.42	1.79	Thanjavur
18.	G.A No.6 Rear Channel	G.A. main canal	51.41	1.50	Thanjavur
19.	G.A No.7 Channel	G.A. main canal	53.87	2.02	Thanjavur
20.	G.A No.8 Channel	G.A. main canal	56.20	1.48	Thanjavur
21.	G.A No.8 Rear Channel	G.A. main canal	57.66	0.40	Thanjavur
22.	G.A No. 9	G.A. main canal	60.96	5.32	Thanjavur
23.	G.A No. 11	G.A. main canal	67.06	1.10	Thanjavur
24.	Silathur Branch Canal	G.A. main canal	68.69	2.81	Thanjavur
25.	G.A No. 12	G.A. main canal	69.69	0.57	Thanjavur
26.	Akkaraivattam Main Canal	G.A. main canal	75.15	2.53	Thanjavur
27.	G.A No. 13	G.A. main canal	75.29	3.44	Thanjavur
28.	Naduvikkottai HS.	G.A. main canal	80.25	4.21	Thanjavur
29.	G.A No. 14	G.A. main canal	81.42	0.67	Thanjavur
30.	G.A No. 16	G.A. main canal	89.28	1.40	Thanjavur
31.	G.A No. 17	G.A. main canal	90.25	1.37	Thanjavur
32.	Neduvasal Channel	G.A. main canal	93.29	3.12	Thanjavur
33.	G.A No. 18	G.A. main canal	94.50	2.35	Thanjavur

No.	Distributaries	Parent Canal / Channel	Off taking Chainage (km)	Length (km)	District
34.	G.A No. 19	G.A. main canal	97.30	1.83	Thanjavur
35.	G.A No. 20	G.A. main canal	103.16	2.47	Thanjavur
36.	Pinnavasal Vadapaty channel	G.A. main canal	105.45	3.39	Thanjavur
37.	Pinnavasal Thenpathy Channel	G.A. main canal	109.16	3.33	Thanjavur
38.	Sornakkadu Branch Canal	G.A. extension channel	110.47	0.67	Thanjavur
39.	Ayangudy Branch Canal	G.A. extension channel	118.69	4.05	Thanjavur
40.	Sirumarudur Channel	G.A. new main channel	131.78	4.12	Thanjavur
			Total	**79.71**	

Table 6 : Details of G.A. Canal Laterals

No.	Branch Canal / Distributary	No. of Laterals	Total Length (km)
1.	Chakkara Branch Canal	9	12.17
2.	Neivasal Thenpathy Branch Canal	6	16.64
3.	Vattacheri Branch Canal	4	2.01
4.	Kalyana Odai Branch Canal	120	301.47
5.	Rajamadam Branch Canal	40	64.19
6.	Right Side Supply Channel	1	6.25
7.	Left Side Supply Channel	1	12.00
8.	Vedapuri Channel	1	8.33
9.	Olavayal Branch Canal	6	12.24
10.	Silathur Branch Canal	3	2.60
11.	Akkaraivattam Main Canal	2	4.33
12.	Alivalam Main Canal	7	16.89
13.	Naduvikkottai HS.	3	7.85
14.	Kayavur Branch Canal	2	2.60
15.	Pannavayal Branch Canal	3	6.99
16.	Puduppattinam Branch Canal	31	101.63
17.	Pinnavasal Thenpathy Channel	4	12.10
18.	Ayangudy Branch canal	1	1.07
19.	Anavayal Branch canal	3	3.29

No.	Branch Canal / Distributary	No. of Laterals	Total Length (km)
20.	Ammanichadram Branch Canal	2	7.98
21.	Thiruvappady Main Channel	8	7.49
22.	Kalakkamanagalam Channel	5	12.87
23.	Sirumarudur Channel	1	2.57
Total		**263**	**625.56**

The Salient features of GACS are presented in Table – 7:

Table 7 : Salient Features of GACS

Sl.No.	Particulars	Details
1	Name of the Project	Grand Anicut Canal System
2	River	Cauvery
3	Name of the River Basin	Cauvery Basin
4	Location of Barrage / diversion structures	Kallanai in Tiruchirappalli
5	Latitude	10°49'44''N
6	Longitude	78°49'02" E
7	Offtake location	From Right flank of G.A. (barrage) at Kallanai
8	District benefitted	Thanjavur and Pudukottai
9	Total length of G.A. Main Canal (km)	148.65
	i. G.A. Main Canal (km)	109.16
	ii. G.A. Extension channel (km)	17.67
	iii. New Main Channel (km)	9.07
	iv. Mahaganapathipuram Main Channel (km)	8.53
	v. Mahaganapathipuram feeder channel (km)	2.85
	vi. Mumbalai Distributary (km)	1.37
10	Command area (Ha.)	92,057
11	Discharge in cumecs	111
12	**Nos. of structures**	
	a. Cross Regulator	45

Sl.No.	Particulars	Details	
	b. Sluices	2,805	
	c. Drops	966	
	d. Aqueduct	72	
	e. Syphons	310	
	f. Under Tunnel	131	
13	Bed width at statring point in m	54.86	
14	Bed width at End point in 'm'	12.344	
15	Full supply depth in 'm'	2.135	
16	Free board	0.75	
17	Bed fall	1 in 6666.66	
18	Canal bank inner slope	1.5 : 1	
19	Canal bank Outer slope	1.5 : 1	
20	Ayacut details in Acres	**2,27,472**	
	i.Thanjavur District		
	Canal network for 1,078.09 km		
	Class	**No**	**Length (km)**	**Ayacut (acre)**
	A	58	369.73	65,455.46
	B	129	400.20	74,724.99
	C	82	228.32	40,157.97
	D	21	63.19	9,611.13
	E	6	16.65	1,907.13
	Sub total	296	1,078.09	**1,91,856.68**
	Direct sluice			**8,586.32**
	Sub total i			**2,00,443.00**

Sl.No.	Particulars		Details	
	ii. Pudukkottai District			**27,029**
	Canal network for 153.92 km			
	Class	**No**	**Length (km)**	**Ayacut (acre)**
	A	7	68.98	15,641.52
	B	24	84.94	9,788.66
	Sub total	31	153.92	25,430.18
	Direct sluice			1,598.82
	Sub total ii			**27,029.00**
	TOTAL (i+ii)			**2,27,472.00**
21	Crop Water requirement in TMC		46.45	
22	Maximum annual rainfall in Thanjavur (mm)		991.50	
23	Maximum annual rainfall in Pudukkottai (mm)		816.90	

2.3 CULTIVABLE COMMAND AREA (CCA)

The CCA as per the approved DPR for GACS is 92,067 Ha. The total area irrigated, including for second crop, is 1,00,191 Ha. Thus, the water requirement, considering an irrigation duration of 145 days, is 42.50 TMC at the Head Works i.e., Grand Anicut, which is well within the allocation of 46.45 TMC to irrigate 1,11,695 Ha at 65% conveyance efficiency by CWDT.

2.4 PROJECT COMPONENTS

The WRD, GoTN owns, operates and maintains the various components of GACS i.e., Canals, Tanks, hydraulic & other structures, including roads, buildings & bridges. The Field Channels are owned, operated & maintained by respective field owners. The abstract of project interventions for the ERM works of GA canal are detailed in Table 8.

Table 8 : Project Interventions

Particulars	Unit	Existing	Proposed
Bed and Side Lining	km	1,323.32	1,030.00
Regulators	Nos	45	26
Syphons	Nos	102	66

Well Syphons	Nos	132	15
Canal Syphons	Nos	76	25
Aqueducts	Nos	72	7
Under Tunnel	Nos	131	58
Drops	Nos	966	245
Head Sluices	Nos	293	169
Direct Sluices	Nos	358	283
Rear Channel Sluices	Nos	8	-
Pipe Sluices	Nos	2,146	609
Bridges	Nos	184	3
Gauging Bridges	Nos	10	0
Tanks	Nos	694	33
Buildings	Nos	116	74
Roads	km	452	31.56
End Dams	Nos	127	8
Bank Strengthening	km	619	744.094
Steps & Ramps	Nos	721	418
SCADA	-	-	Entire Project

2.5 ASSOCIATED FACILITIES

- **Mettur Dam**

Mettur Dam also known as Stanley Reservoir construted across River Cauvery around 1934, is functioning continuously to supply water for irrigation as well as power generation. Mettur Dam is in the upper reach of Grand Anicut at a distance of around 205 km. This dam is taken up under Dam Rehabilitation and Improvement Project (DRIP) project and number of works for improving the stability of the dam is being implemented under this project from 2021 to 2022. Safety and Stability of the dam is being continuously monitored by the WRD.

- **Other Facilities**

WAPCOS have prepared the DPR, based on a detailed walk-through survey, topographical survey, detailed inventory of the structures, and structural & hydraulic condition assessment

(using Rebound Hammer method of non-destructive testing) of the Canal system and its Hydraulic structures viz., Regulators, Pipe Sluice, Aqueducts, Canal Drops, Escape channels, Syphons, tank structures, Roads & Bridges, Steps/Ramps, etc. The Topographic survey and base line survey have complied with requirement of GoTN & CWC, GOI.

Based on the above-mentioned detailed survey and conditional assessment, WAPCOS have identified components of Canal System, which need reconstruction, and repair and structures not required improvements due to its good condition. It has also identified new components, which are necessary for equitable distribution, maintaining hydraulic profile and for discharge control in GACS. These components are hereinafter collectively referred to as Project and is a subset of GACS. The details of components existing and proposed for improvement under GAC ERM is given in Table 8.

The report and the information kilometer wise along with photographs of canal reaches and structures were presented in the Baseline Survey Report, including the structures of which were not considered for improvement due to its good condition. Details of few structures which were not considered for improvement due to its good condition are described below alongwith the Photographs.

Details of few structures which were not considered for improvement due to its good condition are described below alongwith the Photographs.

S.No.	Chainage in km	Type of Structures	Surveyed Structure details	Existing condition	Proposed improvement	Improvements finalized	Photographs
1	59.850	Road bridge	Carriage width of 7.45 m and length of 43.60 m, piers is of 4 no.	Structure is built recently.	Structure is in good condition.	No improvements envisaged.	 

S.No.	Chainage in km	Type of Structures	Surveyed Structure details	Existing condition	Proposed improvement	Improvements finalized	Photographs
2	30.182	Drop No 1	(a) Drop height - 1.6 m. (b) Crest wall height - 1.50 m	Brick Masonry constructed in 1927 - 35	Good Condition	No improvements envisaged.	

S.No.	Chainage in km	Type of Structures	Surveyed Structure details	Existing condition	Proposed improvement	Improvements finalized	Photographs
3	6.553	Jambugapuram Channel	Gate size - 0.9 m x 0.90 m		Gate size - 0.9 m x 0.90 m	No improvements envisaged.	 

S.No.	Chainage in km	Type of Structures	Surveyed Structure details	Existing condition	Proposed improvement	Improvements finalized	Photographs
4	8.778	Culvert	(a) Abutment length - 7.40 m. (b) Box of Top width - 3.65, Bottom width -3.35 & height - 1.50 m. (c) Deckslab of length 4.25 m & width - 7.80m, thickness - 0.35 m	Brick Masonry constructed in 1927 - 35	Good Condition	No improvements envisaged.	 

S.No.	Chainage in km	Type of Structures	Surveyed Structure details	Existing condition	Proposed improvement	Improvements finalized	Photographs
5	0.687	Drop No 2	(a) Drop height - 0.65 m. (b) Crest height - 3.80 m		Good Condition		

2.6 PROJECT COST

The Project Cost for ERM works of GACS is 2,639.15 Crores (USD Million 377.02) at price level 2014-15, of which AIIB shall provide a loan facility for 70% of Project Cost i.e., INR 1609.125 Crores (USD 229.87 Million) and balance 30% of Project Cost i.e., 689.625 Crores (USD 98.52 Million) shall be borne by GoTN.

2.7 PROJECT IMPLEMENTATION PLAN

The ERM works of the GACS is proposed to be implemented in 16 Packages scheduled to be completed over a period of 03 years. The details of work proposed under each package are given in Table 9.

Table 9 : Package wise list for ERM works of GAC

S No.	Package No.	Name of Work
1	Package 1	Rehabilitation of Irrigation Infrrastructures in G.A. Main Canal L.S. from 0.000 km to 12.624 km. and G.A. No.1A Channel, G.A. No.1 Rear Channel, GA. No. 1B Rear Channel with Feeding Tanks in Budalur Taluk of Thanjavur District.
2	Package 2	Rehabilitation of Irrigation Infrastructures in G.A. Main Canal L.S From 12.624 km to 30.430 km, G.A. No.2 rear Channel, GA. No.3 channels and Chakkara Branch channels with feeding tanks in Budalur And Thanjavur Taluks of Thanjavur District.
3	Package 3	Rehabilitation of Irrigation Infra structures In G.A. Main canal L.S from 30.430 km to 45.290 km and G.A No.4 channel, G.A no.5 channel , G.A N0.5A , Rear Channel,and NeivasalThenpathy Branch channels with feeding Tanks in Papanasam and OrathanaduTaluk Of Thanjavur District.
4	Package 4	Rehabilitation of Irrigation Infrastructure in G.A.Main Canal L.S. from 45.290 Km. to 58.650 Km., V.T.Channel , G.A.No.6 Channel, G.A.No. 7 Channel, G.A.No. 8 Channel, G.A No.8 Rear Channel, and Kalyanaodai Branch Canal L.S. from 0.000 Km. to 13.000 Km, Kulamangalam main Channel, Paruthikkottai Channel, Melavannipattu Channel with Feeding Tanks in Thanjavur, Papanasam, OrathanaduTaluks of Thanjavur District.
5	Package 8	Rehabilitation of Irrigation infrastructures in G.A Main canal from LS 58.650 km to 92.200 km Akkaravattam Main channel, Alivalam channel, Neduvikottai channel, G.A.No.13 channel and G.A. No.14 channel with feeding tanks in orathanadu and Pattukkottai taluks of Thanjavur District and Karambakudi taluk of Pudukkottai District.

S No.	Package No.	Name of Work
6	Package 5	Rehabilitation of Irrigation Infrastructures in Kalyana odai Branch Canal LS from 13.000 to 29.000 Km, Thirumangalakottai Main Channel L.S. from 0.000 to 5.030 Km and Branch Channels with Feeding Tanks in Orathanadu Taluk of Thanjavur District.
7	Package 6	Rehabilitation of Irrigation Infrastructures in K.B. Canal L.S. from 29.000 to 49.000 Km and Branch Channels with Feeding Tanks in Orathanadu and Pattukkottai Taluks of Thanjavur District.
8	Package 7	Rehabilitation of Irrigation Infrastructures in Vadakadu Branch Canal in LS from 0.000 to 35.280 Km, Vedapuri Supply Channel LS from 0.000 to 8.350 Km, Vendakkottai Left Side Supply Channel LS from 0.000 Km to 12.500 Km and Branch Channels with Feeding Tanks in Orathanadu and Pattukkottai Taluks of Thanjavur District.
9	Package 9	Rehabilitation of Irrigation Infrastructures in Rajamadam Main Canal, Branch Channels with Feeding Tanks in Orathanadu and Pattukkottai Taluks of Thanjavur District.
10	Package 10	Rehabilitation of Irrigation Infrastructures in Olavayal Main channel, Sillathur Main Channel, G.A. No. 9 Channel, G.A. No. 11 Channel and G.A.No. 12 Channel, Kayavur Main channel, Pannavayal Main Channel, G.A. No.16 Channel and G.A. No. 17 Channel with Feeding Tanks in Orathanadu and Pattukottai Taluks of Thanjavur District and Karambakudi Taluk of Pudukottai District.
11	Package 11	Rehabilitation of irrigation infrastructures in G.A. main Canal LS from 92.200 km to 109.16 km, Branch Channels with Feeding Tanks in Pattukkottai and Peravurani Taluks of Thanjavur District.
12	Package 12	Rehabilitation of irrigation infrastructures in G.A. extension Channel LS from 109.16 km to 126.83 km, with Feeding tanks in Peravurani Taluk of Thanjavur District and Alangudi, Aranthangi, Avudaiyarkoil and Manamelkudi Taluks of Pudukkottai District.
13	Package 13	Rehabilitation of irrigation infrastructures in New Main Channel from LS.126.83 km to 135.91 km, Mahaganapathipuram Channel from LS.135.91 km to 148.65 km and Branch Channels with Feeding tanks in Peravurani Taluk of Thanjavur District and Alangudi, Aranthangi, Avudaiyarkoil and Manamelkudi Taluks of Pudukkottai District.
14	Package 14	Rehabilitation of irrigation infrastructures in Puduppatinam Canal from LS.0.000 km to 14.530 km and Sethubavachathiram Main Channel from LS.0 to 15.609 km and branch channels with Feeding tanks in Pattukottai and Peravurani Taluks of Thanjavur District.

S No.	Package No.	Name of Work
15	Package 15	Rehabilitation of irrigation infrastructures in Puduppatinam Main Channels from LS 14.53 km to 24.09 km and it's branch channels with Feeding tanks in Pattukottai Taluk of Thanjavur District.
16	Package 16	Detailed Survey, Preparation of Estimates, SCADA and DPR for Extension, Renovation and Modernisation of Grand Anicut Canal System.

WRD had already awarded contracts for five packages which are under implementation and requested the AIIB to consider these five contracts also for its financing. In the Aide Memoire of Mission Visit of August 3-5, 2022, it has been mentioned that the bank will conduct its review and due diligence of the contracts awarded, especially from procurement and E&S perspectives for the purpose of financing the five ongoing contracts.

In view of this, it has been suggested to submit an ESDDR to the draft ESIA for the construction works awarded packages. It was suggested to highlight the approach adopted for the environmental safeguard implementation including the compliance to the regulatory requirements, suitable safeguard clauses in the Bid document (under the General conditions and specific conditions), and ESMP.

In view of the above, an ESDDR to the draft ESIA report has been prepared and the report consists of the following:

i. About Grand Anicut Canal System
ii. Need for Modernization of the Canal system
iii. Components proposed for Rehabilitation /Modernisation under ERM
iv. Details /Status of Work Packages already awarded /under Implementation

Status of Environmental and Social Management Plan (ESMP) in ongoing five packages including management of silt from silt traps during operation phase.

CHAPTER 3: LEGAL AND REGULATORY FRAMEWORK

3.1 INTRODUCTION

The project investments would be in compliance with the relevant legislations of India (central level) and Tamil Nadu (state level) and with the safeguard policies of the AIIB. This chapter, based on the review and analysis of the existing legal and policy environment, highlights the applicable legislations which have a bearing on the implementation of ERM works of GACS. Applicable legislations during implementation of the project and necessary provisions for compliance have been examined and presented in this chapter.

3.2 APPLICABLE RULES AND REGULATIONS OF GoI AND GoTN

The proposed project does not fall under the preview of EIA notification 2006 and its subsequent amendments as the said project activity is Extension, Renovation and Modernization work. However other legislations of GoI and GoTN with respect to environmental and social management which are applicable to the project components have been reviewed. The project has a Resettlement Policy Framework (RPF) to mitigate any likely impact of the project on persons, households or communities. The RPF has been given as a standalone document for the project. The relevance of national and state level legislations to the project is presented in Table – 10.

Table 10 : Relevant Acts, Rules and Policies of GoI and GoTN

Relevant Act/Policies/Rules	Objective	Relevance to project components
Environmental Legislative Framework		
Environment (Protection) Act, 1986	EPA (1986) is an umbrella Act that provides for introduction of various regulations aimed at environmental conservation and protection.	Applicable as this project requires Consent to Establish (CtE) and Consent to Operate (CtO) from the Tamil Nadu Pollution Control Board (TNPCB). However Batching plant / Hot Mix plants / Mining of minerals and materials require CtO and CtE from TNPCB
The Water (Prevention and Control of Pollution) Act 1974 The Water (Prevention and Control of Pollution) Rules 1975 Subsequent amendments	The Act and Rules outlines the activities which are prohibited on account of their potential to cause water pollution. Agriculture practices are excluded but activities like Irrigation, etc. are covered under the Act for which necessary assessment is required.	
The Air (Prevention and Control of	The Act and Rules outlines the activities which are prohibited on	

Relevant Act/Policies/Rules	Objective	Relevance to project components
Pollution) Act 1981 The Air (Prevention and Control of Pollution) Rules, 1982 Subsequent amendments	account of their potential to cause air pollution.	
The Noise Pollution (Regulation and Control) Rules, 2000 Subsequent Amendments	The Rules outlines the regulations and control of noise producing and generating sources with the objective of maintaining the ambient air quality standards in respect of noise.	Applicable as this project envisages usage of construction equipment and machinery.
Forest (Conservation) Act,1980	This Act provides guidelines for conservation of forests and diversion of forest land for non-forest use. The law also states guidelines on de-reservation of various categories of forests for diversion of forest land. This law describes the penalty for contravention of the provisions of the Act. Restriction on the de-reservation of forests or use of forest land for non-forest purpose.	Applicable Although there is no forest land in the project area, however, for removal of forest trees in the embankments, the provisions of the Act shall be applicable.
Tamil Nadu Forest Act, 1882	The Act regulates the collection sale and transit of forest produce.	Applicable Although there is no forest land in the project area, however, removal of trees shall be compensated in the ratio of 1:10
The Indian Wildlife (Protection) Act, 1972, amended 1993 The Wild Life (Protection) Amendment Act,2002	The Act provides guidelines for protection of wildlife including mammals, avi-fauna, reptiles, etc. It also states the norms for hunting of wild animals, prohibition of picking, uprooting, etc., of specified plants. The Act deals with the declaration of	Applicable Although the project area does not support wildlife, however, the following biodiversity hotspot fall in close proximity of less than 5 km.

Relevant Act/Policies/Rules	Objective	Relevance to project components
	area as Sanctuary, National Park, and closed area and also states the restriction of entries in the sanctuary.	Vaduvoor bird sanctuary Point calimere wildlife sanctuary
Biodiversity Act, 2002 Biodiversity Rules, 2004	The Act essentially controls access to indigenous biodiversity resources.	Applicable Although, the area of the project component does not have biodiversity, however if the employer violates any provision of the Act, the same shall be applicable.
National Policy on Safety, Health and Environment at Workplace	The policy aims to secure health of strength of employees and ensure humane conditions of work, including maternity relief to women	Applicable The provisions will apply to ensure that labour camps and working conditions are safe and humane.
Tamil Nadu Irrigation, levy of betterment contribution Act No.7 of 1955 and its subsequent amendments.	It provides for betterment assessment be made against the land which is significantly benefitted by the completion of certain improvement works.	Applicable The project involves irrigation related components; the water tax shall be collected as per the State Act.
Tamil Nadu Irrigation Tanks (Improvement Act. No. 19 of 1949) and its subsequent amendments.	Under this Act the government has authority to improve efficiency and capacity of Government owned and operated tanks regardless of locations.	Applicable The project involves irrigation related components viz., standardising the bund, repair of hydraulic structures, inlet and out channels.
Tamil Nadu Irrigation (Voluntary Cess) Act No. 13 of 1942 and subsequent Amendment	This Act pertains to a special Levy against land for Maintenance of certain irrigation and drainage works constructed and maintained by the government	Applicable The project involves irrigation related components; the project to confirm whether any special levy would be imposed and how the proceeds would be utilized, either by WRD or through Water User Associations.

Relevant Act/Policies/Rules	Objective	Relevance to project components
Tamil Nadu Ground Water (Development and Management) Act, 2003	The Act regulates the development and management of the ground water resources of the State.	Applicable The project interventions shall have impact on the groundwater resources; the project should highlight how conjunctive use of water resources are promoted under the project
The Tamil Nadu Farmers' Management of Irrigation Systems Act, 2000	It provides for Farmers' participation in the Management of Irrigation Systems To promote and secure distribution of water among its users, adequate maintenance of the irrigation system, efficient and economical utilization of water to optimize agricultural production	Applicable The project shall involve inclusion of Farmers Group, SHGs in the implementation of system rehabilitation, O&M; the project should ensure early capacity development of Farmers Group.
Solid Waste Management Rules, 2016	The provisions of the Act prevent littering and mandate proper segregation, collection, storage and disposal of municipal solid waste.	Applicable The project will have provisions to manage and dispose solid wastes generated through project investments
Construction and Demolition Waste Management Rules, 2016	Rules and regulation for construction & Demolition Waste	Applicable The project shall generate construction and demolition wastes.
Hazardous and Other Wastes (Management and Transboundary Movement) Rules, 2016	Rules and regulation for management and movement of Hazardous and other wastes	Applicable Although there is no hazardous wastes envisaged in the project, however, if there is any violation of provisions of the Rules, the same shall be applicable.
Plastic Waste Management Rules, 2016	The Act stipulates to collect separately and safe disposal.	Applicable The Contractor should ensure proper plastic waste

Relevant Act/Policies/Rules	Objective	Relevance to project components
		management in labour camps and workplaces.
Notification on utilisation of Fly Ash, 1999 and subsequent amendments	Promoting the utilization of fly ash in the manufacture of building materials and in construction activity	Applicable The project involves construction activities.
The Tamil Nadu Minor Mineral Concession Rules, 1959	Rules and regulation for quarrying of minor minerals	Applicable The project involves use of minor minerals
Minor Mineral Conservation and Development Rules, 2010	Rules and regulation for conservation and development of minor minerals	Applicable The project involves indirect use of minor minerals which shall be obtained from government aurthoirsed quarries / mines / agency.
Explosives Act, 1884 and subsequent amendments	An Act to regulate the manufacture, possession, use, sale, transport, import and export of explosives.	Not Applicable as this project does not envisage usage of explosives
Explosives Rules, 2008 and subsequent amendments	These rules are applicable for regulating the manufacture, import, export, transport, and possession for sale or use of explosives.	
The Tamil Nadu Protection of Tanks and Eviction of Encroachment Act, 2007	An Act to protect the water bodies from encroachments and for proper use.	Applicable The project involves tanks in irrigation components where there is no encroachment and this project has prepared a seprate RPF to mitigate any future inpacts.
Environmental Impact Assessment Notification, 2006 and subsequent amendments	The EIA notification outlines the procedure for obtaining Environmental Clearance. As per the notification, a list of projects, requiring Environmental	Not Applicable as the project components do not come under the purview.

Relevant Act/Policies/Rules	Objective	Relevance to project components
	Clearance from regulatory agencies at the State or Central government level has been provided. As per this notification, irrigation projects envisaging irrigation over a CCA between 2000 to 10000 ha. require Environmental Clearance from regulatory agencies at state government level. Likewise, projects envisaging irrigation over CCA >10,000 ha require Environmental Clearance from regulatory agency at Central Government level.	As per the notification Schedule it is included in Sl.No 4, Irrigation projects. As the project acitivities involves extension, rehabilitation, and modernization of River channel infrastructure including de-silting of Riverbed, providing of new structures, etc. without any increase in command area, thus the project does not fall under the purview of EIA notification and its subsequent amendments and does not require Environmental Clearance.
Coastal Regulation Zone Notification, 2019 and subsequent amendments	The CRZ notifications stipulates the regulations for conservation and protection of the coastal areas	Not Applicable as the project area does not fall in CRZ notified areas.
Public Liability and Insurance Act, 1991	The Act provides protection from liability arising due to accidents from handling of hazardous chemicals	Applicable Contractor should take insurance policies providing for insurance against liability
Central Motor Vehicle Act 1988 and amendment Central Motor Vehicle Rules, 1989 and amendments till date	The Act aims to minimize the road accidents, penalizing the guilty, provision of compensation to victim and family and check vehicular air and noise pollution.	Applicable Contractor has to ensure valid license, Pollution Under Control (PUC) certified vehicles to be used in construction sites.
The National Green Tribunal Act, 2010	Act provides for effective and expeditious disposal of cases relating to environmental protection and conservation of forests and other natural resources including enforcement of any legal right relating to environment and giving	Applicable to respective areas where development activities may cause any damage to environment and property.

Relevant Act/Policies/Rules	Objective	Relevance to project components
	relief and compensation for damages to persons and property.	
Ancient Monuments and Archaeological Sites and Remains Act, 1958	Act provides for conservation of cultural and historical remains, if any archaeological remain is found during implementation of project activities	Not Applicable The Contractor shall inform to the respective department if any such archaeological remains are found.
Agriculture and Horticulture		
Other Acts/Rules The Seed Act 1966; Seed Rules 1968; Seeds (Control) Order 1983; Insecticide (Control) Order 1985; Fertilizer Control Order 1985; Fertilizer Movement Control Order 1973; Essential Commodities Act (Amended - 1986) Protection of Plant Variety and Farmers Right Act, 2001 (PPVFR Act)	The respective Acts, Rules, Orders regulates the items under their purview.	Applicable The project intervention involves agriculture productivity enhancement and diversification by ensuring availability of high-quality seeds; setting up of commodity groups, setting up Farmer Producer Organizations to protect Farmer's rights.
Wetland		
Wetland (Conservation and Management) Rules, 2010	To ensure better conservation and management and to prevent degradation of existing wetlands in India.	Not Applicable The project area does not have recognized wetlands.

Relevant Act/Policies/Rules	Objective	Relevance to project components
Social Legislative Framework		
The Right to Fair Compensation and Transparency in Land Acquisition Rehabilitation and Resettlement Act, 2013	The Act lays down the procedure for land acquisition, compensation for acquisition of homestead, land, etc. Resettlement & Rehabilitation Plan will be prepared for the families losing land, homestead and other properties.	Not Applicable As per available information, the project components does not involve land acquisition
Workmen Compensation Act, 1923	The Act provides for compensation in case of injury by accident arising out of and during the course of employment	Applicable The Contractor has to record all cases of accidents and provide compensation.
Minimum Wages Act, 1948	The Act makes it mandatory for the employer to pay every employee in a scheduled employment under him wages at the rate not less than the minimum rates of wages fixed under the Act.	Applicable The project involves labour employment; the project will document and monitor paid wages and as far as possible discourage cash payments
The Payment of Gratuity Act, 1972 and subsequent amendments	The Act provides for payment of gratuity to employees	Applicable The Contractor should ensure payment of gratuity to employees
The Employees' Provident Funds and Miscellaneous Provisions Act, 1952 and subsequent amendments	The Act provides for provident funds, pension fund etc. to employees	Applicable The Contractor should ensure payment of PF to employees
The Payment of Wages Act, 1936 and subsequent amendments	The Act regulates payment of wages of certain classes of employees.	Applicable The Contractor should ensure the provisions of Act.
Mahatma Gandhi National Rural	The aim of the act to guarantee the right to work and wage employment	Applicable The project involves labour

Relevant Act/Policies/Rules	Objective	Relevance to project components
Employment Guarantee Act, 2005	to enhance the livelihood security of people in the rural areas	employment and shall converge with this Act to leverage additional funds.
National Policy for Empowerment of Women, 2001	The policy advocates for equal access to participation and decision making of women in social, political and economic life of the nation and mainstreaming a gender perspective in the development process.	Applicable The project shall provide equal access and opportunity to women in employment, remuneration, occupational health and safety, social security etc. and promoting opportunities for office bearer positions
Building & Other Construction workers (Regulation of Employment & Condition of Service) Act, 1996	To regulate the employment and condition of service of building and other construction workers	Applicable Contractor should have valid labour license.
Contract Labour (Regulation and Abolition) Act, 1970	The Act is applicable to the establishments or Contractor of principal employer if they employ 20 or more contract labour.	Applicable Contractor has to register with Labour Department.
Equal Remuneration Act, 1979	The Act provides for payment of equal wages for work of equal nature to Male and Female workers.	Applicable Contractor has to ensure equal remuneration to male and female workers.
The Inter-State Migrant Workmen (Regulation of Employment and Conditions of Service) Act, 1979	The Act is applicable to an establishment which employs 5 or more inter-state migrant workmen through an intermediary.	Applicable Contractor has to register with Labour Department.
The Child Labour (Prohibition and Regulation) Act, 1986	The Act prohibits the engagement of children in certain employments and to regulate the conditions of work or children in certain other employments.	Applicable To prevent contractor from employing child labour who shall come under the purview of the Act; the project will include

Relevant Act/Policies/Rules	Objective	Relevance to project components
		relevant provisions in the bid document for complying with this Act.
The Industrial Disputes Act, 1947	An Act to make provision for the investigation and settlement of industrial disputes.	Not Applicable
The Factories Act, 1948	An Act to consolidate and amend the law regulating labour in factories	Not Applicable
Right to Information (RTI) Act, 2005.	The Act provides for setting out the practical regime of right to information for citizens to secure access to information under the control of public authorities, in order to promote transparency and accountability in the working of every public authority. Under the provisions of the Act, any India citizen may request information from a "public authority" (a body of Government) which is required to reply expeditiously or within thirty days.	Applicable PAPs access to records and information about the entitlements and resettlement plans

3.3 INTERNATIONAL CONVENTIONS AND PROTOCOLS

India is party to several International and Regional Conventions and Protocols. The most relevant obligations are listed below:

- Convention on Biological Diversity (CBD), 1992
- Convention on Protection of the World Cultural and Heritage, 1972
- Convention on Wetlands (Ramsar Convention), 1975
- International Union for the Conservation of Nature (IUCN), 1948
- The United Nations Framework Convention on Climate Change (UNFCCC), 1992
- Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES), 1975

3.4 APPLICABLE AIIB ENVIRONMENTAL AND SOCIAL POLICY AND ENVIRONMENTAL AND SOCIAL STANDARDS

When identifying and designing a project, AIIB's operational policies help to assess the possible environmental and social risks and the impacts (positive or negative) associated with the development interventions proposed. During the project implementation, safeguards shall help in defining measures and also the processes to effectively manage risks and enhance positive impacts. The process of applying ESP can be an important opportunity for stakeholder's engagement, enhancing the quality of project proposals and increase in ownership. The ESF of AIIB, 2019 stipulates an ESP as well as an Environment and Social Standards (ESSs). The ESSs, which are likely to be triggered due to the proposed project, are outlined in Table 11 as follows:

Table 11 : Applicable AIIB Environment and Social Standards

AIIB ESS	Applicability (Yes/No)	Relevance to the Project
ESS 1 Environmental and Social Assessment and Management	Yes	Project activities could have an impact on the environment. Similarly, the project has a significant impact on social environment with issues around gender and equity of participation.
ESS 2 Involuntary Resettlement	Yes	The project is unlikely to involve land acquisition since all works will be within the available right-of-way. However, to implement the project, WRD may have to clear the lands which belong to WRD but are claimed, occupied or cultivated by other people.
ESS 3 Indigenous Peoples	No	As the project interventions shall not involve any Indigenous people (Tribal communities in Indian context). Hence, this policy will not be triggered.

3.5 GAP ANALYSIS BETWEEN AIIB POLICIES AND NATIONAL STANDARDS

S. No.	Project Stage	AIIB ESF 2019	National Regulations	Gaps Identified
1.	Project Screening and Categorization	Analyse potential impacts and risks of the project by Screening the proposed project at the concept stage and categorise the projects categorized as A, B, C and FI in order to determine the nature and level of the required environmental and social assessment etc.	As per EIA notification 2006, All projects and activities are broadly categorized in to two categories - Category A and Category B (sub categorised as B1 and B2), based on the spatial extent of potential impacts and potential impacts on human health, natural and manmade resources	ERM irrigation projects are not listed as environmental sensitive projects under EIA notification 2006. However, according to the AIIB ESF 2019, all projects require assessment and mitigation of potential environmental and social impacts. The project is categorised as Category B, due to the limited potential E&S impacts.
2.	Conduct Environmental and Social Assessment	Client to undertake an environmental and social assessment to identify direct, indirect, cumulative and induced Project-related risks and impacts on physical, biological, socioeconomic and cultural resources in the Project's area of influence	As per EIA notification 2006 Category A - Require Prior Environmental Clearance (EC) from MoEF&CC through recommendation of Environmental Appraisal Committee (EAC). Category B - Require environment clearance from SEIAA	As per National regulations / standards (EIA notification 2006) ERM irrigation projects are not listed in EIA notification. Hence, EIA is not a pre-requisite criterion as per National Guidelines. The ESP of AIIB lists projects which may have adverse environmental and social impacts and hence requires ESIA.
3.	Assessment of Alternatives	Examine, all in a comparative manner: (a) alternatives to the proposed Project that are relevant to the stage of the Project's development; and (b) their potential environmental and social risks and impacts; and document the rationale for selecting the particular alternative proposed	As per EIA notification alternatives to the project's location, design, and technology document rationale or selecting the particular project location, design, and technology needs to take under consideration for Category A and Category B1 if the scoping exercise results in need of alternatives.	ERM irrigation projects are not listed as environmental sensitive projects under EIA notification 2006, hence alternatives is not mandatory. However, according to the ESP, all projects require assessment and mitigation of potential environmental and social impacts.

S. No.	Project Stage	AIIB ESF 2019	National Regulations	Gaps Identified
4.	Prepare Environmental and Social Management Plan (ESMP)	Establish the measures to mitigate monitor and manage the impacts. ESMP shall include Mitigation and management measures, Environmental and social monitoring and reporting requirements, institutional or organizational arrangements, Implementation schedule and cost estimates, including environmental and social mitigation and monitoring costs, which are integrated into the Project's overall schedule and Performance indicators.	A project specific EIA / EMP is required only in case project trigger the EIA notification, 2006 (amended thereof)	As per the GoI and GoTN guidelines ESMP development and budget allocation is not required. The same is required as per AIIB's guidelines.
5.	Information Disclosure	Public disclosure of E&S documents, including ESMP, on Client and AIIB websites as per policy provisions. Local translations of executive summaries of E&S documents should be disclosed as well. Regular disclosure of updated environmental and social information in the Project.	As per the EIA notification, 2006 Information disclosure required to be undertaken through public notice prior to the approval by the MoEF&CC only for Category A and B1 projects	As per national regulations, ERM irrigation projects do not need information disclosure whereas the AIIB guideline requires information disclosure.
6.	Public Consultation and Use of Project Level Grievance Redress Mechanisms	Client conducts meaningful consultation with Project affected people to facilitate their informed participation in the consultations. Client continues consultation with stakeholders throughout the Project implementation as 'necessary on issues related to environmental and social performance and	As per EIA notification 2006, all Category A and Category B1 projects or activities are required to undertake Public Consultation with certain narrowly specified exceptions.	As per national regulations, ERM irrigation projects do not need public consultation. EIA notification does not cover the grievance redress mechanism but AIIB guidelines requires a mechanism to receive and facilitate resolution of grievances or complaints

S. No.	Project Stage	AIIB ESF 2019	National Regulations	Gaps Identified
		implementation of the Project-level GRM		
7.	Use of Environmental Standards	As a general rule, AIIB bases the project assessment on the regulations that apply in the country in which the project is to be implemented. These regulations must be consistent with international environmental, social, health, safety and labour standards. These include the general and sector Environmental, Health and Safety (EHS) Guidelines of the World Bank Group. For pollution prevention purpose, international standards and CPCB standards whichever stringent will apply. Contaminants in soil/silt like heavymetals and PHCs including pesticides.	The Environment (Protection) Rules, 1986 Various legislations addressing aspects such as air and water pollution, hazardous substance management, etc. Occupational health and safety standards included in the Factories Act (India) and various India specific Labour Laws. There are no national standards for soil/silt contaminants like heavymetals and PHCs including pesticides.	There are no specific AIIB guidelines on applicability of minimum Environmental Standards. National Standards clearly sets minimum environmental limits on air, water, noise and soil quality, which should be followed. There is no applicable National Standard on sediment contaminants level. IFC follows US EPA guidelines. Hence US EPA guidelines are used for the comparison of soil contaminants level.
8.	Monitoring and Reporting	The Bank requires the Client to implement the Project in compliance with the ESMP, ESMPF, LARP/LAP/RP, LARPF/LAPF/RPF, IPP and IPPF (as applicable) or other Bank-approved documentation, and any other environmental and social obligations in the Legal Agreements for the Project; and prepare and furnish to the Bank periodic monitoring reports on the Client's	For Category A and B1 projects post environmental clearance (EC) monitoring is stipulated by the regulations, with half yearly compliance reports to be made available as public documents. Also, latest reports are displayed on website of regulatory authority which is not required for category B2 projects.	As per Indian Standards the ERM irrigation projects do not require any monitoring and reporting whereas as per AIIB ESP the project requires monitoring and reporting.

S. No.	Project Stage	AIIB ESF 2019	National Regulations	Gaps Identified
		performance under the Project relating to environmental and social risks and impacts.		
9.	Compensation, Resettlement and Rehabilitation	As per AIIB's requirement, regardless of the property title status, solutions on both situations of physical and/or economic displacement should be developed in consultation with the affected people. This may include inter alia measures such as e.g. provision of alternative housing, moving assistance, relocation allowances, compensation or other forms of support in order to improve or at least re-establish the livelihood of the affected people.	Valuation of the land shall be done following the procedure laid down in RECTLARR Act, 2013. Value of the land and compensation amount shall be approved by the negotiation committee or under compulsory acquisition by district collector. The compensation towards any other damage without the acquisition of land are provided which are assessed/reviewed by the Revenue Authorities.	National Regulations do not cover all displaced persons, such as non-titled on government land. While AIIB requires compensation for all affected people regardless of property title status

CHAPTER 4: ENVIRONMENTAL AND SOCIAL BASELINE STATUS

4.1 GENERAL

Before the start of any Environmental and social Impact Assessment study, it is necessary to identify the baseline levels of relevant environmental and social parameters which are likely to be affected as a result of the proposed activity. The planning of baseline survey commenced with the shortlisting of impacts and identification of parameters for which the data needs to be collected. The study area map is given in Figure - 5.

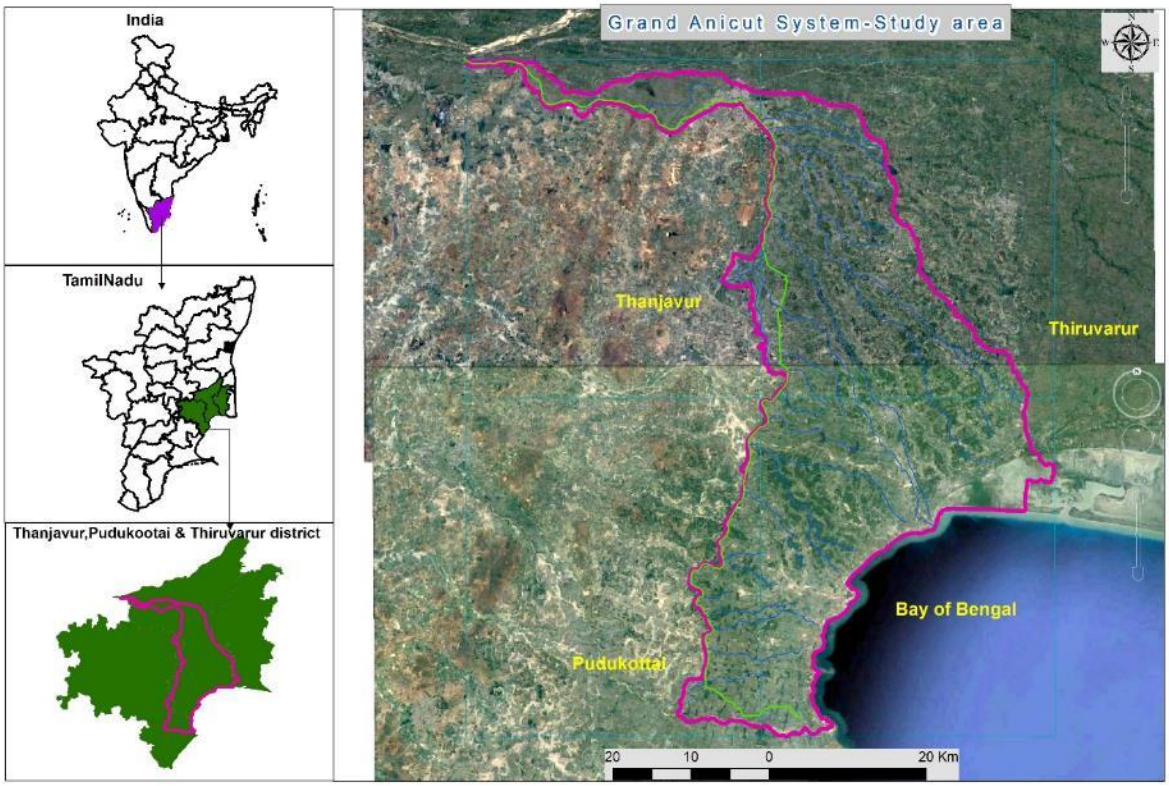


Figure 5 Study Area Map

The baseline status has been divided into following three categories:

- Physico-chemical aspects
- Ecological aspects
- Socio-Economic aspects

4.2 PHYSICO-CHEMICAL ASPECTS

4.2.1. Climate

Rainfall

The average annual rainfall and the 5 years rainfall recorded Thanjuavur District is as follows:

Actual Rainfall in mm	Normal Rainfall in mm

2017	2018	2019	2020	2021	
1077.0	703.8	942.3	968.1	1779.7	991.50

The average annual rainfall and the 5 years rainfall recorded Pudukottai District is as follows

Actual Rainfall in mm					**Normal Rainfall in mm**
2017	2018	2019	2020	2021	
724.4	692.1	876.2	947.6	1188.7	816.90

*Source: TWAD Board.

Relative Humidity

The maximum relative humidity varies from 44% to 88% Thanjavur District. The maximum relative humidity varies from 44% to 88% Pudukottai District.

Temperature

The period from November to February in Thanjavur is pleasant, with a climate full of warm days and cool nights. The onset of summer is from March, with the mercury reaching its peak by the end of May and June. The average temperatures range from 27 °C in January to 36 °C in May and June.

The temperature in Pudukottai District ranges from a maximum of 40.10°C to minimum of 18.60°C. Hot weather is experienced from April to June and November to January are the coldest months.

4.2.2. Geomorphology

Different geomorphic units like flood plain, delta plains, natural levees and sedimentary high ground are noticed in Thanjavur District. Sedimentary high ground ranging in elevation between 60 and 80 m MSL found in southern side of Thanjavur town mainly constitute laterites. Area north of Thanjavur had been fully covered by flood plains. Isolated levee complexes are found parallel to the Vennar River course.

Pudukottai District is characterised by an undulating topography with residual hills in the northern, western and southern parts of the District, where as in the eastern part of the District is a flat terrain consisting of alluvial plains. The elevation of the terrain of the western part of the area is about 125 m above msl, where as towards coast it is about 1 m above msl.

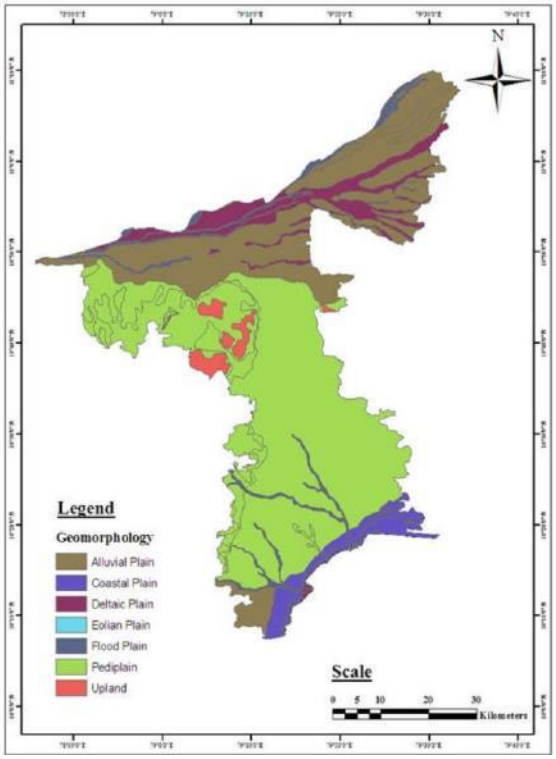


Figure 6: Geomorphology – Thanjavur District

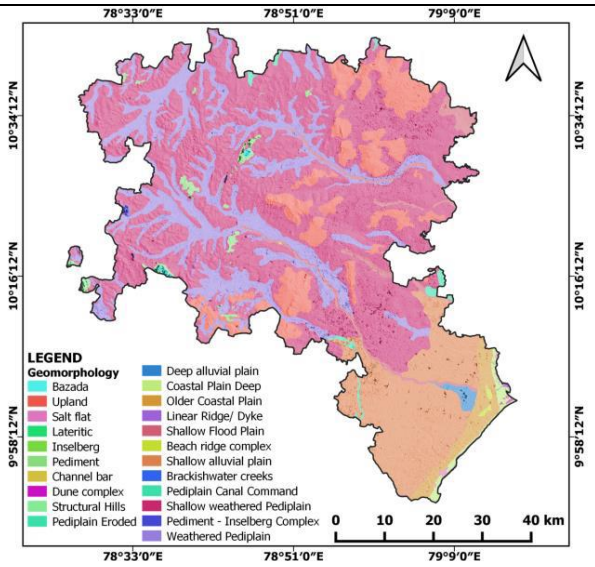


Figure 7: Geomorphology – Pudukottai District

4.2.3. Seismicity

The area falls under seismic zone–II as per Seismic Zoning Map of the country given in IS 1983 (part I): 2002. The seismic zoning map is enclosed as Figure – 8.

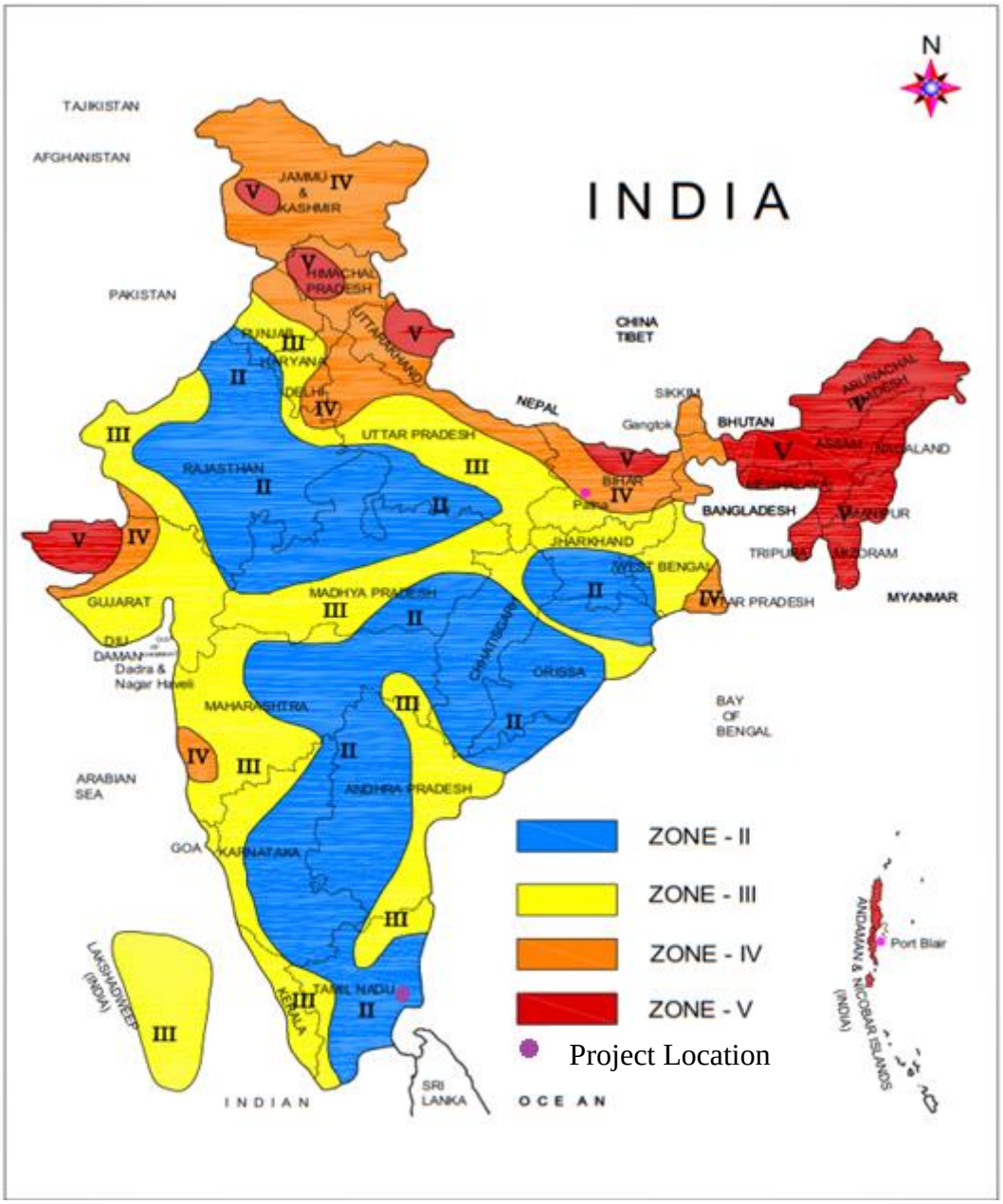


Figure 8: Seismic Zoning Map

4.2.4. Water Quality

Apart from domestic sources, there are no other major sources of pollution in the project area. The area has no major water polluting industries. There could be few small household industries, which do not generate effluent in significant quantity to cause any significant impact on quality of the receiving water body. The sampling was carried out during August 2020. As a part of the field study, water samples (surface water and ground water) were collected randomly from various locations as given in Table – 12 and shown in figure 9 and 10.

Table 12: Water Sampling Locations

Station	Location	Type of Sample	Geo-coordinates	
Groundwater				
Station - 1	Nagudi - Aranthangi Block	Groundwater	10°09'07"N	79°06'20"E
Station - 2	Seruvaviduthi Vadapathi - Peravurani Block	Groundwater	10°23'07"N	79°09'16"E
Station - 3	Thelungan Kudikadu - Orathanadu Block	Groundwater	10°35'48"N	79°15'47"E
Station - 4	Sendankadu - Pattukkottai Block	Groundwater	10°28'17"N	79°20'04"E
Station - 5	Kuruvadipatti - Thanjavur Block	Groundwater	10°45'15"N	79°02'27"E
Station - 6	Kiliyur - Budalur Block	Groundwater	10°49'25"N	78°51'09"E
Surface Water				
Station - 1	Nagudi - Aranthangi Block	Surface Water	10°09'32"N	79°06'25"E
Station - 2	Seruvaviduthi Vadapathi - Peravurani Block	Surface Water	10°23'17"N	79°09'08"E
Station - 3	Thelungan Kudikadu - Orathanadu Block	Surface Water	10°35'50"N	79°15'45"E
Station - 4	Sendankadu - Pattukkottai Block	Surface Water	10°29'44"N	79°20'45"E
Station - 5	Kuruvadipatti - Thanjavur Block	Surface Water	10°45'18"N	79°02'40"E
Station - 6	Kiliyur - Budalur Block	Surface Water	10°49'23"N	78°51'10"E

The results of ground water quality and surface water quality during study period are given in Table – 13 and 14 respectively.

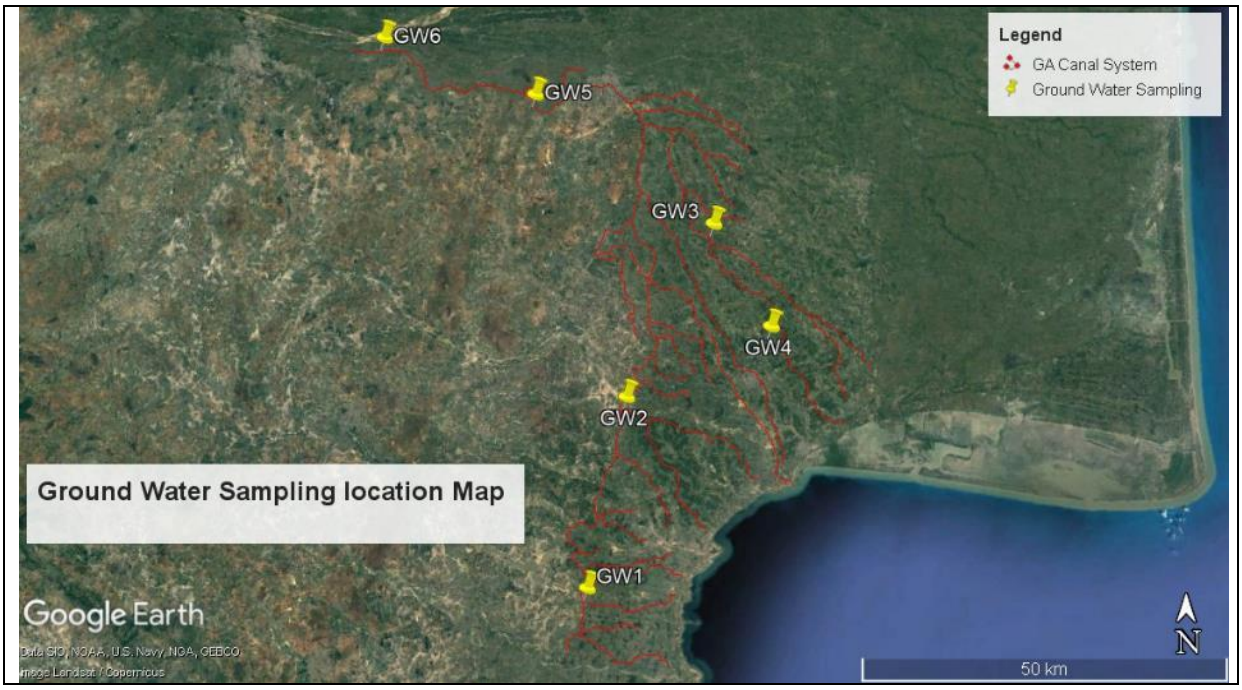


Figure 9: Ground Water Sampling Location Map

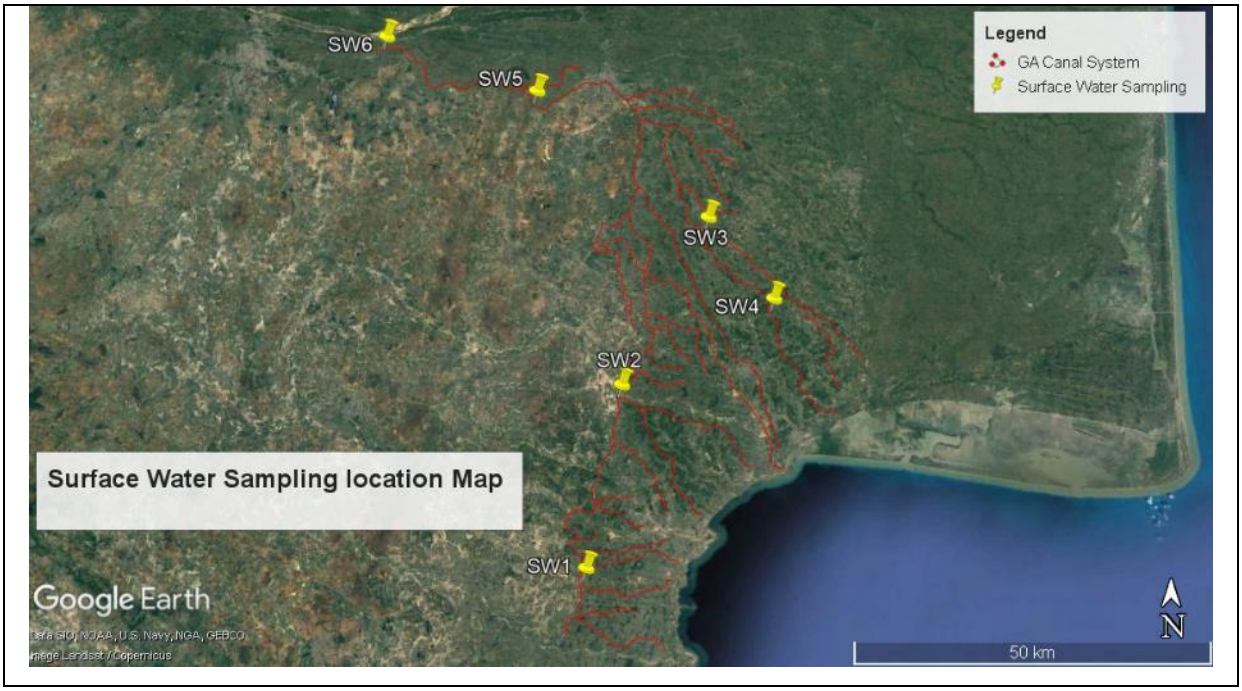


Figure 10: Surface Water Sampling Location Map

Table 13: Results of Ground Water Quality Analysis during study period

WATER SAMPLE RESULTS			Nagudi - Aranthangi Block	Seruvaviduthi Vadapathi - Peravurani Block	Thelungan Kudikadu - Orathanadu Block	Sendankadu - Pattukkottai Block	Kuruvadipatti - Thanjavur Block	Kiliyur - Budalur Block	*Acceptable	**Cause for Rejection
Sampling Date			19.08.2020	19.08.2020	19.08.2020	19.08.2020	19.08.2020	19.08.2020		
PARAMETERS	**METHOD**	**UNITS**	**Station - 1**	**Station - 2**	**Station - 3**	**Station - 4**	**Station - 5**	**Station - 6**		
pH @ 25°C	IS 3025 (Part 11)-1983 (R.2017)	-	7.8	7.1	7.9	7.7	7.9	7.9	7.0 to 8.5	<6.5 or >9.2
Temperature	2550-B-APHA 23rd Edn.2017	°C	28.6	28.6	28.7	28.6	28.7	28.7	-	-
Conductivity @ 25 °C	IS 3025 (Part 14)-1984 (R.2013)	µs/cm	2540	1350	696	1092	665	1267	-	-
Turbidity	IS 3025 (Part 10)-1984 (R.2017)	NTU	1	< 1	< 1	< 1	< 1	< 1	2.5	10
Total Dissolved Solids	IS 3025 (Part 16)-1984 (R.2017)	mg/l	1512	790	414	632	386	748	500	1500
Total Alkalinity as $CaCO_3$	IS 3025 (Part 23)-1986 (R.2014)	mg/l	99	385	211	246	172	330	200	600
Total	IS 3025 (Part 21)-	mg/l	1090	492	171	316	194	254	200	600

WATER SAMPLE RESULTS			Nagudi - Aranthangi Block	Seruvaviduthi Vadapathi - Peravurani Block	Thelungan Kudikadu - Orathanadu Block	Sendankadu - Pattukkottai Block	Kuruvadipatti - Thanjavur Block	Kiliyur - Budalur Block	*Acceptable	**Cause for Rejection
Hardness as $CaCO_3$	2009 (R.2014)									
Calcium as Ca	IS 3025 (Part 40)-1991 (R.2014)	mg/l	269	123	42	79	48	44	75	200
Magnesium as Mg	IS 3025 (Part 46)-1994 (R.2014)	mg/l	102	45	16	29	18	35	30	150
Sodium as Na	IS 3025 (Part 45)-1993 (R.2014)	mg/l	165	91	73	104	53	109	-	-
Nitrate as NO_3	IS 3025 (Part 34)-1988 (R.2014)	mg/l	0.14	0.03	BDL(DL:0.01)			0.08	45	45
Sulphate as SO_4	IS 3025 (Part 24)-1986 (R.2014)	mg/l	25	22	24	49	29	58	200	400
Chloride as Cl^-	IS 3025 (Part 32)-1988 (R.2014)	mg/l	806	170	62	153	60	118	200	1000
Potassium as K	IS 3025 (Part 45)-1993 (R.2014)	mg/l	2.5	5	3.0	5.0	5	95	-	-
Fluoride as F	IS 3025 (Part 60)-2008 (R.2013)	mg/l	0.38	0.14	0.19	0.16	0.15	0.27	1.0	1.5

WATER SAMPLE RESULTS			Nagudi - Aranthangi Block	Seruvaviduthi Vadapathi - Peravurani Block	Thelungan Kudikadu - Orathanadu Block	Sendankadu - Pattukkottai Block	Kuruvadipatti - Thanjavur Block	Kiliyur - Budalur Block	*Acceptable	**Cause for Rejection
Phosphate as PO_4	4500-P,B,D-APHA 23rd Edn.2017	mg/l	BDL(DL:0.1)						-	-
Silica as SiO_2	IS 3025 (Part 35)-1988 (R.2014)	mg/l	33.5	54.5	52	43	42.8	46	-	-
Iron as Fe	IS 3025 (Part 53)-2003 (R.2014)	mg/l	0.12	0.04	0.07	0.06	0.04	0.08	0.1	1.0
Residual Sodium Carbonate	IS 11624-1986(R.2001)	meq/l	Nil	Nil	0.78	Nil	Nil	1.48	-	-
Phenolic Compounds as C_6H_5OH	IS 3025 (Part 43)-1992 (R.2014)	mg/l	BDL(DL:0.001)						0.001	0.002
Cyanide as CN	IS 3025 (Part 27)-1986 (R.2014)	mg/l	BDL(DL:0.01)						0.05	0.05
Microbiology:										
Total Coliform	IS 1622:1981 (RA.2019)	MPN/100ml	< 2	2	< 2	< 2	< 2	4	-	-
BDL - Below Detection Limit; DL - Detection Limit										

Table 14: Results of Surface Water Quality Analysis during study period

WATER SAMPLE RESULTS			Nagudi - Aranthangi Block	Seruvaviduthi Vadapathi - Peravurani Block	Thelungan Kudikadu - Orathanadu Block	Sendankadu - Pattukkottai Block	Kuruvadipatti - Thanjavur Block	Kiliyur - Budalur Block	Class E : Irrigation
Sampling Date			19.08.2020	19.08.2020	19.08.2020	19.08.2020	19.08.2020	19.08.2020	
PARAMETERS	**METHOD**	**UNITS**	**Station - 1**	**Station - 2**	**Station - 3**	**Station - 4**	**Station - 5**	**Station - 6**	
pH @ 25°C	IS 3025 (Part 11)-1983 (R.2017)	-	7.9	8.4	7.8	8.0	8.1	8.2	6.0 to 8.5
Conductivity @ 25 °C	IS 3025 (Part 14)-1984 (R.2013)	µs/cm	382	503	350	376	332	332	2500
Dissolved Oxygen	IS 3025 (Part 38)-1989 (R.2014)	mg/l	6.8	6.9	6.8	6.9	6.9	6.8	-
Sodium Absorption Ratio	IS 11624-1986(R.2001)	-	1.54	1.27	0.91	0.98	0.84	0.88	20
Residual Sodium Carbonate		meq/l	0.36	Nil	Nil	Nil	Nil	Nil	-
Boron as B	IS 3025 (Part 57)-2005 (R.2017)	mg/l	BDL(DL:0.1)						-
Free Ammonia	IS 3025 (Part 34)-1988	mg/l	BDL(DL:0.1)						-

WATER SAMPLE RESULTS			Nagudi - Aranthangi Block	Seruvaviduthi Vadapathi - Peravurani Block	Thelungan Kudikadu - Orathanadu Block	Sendankadu - Pattukkottai Block	Kuruvadipatti - Thanjavur Block	Kiliyur - Budalur Block	Class E : Irrigation
as NH_3	(R.2014)								
Total Dissolved Solids	IS 3025 (Part 16)-1984 (R.2017)	mg/l	230	308	208	226	204	204	2100
Total Suspended Solids	IS 3025 (Part 17)-1984 (R.2017)	mg/l	16	10	14	14	12	7	-
Oil & Grease	5520-O&G-B APHA 23rd Edn.2017 (Partition Gravimetric Method)	mg/l	< 2	< 2	< 2	< 2	< 2	< 2	-
Chloride as Cl^-	IS 3025 (Part 32)-1988 (R.2014)	mg/l	35	41	29	35	29	28	600
Sulphate as SO_4	IS 3025 (Part 24)-1986 (R.2014)	mg/l	9	21	14	14.9	11	11	1000
Chemical Oxygen Demand (COD)	5220-B- APHA 23rd Edn.2017	mg/l	< 4	< 4	< 4	< 4	< 4	< 4	-
Biochemical Oxygen Demand	5210-B APHA 23rd Edn.2017	mg/l	< 2	< 2	< 2	< 2	< 2	< 2	-

WATER SAMPLE RESULTS			Nagudi - Aranthangi Block	Seruvaviduthi Vadapathi - Peravurani Block	Thelungan Kudikadu - Orathanadu Block	Sendankadu - Pattukkottai Block	Kuruvadipatti - Thanjavur Block	Kiliyur - Budalur Block	Class E : Irrigation
(BOD) 5 days @ 20°C									
Microbiology:									
Total Coliform	IS 1622:1981 (RA.2019)	MPN/100 ml	4	11	< 2	< 2	< 2	9	-
Faecal Coliform		MPN/100 ml	< 2	< 2	< 2	< 2	< 2	< 2	-
BDL - Below Detection Limit; DL - Detection Limit									

The pH level indicates that water in study area is in acceptable range. The total hardness in various water samples ranged from 171 to 1090 mg/l. The total hardness level in samples was higher than the permissible limit of 200 mg/l, classifies as “Very Hard”

All the surface water samples tested are well within the Class E standards which is suitable for Irrigation purpose as per Table 4.3

The TDS level ranged from 204 to 1512 mg/l. The TDS levels were higher for ground water samples than the permissible limit of 500 mg/l specified for meeting drinking water requirements.

4.2.5. Soil Quality

In the project area District, the soil is broadly classified into Clayey soils, Sandy soils and mixed soils. As a part of field studies, 20 samples has been collected during study period and were analyzed. The details of sampling locations, which were selected to understand the soil characteristics of the area are given in Table – 15 and shown in Figure 11. The results of the soil sample analysis are given Table – 16.

Table 15: Soil Sampling locations

Station	Location	Type of Sample	Geo-coordinates	
1	Nagudi - Aranthangi Block	Agricultural land	10°09'24"N	79°06'12"E
2	Nagudi - Aranthangi Block	Agricultural land	10°10'43"N	79°06'40"E
3	Seruvaviduthi Vadapathi - Peravurani Block	Agricultural land	10°22'46"N	79°09'14"E
4	Seruvaviduthi Vadapathi - Peravurani Block	Agricultural land	10°23'29"N	79°09'08"E
5	Seruvaviduthi Vadapathi - Peravurani Block	Agricultural land	10°22'43"N	79°11'01"E
6	Sendankadu - Pattukkottai Block	Agricultural land	10°28'44"N	79°20'17"E
7	Sendankadu - Pattukkottai Block	Agricultural land	10°29'01"N	79°21'10"E
8	Sendankadu - Pattukkottai Block	Agricultural land	10°31'34"N	79°19'48"E
9	Thelungan Kudikadu - Orathanadu Block	Agricultural land	10°35'21"N	79°16'05"E
10	Thelungan Kudikadu - Orathanadu Block	Agricultural land	10°36'16"N	79°15'38"E

Station	Location	Type of Sample	Geo-coordinates	
11	Thelungan Kudikadu - Orathanadu Block	Agricultural land	10°36'54"N	79°14'24"E
12	Thelungan Kudikadu - Orathanadu Block	Agricultural land	10°39'06"N	79°13'51"E
13	Kuruvadipatti - Thanjavur Block	Agricultural land	10°45'15"N	79°02'32"E
14	Kuruvadipatti - Thanjavur Block	Agricultural land	10°45'35"N	79°03'11"E
15	Kuruvadipatti - Thanjavur Block	Agricultural land	10°44'56"N	79°03'17"E
16	Kuruvadipatti - Thanjavur Block	Agricultural land	10°46'13"N	79°04'41"E
17	Kiliyur - Budalur Block	Agricultural land	10°47'54"N	78°54'30"E
18	Kiliyur - Budalur Block	Agricultural land	10°49'25"N	78°52'60"E
19	Kiliyur - Budalur Block	Agricultural land	10°49'14"N	78°51'10"E
20	Kiliyur - Budalur Block	Agricultural land	10°49'24"N	78°51'29"E

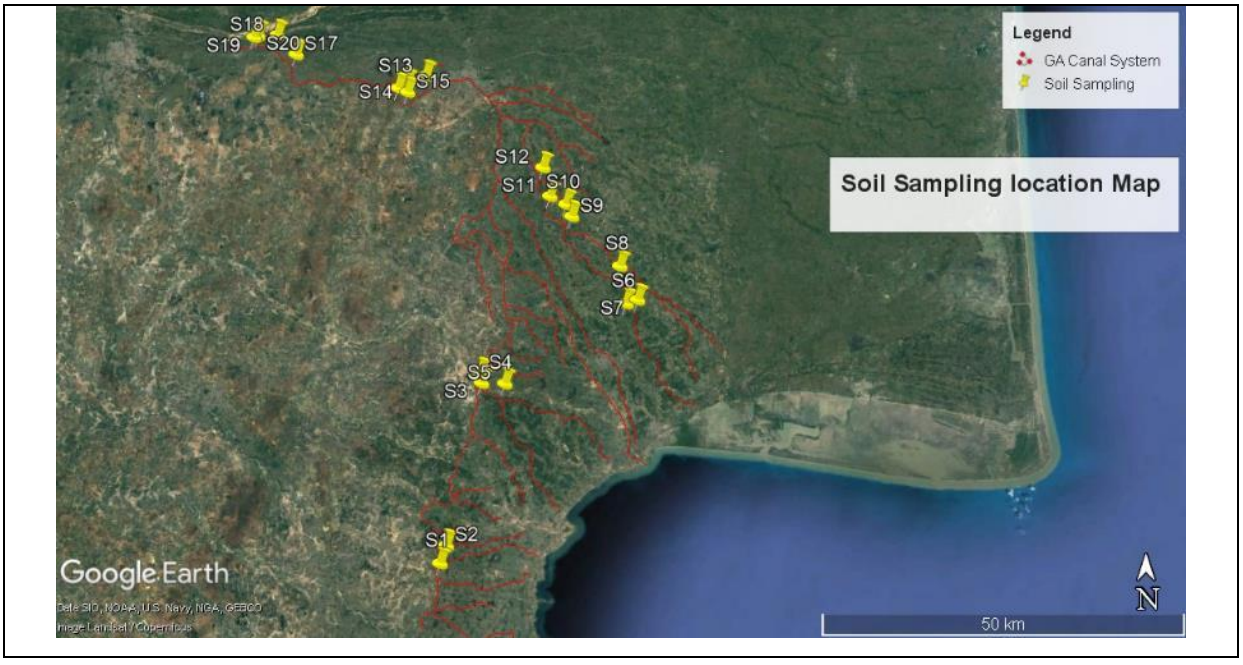


Figure 11: Soil Sampling Location Map

Table 16: Soil quality in the Study area

SOIL SAMPLE RESULTS			1	2	3	4	5	6	7	8	9	10	Soil Rating - TNAU		
Sampling Date			19.08.2020	19.08.2020	19.08.2020	19.08.2020	19.08.2020	19.08.2020	19.08.2020	19.08.2020	19.08.2020	19.08.2020	Low	medium	high
PARAMETERS	**METHOD**	**UNITS**	**Station - 1**	**Station- 2**	**Station- 3**	**Station- 4**	**Station - 5**	**Station - 6**	**Station - 7**	**Station - 8**	**Station- 9**	**Station-10**			
pH	EPA Method-9045 D Rev4,2004	-	5.4	7.3	8.6	8.0	7.6	6.1	5.7	5.9	7.1	5.4	< 6.0 – Acidic 6.0 to 8.5 - Normal to Saline 8.9 to 9.0 - Tending to become Alkaline > 9.0 - Alkaline		
Conductivity	IS 14767: 2000	µs/cm	54	266	154	90	128	963	68	111	101	152	< 1000 – Normal 1000-2000 - Critical for Germination 2000-4000 - Critical for Growth of the Sensitive Crops >4000 - Injurious to most crops		
Texture	FAO Method (Page No.25) 2007	-	Silt	Clay	Silt	Silt	Silt	Clay	Silt	Silt	Clay	Clay	-	-	-
Sand		%	14.22	12.73	13.41	17.58	20.40	6.75	17.87	11.96	9.13	7.80	-	-	-
Silt		%	68.37	18.69	49.78	76.19	42.66	8.92	52.37	61.48	26.49	4.76	-	-	-
Clay		%	17.41	68.58	36.81	6.23	36.94	84.33	29.76	26.56	64.38	87.44	-	-	-
Bulk Density	FAO Method (Page No.35)2007	g/cm^3	1.39	1.23	1.36	1.43	1.35	1.08	1.29	1.36	1.10	1.24	-	-	-

SOIL SAMPLE RESULTS			1	2	3	4	5	6	7	8	9	10	Soil Rating - TNAU		
Sampling Date			19.08.2020	19.08.2020	19.08.2020	19.08.2020	19.08.2020	19.08.2020	19.08.2020	19.08.2020	19.08.2020	19.08.2020	Low	medium	high
PARAMETERS	**METHOD**	**UNITS**	**Station - 1**	**Station- 2**	**Station- 3**	**Station- 4**	**Station - 5**	**Station - 6**	**Station - 7**	**Station - 8**	**Station- 9**	**Station-10**			
Water Holding Capacity	CTL/SOP/SOIL/024	%	17.4	26.1	19.5	14.3	22.2	23.4	24.9	15.4	23.9	9.8	-	-	-
Organic Carbon	FAO Method (Pg. No.61) 2007 (Walkley Black wet combustion method)	%	0.21	0.34	0.27	0.22	0.30	0.39	0.25	0.31	0.45	0.37	< 0.5 %	0.5 - 7.5%	> 0.75%
Organic Matter		%	0.36	0.58	0.46	0.38	0.51	0.67	0.43	0.53	0.76	0.64	-	-	-
Available Nitrogen as N	FAO Method (Pg. No.64) 2007 (Kjeldahl method)	kg/ha	342	405	321	251	303	444	438	297	371	444	< 240Kg/ha	240-480kg/ha	> 480Kg/ha
Available Phosphorus as P	FAO Method (Pg. No.75) 2007 (Olsen's method)	kg/ha	33	28.5	37.5	12	28.5	63	43.5	18	55.5	49.5	< 11.0 Kg/ha	11 – 22 Kg/ha	> 22 Kg/ha
Available Potassium as K	FAO Method (Page No.77) 2007 (Flame Photometric Method)	kg/ha	16.5	24	46.5	19.5	52.5	94.5	82.5	255	73.5	61.5	< 110 Kg/ha	110-280Kg/ha	> 280Kg/ha
Cation Exchange Capacity	FAO Method (Page No.54) (Flame Photometric Method)-2007	meq/100g	7.3	8.7	4.9	6.4	6.9	9.2	5.8	6.4	12.4	12.8	-	-	-
Total Calcium as Ca	CTL/SOP/SOIL/032 (EDTA Titrimetric Method)	mg/kg	102	180	161	80	104	203	120	224	118	191	-	-	-
Total Magnesium as Mg		mg/kg	44	61	47	193	39	162	41	85	53	73	-	-	-
Total Sodium as Na	IS 10158-1982 (RA.2014)	mg/kg	116	245	593	96	93	498	96	91	89	179	-	-	-
Total Potassium as Na		mg/kg	98	218	287	139	222	449	538	112	338	304	-	-	-

SOIL SAMPLE RESULTS			1	2	3	4	5	6	7	8	9	10	Soil Rating - TNAU		
Sampling Date			19.08.2020	19.08.2020	19.08.2020	19.08.2020	19.08.2020	19.08.2020	19.08.2020	19.08.2020	19.08.2020	19.08.2020	Low	medium	high
PARAMETERS	**METHOD**	**UNITS**	**Station - 1**	**Station- 2**	**Station- 3**	**Station- 4**	**Station - 5**	**Station - 6**	**Station - 7**	**Station - 8**	**Station- 9**	**Station-10**			
Exchangeable Sodium	FAO Method	meq/100g	0.50	1.06	2.58	0.42	0.40	0.70	0.42	0.40	0.39	0.78	-	-	-
Sodium Absorption Ratio	IS 11624-1986(RA.2001)	-	2.4	4.0	10.5	0.78	1.96	6.29	1.92	1.31	1.7	2.8	-	-	-
Iron as Fe	EPA 3050B–1996 (Rev-2)/EPA 7380-1986	%	0.61	0.89	0.74	0.73	0.78	0.98	0.64	0.68	0.71	0.69	-	-	-
Manganese as Mn	EPA 3050B–1996 (Rev-2)/EPA 7460-1986	mg/kg	23.15	114.15	127.72	41.83	55.75	113.85	23.90	60.67	85.85	46.74	-	-	-
Zinc as Zn	EPA 3050B–1996 (Rev-2)/EPA 7950-1986	mg/kg	28.06	56.73	27.90	33.22	25.68	45.53	25.78	32.01	25.68	35.87	-	-	-
Copper as Cu	EPA 3050B–1996 (Rev-2)/EPA 7210-1986	mg/kg	9.33	25.70	11.13	7.16	12.02	24.20	11.12	10.68	16.36	12.49	-	-	-

SOIL SAMPLE RESULTS			11	12	13	14	15	16	17	18	19	20	Soil Rating - TNAU		
Sampling Date			19.08.2020	19.08.2020	19.08.2020	19.08.2020	19.08.2020	19.08.2020	19.08.2020	19.08.2020	19.08.2020	19.08.2020	Low	Medium	High
PARAMETERS	**METHOD**	**UNITS**	Station - 11	Station - 12	Station - 13	Station - 14	Station - 15	Station - 16	Station - 17	Station - 18	Station - 19	Station - 20			
pH	EPA Method-9045 D Rev4,2004	-	6.2	5.7	7.0	6.1	7.6	8.1	8.3	8.8	7.6	8.4	< 6.0 – Acidic 6.0 to 8.5 - Normal to Saline 8.9 to 9.0 - Tending to become Alkaline > 9.0 - Alkaline		
Conductivity	IS 14767 : 2000	µs/cm	219	141	110	105	88	895	344	477	386	190	< 1000 – Normal 1000-2000 - Critical for Germination 2000-4000 - Critical for Growth of the Sensitive Crops >4000 - Injurious to most crops		
Texture	FAO Method (Page No.25) 2007	-	Silt	Clay	Clay	Clay	Silt	Clay	Clay	Clay	Clay	Clay	-	-	-
Sand		%	6.84	7.35	3.87	10.41	10.05	5.47	5.37	4.25	15.58	16.13	-	-	-
Silt		%	62.73	12.17	19.73	4.97	66.52	2.20	3.06	2.16	29.66	27.39	-	-	-
Clay		%	30.43	80.48	76.40	84.62	23.43	92.33	91.57	93.59	54.76	56.48	-	-	-
Bulk Density	FAO Method (Page No.35) 2007	g/cm^3	1.41	1.26	1.18	1.24	1.39	1.22	1.19	1.24	1.21	1.27	-	-	-

SOIL SAMPLE RESULTS			11	12	13	14	15	16	17	18	19	20	Soil Rating - TNAU		
Sampling Date			19.08.2020	19.08.2020	19.08.2020	19.08.2020	19.08.2020	19.08.2020	19.08.2020	19.08.2020	19.08.2020	19.08.2020	Low	Medium	High
PARAMETERS	**METHOD**	**UNITS**	Station - 11	Station - 12	Station - 13	Station - 14	Station - 15	Station - 16	Station - 17	Station - 18	Station - 19	Station - 20			
Water Holding Capacity	CTL/SOP/SOIL/024	%	20.6	14.9	28.2	12.6	22.8	6.4	8.8	5.7	12.9	14.4	-	-	-
Organic Carbon	FAO Method (Pg. No.61) 2007 (walkley Black wet combustion method)	%	0.34	0.36	0.43	0.47	0.31	0.36	0.38	0.39	0.57	0.52	< 0.5 %	0.5 - 7.5%	> 0.75%
Organic Matter		%	0.59	0.62	0.76	0.82	0.53	0.62	0.66	0.67	0.98	0.89	-	-	-
Available Nitrogen as N	FAO Method (Pg. No.64) 2007 (Kjeldahl method)	kg/ha	282	446	414	477	291	385	402	396	352	336	< 240Kg/ha	240-480kg/ha	> 480Kg/ha
Available Phosphorus as P	FAO Method (Pg. No.75) 2007 (Olsen's method)	kg/ha	15	18	25.5	27	31.5	36	43.5	41	45	51	< 11.0 Kg/ha	11 – 22 Kg/ha	> 22 Kg/ha
Available Potassium as K	FAO Method (Page No.77) 2007 (Flame Photometric Method)	kg/ha	25.5	31.5	48	36	40.5	48	67.5	76.5	82.5	91.5	< 110Kg/ha	110-280Kg/ha	> 280Kg/ha

SOIL SAMPLE RESULTS			11	12	13	14	15	16	17	18	19	20	Soil Rating - TNAU		
Sampling Date			19.08.2020	19.08.2020	19.08.2020	19.08.2020	19.08.2020	19.08.2020	19.08.2020	19.08.2020	19.08.2020	19.08.2020	Low	Medium	High
PARAMETERS	**METHOD**	**UNITS**	Station - 11	Station - 12	Station - 13	Station - 14	Station - 15	Station - 16	Station - 17	Station - 18	Station - 19	Station - 20			
Cation Exchange Capacity	FAO Method (Page No.54) (Flame Photometric Method)-2007	meq/100g	6.5	9.7	8.6	7.8	4.3	11.2	8.2	7.9	8.6	7.2	-	-	-
Total Calcium as Ca	CTL/SOP/SOIL/032 (EDTA Titrimetric Method)	mg/kg	114	180	127	234	160	281	320	361	264	296	-	-	-
Total Magnesium as Mg		mg/kg	56	134	61	218	72	233	182	255	195	201	-	-	-
Total Sodium as Na	IS 10158-1982 (RA.2014)	mg/kg	144	142	240	159	141	584	290	484	271	243	-	-	-
Total Potassium as Na		mg/kg	172	200	881	315	273	591	626	728	905	998	-	-	-
Exchangeable Sodium	FAO Method	meq/100g	0.63	0.62	1.04	0.69	0.61	2.50	1.3	2.10	1.18	1.06	-	-	-
Sodium Absorption Ratio	IS 11624-1986 (RA.2001)	-	2.8	1.95	4.37	1.79	2.3	6.2	3.2	4.75	3.08	2.67	-	-	-
Iron as Fe	EPA 3050B–1996 (Rev-2)/EPA 7380-1986	%	0.64	0.68	1.38	0.79	0.86	0.60	0.83	1.12	0.81	0.80	-	-	-
Manganese as Mn	EPA 3050B–1996 (Rev-	mg/kg	29.72	38.85	226.16	179.23	43.22	54.45	239.57	183.45	127.22	122.81	-	-	-

SOIL SAMPLE RESULTS			11	12	13	14	15	16	17	18	19	20	Soil Rating - TNAU		
Sampling Date			19.08.2020	19.08.2020	19.08.2020	19.08.2020	19.08.2020	19.08.2020	19.08.2020	19.08.2020	19.08.2020	19.08.2020	Low	Medium	High
PARAMETERS	**METHOD**	**UNITS**	Station - 11	Station - 12	Station - 13	Station - 14	Station - 15	Station - 16	Station - 17	Station - 18	Station - 19	Station - 20			
	2)/EPA 7460-1986														
Zinc as Zn	EPA 3050B–1996 (Rev-2)/EPA 7950-1986	mg/kg	39.72	38.61	57.34	49.01	35.13	32.61	41.56	57.04	40.67	35.62	-	-	-
Copper as Cu	EPA 3050B–1996 (Rev-2)/EPA 7210-1986	mg/kg	9.27	9.78	22.95	10.74	7.94	3.38	13.06	16.70	11.96	13.15	-	-	-

As per TNAU Soil Rating, the soil quality in the study area indicates that the soil is low to medium fertile.

The pH rages from 6.0 to 8.5 which indicate soildsare in Normal to Saline condiction.

Conductivity is observed to be < 1000 µs/cm which is a Normal codition for germination.

Figure 12: Field Photographs of Soil and Water Sample Collection

Ambient Air Quality

The ambient air quality with respect to the study zone around the proposed site forms the baseline information. The sources of air pollution in the region are vehicular traffic, dust emissions from unpaved village roads. The ambient air quality was monitored randomly at various locations in the study area listed in Table – 17.

Table 17: Ambient Air Quality Location

Station	Village	Landuse pattern	Latitude(N)	Longitude(E)
Station - 1	Kiliyur (Budalur)	Residential, rural	10° 49' 25"N	78° 51' 11"E
Station – 2	Kuruvadipatti (Thanjavur)	Residential, rural	10° 45' 18"N	79° 02' 26"E
Station – 3	Thelungankudikadu (Orathanadu)	Residential, rural	10° 35' 51"N	79° 15' 47"E
Station – 4	Sendankadu (Pattukkottai)	Residential, rural	10° 28' 14"N	79° 20' 04"E
Station – 5	Seruvavidudhi Vadapadhi (Peravurani)	Residential, rural	10° 23' 06"N	79° 09' 24"E
Station – 6	Nagudi (Aranthangi)	Residential, rural	10° 09' 07"N	79° 06' 19"E

The parameters monitored are listed as below:

- Particulate Matter < 2.5 microns ($PM_{2.5}$)
- Particulate Matter < 10 microns (PM_{10})
- Sulphur Dioxide (SO_2)
- Nitrogen Dioxide (NO_2)

The frequency of sampling was twice a week for four weeks in the month of August 2020. The results of ambient air quality monitoring is given in Table – 18 and summarized in Table – 19. The national ambient air quality standards are given in Table – 20.

Table 18: Ambient Air Quality Results

S No.	Location	Parameters			
		$PM_{2.5}$	PM_{10}	SO_2	NO_2
		µg/m³	µg/m³	µg/m³	µg/m³
AAQ 1	Kiliyur (Budhalur)	21.7	48.4	BDL (DL:3.0)	6.6
		23.4	52.1	4.6	8.7
		24.8	56.7	5.2	10.4
		20.1	42.4	BDL (DL:3.0)	8.1

S No.	Location	Parameters			
		$PM_{2.5}$	PM_{10}	SO_2	NO_2
		µg/m³	µg/m³	µg/m³	µg/m³
		26.1	57.5	5.6	11.5
		24.5	53.5	3.4	10
		21.4	44.5	BDL (DL:3.0)	7.6
		25.2	56.8	3.4	11
AAQ 2	Kuruvadipatti (Thanjavur)	15.2	35.5	BDL (DL:3.0)	5.7
		19.5	40.2	3.7	8.5
		17	38.5	BDL (DL:3.0)	5.5
		20.7	42	3.4	7.2
		21	43.5	BDL (DL:3.0)	6.2
		17.2	38.5	BDL (DL:3.0)	8.2
		15.8	36.5	BDL (DL:3.0)	6.6
		20	41.2	BDL (DL:3.0)	7.5
AAQ 3	Thelungankudikadu (Orathanadu)	26.1	58.5	4.2	9.7
		24.5	55	BDL (DL:3.0)	8.2
		23.4	48.5	BDL (DL:3.0)	8.6
		25.7	56.2	5.5	11.4
		26.8	57.8	BDL (DL:3.0)	9.2
		27.5	58.5	4.8	12.4
		24.5	52.1	BDL (DL:3.0)	10.5
		22.4	47.5	BDL (DL:3.0)	8.5
AAQ 4	Sendankadu (Pattukkottai)	28.2	62.1	7.5	18.2
		33.7	70.5	9.1	21.5
		34	73.4	10.2	24.5
		34.5	71.2	7.6	20.2
		32	68.5	8.7	23.4
		35.6	74.2	10.4	26.5
		29.5	65.5	7	16.5
		34.2	70.8	9.5	22.4

S No.	Location	Parameters			
		$PM_{2.5}$	PM_{10}	SO_2	NO_2
		µg/m³	µg/m³	µg/m³	µg/m³
AAQ 5	Seruvavidudhi Vadapadhi (Peravurani)	12.1	32.4	BDL (DL:3.0)	4.5
		16.2	35.5	BDL (DL:3.0)	5.8
		17.2	38.5	BDL (DL:3.0)	5.2
		18.5	40.1	BDL (DL:3.0)	6.1
		12.5Sendankadu (Pattukkottai)	33.5	BDL (DL:3.0)	3.7
		14.2	35.6	BDL (DL:3.0)	4.8
		16.2	37.5	BDL (DL:3.0)	5.7
		19.5	42	BDL (DL:3.0)	6.5
AAQ 6	Nagudi (Aranthangi)	33.6	70.5	9.2	22.5
		31	68.5	7.3	19.2
		28.7	62.1	6.5	17.2
		30.2	65.5	8.7	20.2
		34.5	73.2	10	23.7
		31.6	69.5	11.2	24.5
		26.5	57.5	6.2	17
		29.5	66.2	7.8	18.5

Table 19: Summary of Ambient Air Quality Monitoring

S No.	Location	Parameters											
		$PM_{2.5}$			PM_{10}			SO_2			NO_2		
		µg/m³			µg/m³			µg/m³			µg/m³		
		Avg.	Max	Min	Avg	Max	Min	Avg	Max	Min	Avg	Max	Min
	NAAQS	60			100			80			80		
1	Kiliyur	23.40	26.10	20.10	51.49	57.50	42.40	4.44	5.60	BDL (DL :3.0)	9.24	11.50	6.60
2	Kuruvadipatti	18.30	21.00	15.20	39.49	43.50	35.50	3.55	3.70		6.93		5.50
3	Thelungankudikadu	25.11	27.50	22.40	54.26	58.50	47.50	4.83	5.50		9.81	12.40	8.20
4	Sendankadu	32.71	35.60	28.20	69.53	74.20	62.10	8.75	10.40	7.00	21.65	26.50	16.50
5	Seruvavidudhi Vadapadhi	15.80	19.50	12.10	36.89	42.00	32.40	BDL (DL:3.0)			5.29	6.50	3.70
6	Nagudi	30.70	34.50	26.50	66.63	73.20	57.50	8.36	11.20	6.20	20.35	24.50	17.00

Table 20: National Ambient Air Quality Standards

S. No.	Pollutant	Time Weighted Average	Industrial, Residential Rural and other area	Ecologically Sensitive area (notified by Central Government)
1.	Sulphur Dioxide (SO_2), µg/m³	Annual*	50	20
		24 hours **	80	80
2.	Nitrogen Dioxide (NO_2), µg/m³	Annual*	40	30
		24 hours**	80	80
3.	Particulate Matter less than microns, PM_{10}, µg/m³	Annual*	60	60
		24 hours **	100	100
4.	Particulate Matter less than 2.5 microns, $PM_{2.5}$, µg/m³	Annual*	40	40
		24 hours **	60	60

*Annual arithmetic mean of minimum 104 measurement in a year at a particular site taken twice a week 24 hourly at a uniform intervals.

**24 hourly or 08 hourly or 01 hourly monitored values, as applicable, shall be complied with 98% of the time in a year. 2% of the time, they may exceed the limits but not on two consecutive days of monitoring.

Ambient Air Quality Status

The average concentration of $PM_{2.5}$ at various stations ranged between 15.80 to 32.71 µg/m^3 with a maximum value of 35.60 µg/m^3 at station Sendankadu (Pattukkottai) and minimum value of 12.10 µg/m^3 was recorded at Seruvavidudhi Vadapadhi (Peravurani).

The average concentration of PM_{10} at various stations monitored ranged from 36.89 to 69.53 µg/m^3. The highest PM_{10} value was recorded as 74.10 µg/m^3 at Sendankadu (Pattukkottai) and lowest values of 32.40 µg/m^3 was recorded at Seruvavidudhi Vadapadhi (Peravurani).

The average SO_2 concentration at various sampling stations ranged from less than 3.00 to 8.36 µg/m^3. The highest SO_2 value was recorded as 11.20 µg/m^3 at Nagudi (Aranthangi) and lowest values of BDL (DL:3.0) was recorded at four Villages.

During the study period, average NO_2 concentration at various sampling stations ranged from 5.29 to 21.65 µg/m^3. The highest NO_2 value was recorded as 21.65 µg/m^3 at Sendankadu (Pattukkottai) and lowest values of 3.70 µg/m^3 was recorded at Seruvavidudhi Vadapadhi (Peravurani).

All the parameters monitored during the study period at various stations was observed to be well below the prescribed limits specified for industrial, residential, rural and other area.

Figure 13 Field Photographs of Ambient Air Quality Monitoring

Station 1 - Killiyur

Station 2 - Kuruvadipatti

Station 3 - Thelungankudikadu

Station 4 - Sendankkadu

Station 5 - Seruvaviduthi North

Station 6 - Nagudi

4.2.6. Land use Pattern

Landuse describes how a patch of land is used (e.g., for agriculture, settlement, forest), whereas land cover describes the materials (such as vegetation, rocks or buildings) that are present on the surface. Accurate land use and land cover identification is the key to most of the planning processes. The land use pattern of the study area has been studied through digital satellite imagery data. Remote sensing satellite data of two Resourcesat- 2 Satellite (LISS-IVMX) Data path 100 row 065, Sub-scene B dated 21.02.2015 was procured from National Remote Sensing Agency (NRSA), Hyderabad. The data was processed through ERDAS imagine software package available with WAPCOS. Ground truth studies were conducted in the area to validate various signals in the satellite images and correlate them with different land use domains. The False Colour Composite (FCC) and classified image of the Study area is given in Figures 14 and 15 respectively. Land use pattern of Study area is outlined in Table-21.

Land use for study Area

The major landuse category in the study area is Agricultural Land, as it accounts for about 59.35% of the study area followed by Vegetation (23.74%). The area under Barren land and Water body is 13.59 % and 2.73 % of the study area respectively.

The area under settlement accounts for about 0.59 % respectively of the study area. The details of the landuse pattern of the study area are given in Table – 21. The FCC and classified images of the study area are given in Figures – 14 and 15 respectively

Table 21: Landuse pattern of the Study Area based on satellite data

Type	Area (ha)	Area (%)
Water Body	497	2.73
Vegetation	4,323	23.74
Agricultural Land	10,807	59.35
Barren Land	2,475	13.59
Settlement/ Built up area	107	0.59
Total	**18,209**	**100.00**

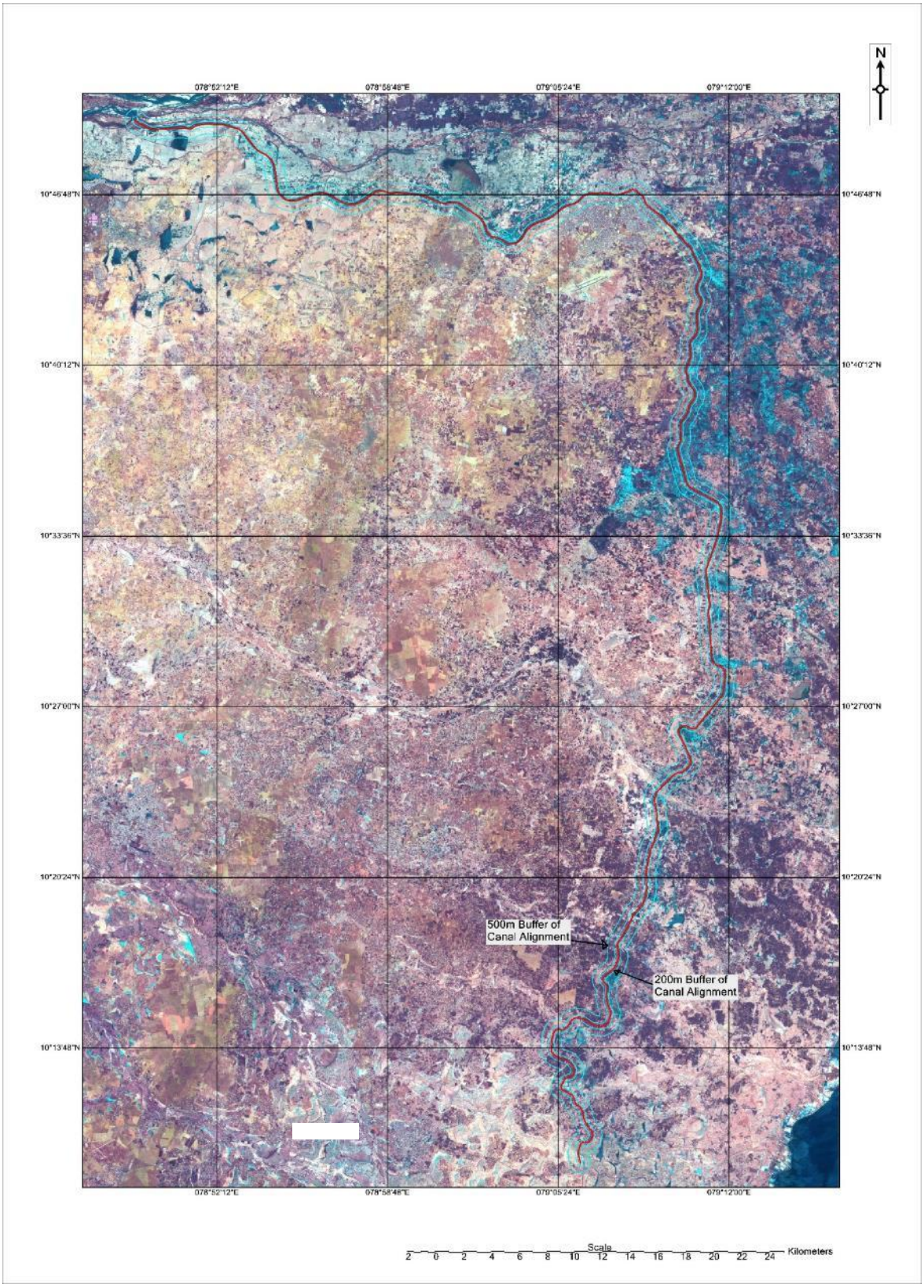


Figure 14: FCC of the study area

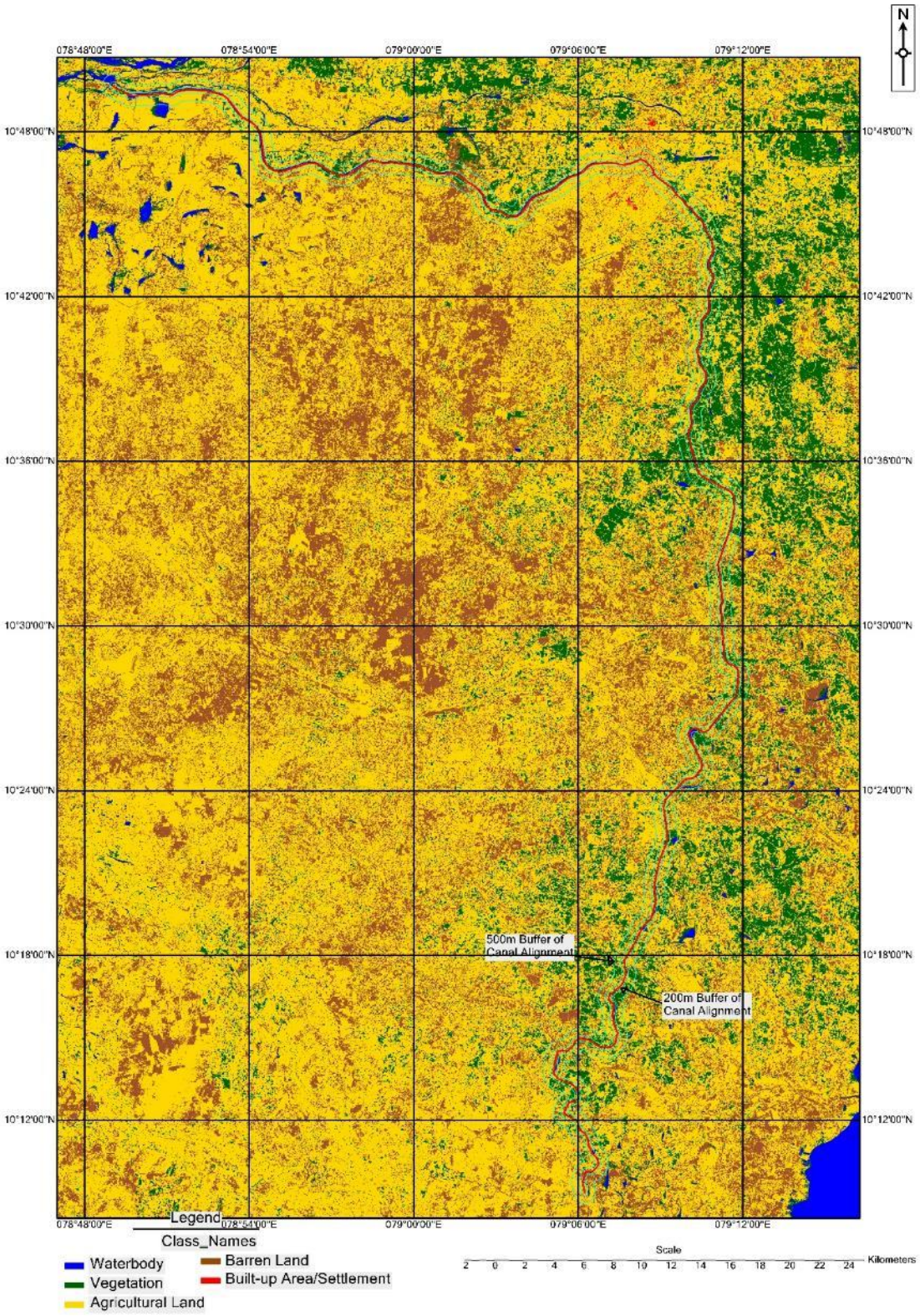


Figure 15: Classified imagery of the study area

4.2.7. Sediment Quality

As a part of field studies, 10 sediment samples were collected in the canal and tanks were analyzed for heavy metals and residual pesticides. The details of sampling locations, which were selected to understand the soil characteristics of the area and the results of the soil sample analysis are given Table – 22.

Table 22: Results of Sediment Quality

SOIL SAMPLE RESULTS				Maraneri Tank	Thondam patti Tank	Edakudi-Mudhala kurichi taluk	GA Canal LS 668	Ponneri Tank	Rangudayan Tank	Vettikulam Tank	Sennakuli kulam Tank	Karuna kulam Tank	Mumbalaai Tank	EPA Heavy metal guidelines (mg./ kg. dry)		
Sampling date				01.08.2023	01.08.2023	01.08.2023	01.08.2023	01.08.2023	01.08.2023	01.08.2023	01.08.2023	01.08.2023	01.08.2023	NP	MP	HP
Location		Latitude		10°47'57.1"N	10°49'09.1" N	10°46'45.84" N	10°46'50.16"N	10°45'33.84"N	10°47'37.68"N	10°40'8.59"N	10°39'49.32"N	10°29'39.48"N	10°4'3.72"N			
		Longitude		78°53'13.4"E	78°53'15.5" E	78°57'26.64"E	78°58'8.76"E	79°11'26.16"E	79°6'24.48"E	79°10'41.74"E	79°10'25.68"E	79°11'37.68"E	79°13'35.76" E			
PARAMETERS		**INSTRUMENT**	**METHOD**													
1	**Pesticide Residue(µg/kg)**															
a.	Chlor pyrifos	GCMS MS	ITC/CHN/ENV/STP/030	BLQ (LOQ: 0.02)	BLQ (LOQ: 0.02)	BLQ (LOQ:0.02)	BLQ (LOQ: 0.02)	BLQ (LOQ: 0.02)	BLQ (LOQ: 0.02)	BLQ (LOQ: 0.02)	BLQ (LOQ: 0.02)	BLQ (LOQ: 0.02)	BLQ (LOQ: 0.02)			
b.	Methyl Parathion	GCMS MS	ITC/CHN/ENV/STP/030	BLQ (LOQ: 0.02)	BLQ (LOQ: 0.02)	BLQ (LOQ:0.02)	BLQ (LOQ: 0.02)	BLQ (LOQ: 0.02)	BLQ (LOQ: 0.02)	BLQ (LOQ: 0.02)	BLQ (LOQ: 0.02)	BLQ (LOQ: 0.02)	BLQ (LOQ: 0.02)			
c.	Mono crotphos	GCMS MS	ITC/CHN/ENV/STP/030	BLQ (LOQ: 0.01)	BLQ (LOQ: 0.01)	BLQ (LOQ: 0.01)	BLQ (LOQ: 0.01)	BLQ (LOQ: 0.01)	BLQ (LOQ: 0.01)	BLQ (LOQ: 0.01)	BLQ (LOQ: 0.01)	BLQ (LOQ: 0.01)	BLQ (LOQ: 0.01)			
d.	Endo sulfan	GCMS MS	ITC/CHN/ENV/STP/030	BLQ (LOQ: 0.02)	BLQ (LOQ: 0.02)	BLQ (LOQ:0.02)	BLQ (LOQ: 0.02)	BLQ (LOQ: 0.02)	BLQ (LOQ: 0.02)	BLQ (LOQ: 0.02)	BLQ (LOQ: 0.02)	BLQ (LOQ: 0.02)	BLQ (LOQ: 0.02)			

SOIL SAMPLE RESULTS				Maraneri Tank	Thondam patti Tank	Edakudi-Mudhala kurichi taluk	GA Canal LS 668	Ponneri Tank	Rangudayan Tank	Vettikulam Tank	Sennakuli kulam Tank	Karuna kulam Tank	Mumbalaai Tank	EPA Heavy metal guidelines (mg./ kg. dry)		
2	**Heavy Metals**															
a.	Lead as Pb, (mg/kg)	ICPOES	USEPA 6010 D	1.06	5.52	3.65	1.72	3.9	5.70	3.66	1.71	4.33	14.37	<40	40-60	>60
b.	Arsenic as As, (mg/kg)	ICPOES	USEPA 6010 D	BLQ (LOQ: 0.1)	1.4	0.52	0.73	0.93	3.14	0.54	0.33	0.82	5.02	<3	3-8	>8
c.	Cadmium as Cd, (mg/ kg)	ICPOES	USEPA 6010 D	BLQ (LOQ: 0.1)	BLQ (LOQ: 0.1)	BLQ (LOQ: 0.1)	BLQ (LOQ: 0.1)	BLQ (LOQ:0.1)	BLQ (LOQ:0.1)	BLQ (LOQ:0.1)	BLQ (LOQ:0.1)	BLQ (LOQ:0.1)	BLQ (LOQ:0.1)	-	<6	>6
d.	Mercury as Hg (mg/kg)	ICPMS	USEPA 200.8	BLQ (LOQ: 0.1)	BLQ (LOQ:0.1)	BLQ (LOQ:0.1)	1.63	BLQ (LOQ:0.1)	BLQ (LOQ:0.1)	BLQ (LOQ:0.1)	BLQ (LOQ:0.1)	BLQ (LOQ:0.1)	BLQ (LOQ:0.1)			
e.	Chromium as Cr (mg/kg)	ICPOES	USEPA 6010 D	19.4	95.24	44.19	59.15	66.01	94.14	29.52	45.64	49	134.02	< 25	25-75	> 75
f.	Copper as Cu, (mg/ kg)	ICPOES	USEPA 6010 D	2.9	22.49	11.34	10.15	17.34	17.35	15.92	6.9	14.5	45.90	< 25	25-50	>50
g.	Cobalt as Co, (mg/ kg)	ICPOES	USEPA 6010 D	1.65	16.41	7.87	7.87	22.58	11.55	11.27	2.23	8.5	32.03			
h.	Zinc as Zn, (mg/ kg)	ICPOES	USEPA 6010 D	3.27	28.82	11.2	20.63	6.77	20.45	3.95	48.98	7.11	53.69			
i.	Nickle as Ni, (mg/kg)	ICPOES	USEPA 6010 D	3.18	40.3	15.6	16.87	32.51	26.54	20.67	5.99	18.33	73.87	< 20	20-50	>50

NP – Not Polluted; MP – Meduim Polluted; HP – Polluted; BLQ – Below limit of Quanitification

Pesticide Residue (µg/kg) in all the samples have been assessed to be below limit of Quantification.

The analsysis of heavy metals assessed and compared to EPA heavy metals guidelines. The sediment quality in the study area indicates that the sediment is from Not polluted to Medium Polluted.

4.3 ECOLOGICAL ASPECTS

4.3.1 Terrestrial Ecology

Flora

During the floristic initial survey of present study, a total of 99 plant species have been recorded in the project area. The results of the present study shows that out of 99 plants, the dominating plant group was tress, which contributes 34 species (34.34%) followed by shurbs with 24 species (24.24%), Herbs with 24 species (24.24%). Table 23 shows the details of Floristic Composition. The details of the floral species recorded in the project area are enlisted in Table 24

Table 23: Floristic composition of the study area

S. No	Plant habit	No. of species	Percentage of species
1	Herbs	24	24.24
2	Shrubs	24	24.24
3	Trees	34	34.34
4	Grasses	10	10.10
5	Climbers	7	7.07
	Total	**99**	**100.00**

Table 24: List of floral species recorded in the project area

S.N	Botanical name of the Tree	Local name	Family	Growth habit	Division	*Conservation status
1	*Acacia ferruginea DC.*	Velvelam	Mimosaceae	Tree	Dicot	**VU**
2	*Acacia nilotica Willd. Ex Delile*	Karuvelum	Mimosaceae	Tree	Dicot	**LC**
3	*Acacia planifrons Wight &Arn.*	Kodaivelum	Mimosaceae	Tree	Dicot	**NE**
4	*Aegle marmelos*	Vilvam	Rutaceae	Tree	Monocot	NT
5	*Albizia lebbeck (L.) Willd.*	Vagai/Kona	Mimosaceae	Tree	Dicot	**LC**
6	*Anacardium occidentale* L.	Mundiri	Anacardiaceae	Tree	Dicot	**LC**
7	*Azadirachta indica A. Juss*	Vembu	Meliaceae	Tree	Dicot	**LC**
8	*Bauhinia tomentosa*	Thiruvatti	Fabaceae	Tree	Dicot	**LC**
9	*Borassus flabellifer L.*	Toddypalm/Panai	Arecaceae	Tree	Monocot	**EN**
10	*Caesalpinia sappan*	Nonamaram	Fabaceae	Tree	Dicot	**LC**
11	*Carica papaya*	Pappali	Caricaceae	Tree	Dicot	**DD**

S.N	Botanical name of the Tree	Local name	Family	Growth habit	Division	*Conservation status
	L.					
12	*Cassia fistula L.*	Sarakkonnai	Caesalpiniaceae	Tree	Dicot	**LC**
13	*Cocos nucifera L.*	Thennai/Coconut	Arecaceae	Tree	Monocot	**LC**
14	*Cordia obliqua willd*	Clammy Cherry	Boraginaceae	Tree	Dicot	**NE**
15	*Eucalyptus sp.*	Thaila maram	Myrtaceae	Tree	Dicot	**EN**
16	*Ficus benghalensis L.*	Per-al/Ichchi	Moraceae	Tree	Dicot	**NE**
17	*Ficus religiosa L.*	Arasu	Moraceae	Tree	Dicot	**LC**
18	*Grewia tiliaefolia vahl.*	Unu	Tiliacaeae	Tree	Dicot	**LC**
19	*Hibiscus tiliaceus L.*	Nirparathi	Malvaceae	Tree	Dicot	**LC**
20	*Leucaena leucocephala*	Soundal	Fabaceae	Tree	Dicot	**NE**
21	*Mangifera indica L.*	Maa/Mango	Anacardiaceae	Tree	Dicot	**DD**
22	*Moringa oleifera Lam.*	Murungai	Moringaceae	Tree	Dicot	**LC**
23	*Musa bulbisiana colla*	Vazhai	Musaceae	Tree	Monocot	**LC**
24	*Phoenix sylvestris*	Eechamaran	Arecaceae	Tree	Dicot	**LC**
25	*Pongamia pinnata (L.) Pierre.*	Pungan	Fabaceae	Tree	Dicot	**LC**
26	*Ricinus communis L.*	Castor/Amanakku	Euphorbiaceae	Tree	Dicot	**LC**
27	*Samanea saman*	ThoonguVaagai/ ThoonguMoonji	Fabaceae	Tree	Dicot	**LC**
28	*Sapindus emergenatus*	Poondhi Kai	Sapindaceae	Tree	-	**NE**
29	*Syzygium cumini (L.) Skeels*	Naval	Myrtaceae	Tree	Dicot	**LC**
30	*Tamarindus indica L.*	Puli	Caesalpiniaceae	Tree	Dicot	**LC**
31	*Tectona grandis L. f.*	Thekku	Verbenaceae	Tree	Dicot	**EN**
32	*Terminalia catappa L.*	Badam Maram	Combretaceae	Tree	Dicot	**LC**
33	*Albizia amara* (Roxb.) Boivin.	Usilai	Mimosaceae	Tree	Dicot	**LC**
34	*Alstonia scholaris* (L.)	Ezhilai palai	Apocynaceae	Tree	Dicot	**LC**

S.N	Botanical name of the Tree	Local name	Family	Growth habit	Division	*Conservation status
	R. Br.					
35	*Abutilon indicum (L.) Sweet*	Paniyarattuti	Malvaceae	Shrub	Dicot	**NE**
36	*Acacia caesia (L.) Willd*	Karinda	Mimosaceae	Shrub	Dicot	**LC**
37	*Aloysin citrodora*	-	Verbenaceae	Shrub	Dicot	**LC**
38	*Calotropis*	Erukam	Apocynaceae	Shrub	Dicot	**LC**
39	*Calotropis gigaantia (L.) R. Br.*	Erukku	Asclepiadaceae	Shrub	Monocot	**LC**
40	*Calotropis procera (Aiton) R. Br.*	Vellerukku	Asclepiadaceae	Shrub	Monocot	**LC**
41	*Cipadessa baccifera (Roth.) Miq.*	Pullipencheddi	Meliaceae	Shrub	Dicot	**LC**
42	*Cissus quadrangularis L.*	Pirandai	Vitaceae	Shrub	Dicot	**LC**
43	*Clerodendrum inerme L.*	Changu kuppi	Verbenaceae	Shrub	Dicot	**NE**
44	*Giant calotrope*	Malaiyerukku	Apocynaceae	Shrub	Dicot	**NE**
45	*Gluta travancorica Bedd.*	Shencurani	Anacardiaceae	Shrub	Dicot	**NT**
46	*Indigofera Enneaphylla*	Seppu nerinji	Fabaceae	Shrub	Dicot	**NE**
47	*Jatropha gossipifolia L.*	Adalai	Euphorbiaceae	Shrub	Dicot	**NE**
48	*Jatropha gossypiifolia*	Kattamanakku	Euphorbiaceae	Shrub	Dicot	**LC**
49	*Jatropha tanjorensis*	Kattamanakku	Euphorbiaceae	Shrub	Dicot	**NE**
50	*Prosopis juliflora (Sw.) DC.*	Semai karuvai	Mimosaceae	Shrub	Dicot	**NE**
51	*Senna auriculata (L.) Roxb.*	Aavarai	Caesalpiniaceae	Shrub	Dicot	**NE**
52	*Senna nigricansVahl*	Thozhukani	Caesalpiniaceae	Shrub	Dicot	**NE**
53	*Senna occidentalis (L.) Link*	Thagarai	Caesalpiniaceae	Shrub	Dicot	**LC**
54	*Thevetia peruviana (Pers.) K.*	Arali	Apocynaceae	Shrub	Dicot	**VU**

S.N	Botanical name of the Tree	Local name	Family	Growth habit	Division	*Conservation status
	Schum					
55	*Urena lobata L.*	Ottatti	Malvaceae	Shrub	*Urena lobata L.*	**LC**
56	*Wrightia tinctoria*	Veppalai	Apocynaceae	Shrub	*Wrightia tinctoria*	**LC**
57	*Ziziphus mauritiana Lam.*	Ellandai	Rhamnaceae	Shrub	*Ziziphus mauritiana Lam.*	**LC**
58	*Ziziphus oenoplia (L.) Mill.*	Suraimullu	Rhamnaceae	Shrub	*Ziziphus oenoplia (L.) Mill.*	**NE**
59	*Acalypha indica L.*	Sirusinni	Euphorbiaceae	Herb	Dicot	**NE**
60	*Allium sativum*	Poondu Chedi	Amaryllidaceae	Herb	Monocot	**NE**
61	*Amaranthus viridis L.*	Kuppaik kerai	Amaranthaceae	Herb	Dicot	**NE**
62	*Boerhavia diffusa L.*	Mukarattai	Nyctaginaceae	Herb	Dicot	**NE**
63	*Cassia uniflora Mill.*	Peyavarai	Caesalpiniaceae	Herb	Dicot	**NE**
64	*Centella asiatica (L.) Urban*	Vallarai	Apiaceae	Herb	Dicot	**LC**
65	*Cleome viscosa L.*	Naai kadugu	Capparaceae	Herb	Dicot	**NE**
66	*Corchorus aestuans L.*	Punnakku poondu	Tiliaceae	Herb	Dicot	**LC**
67	*Croton bonplandianum Baill*	Reilpoondu /Aatthuppoondu	Euphorbiaceae	Herb	Dicot	**NE**
68	*Hedyotis corymbosa (L.) Lam.*	-	Rubiaceae	Herb	Dicot	**NE**
69	*Indigofera hirsuta L.*	-	Fabaceae	Herb	Dicot	**NE**
70	*Indigofera linnaei Ali.*	Sheppunerunji	Fabaceae	Herb	Dicot	**NE**
71	*Leucas aspera (Wild) Link*	Thumbai	Lamiaceae	Herb	Dicot	**NE**
72	*Lindernia antipoda (L.) Alston*	Thannippoondu	Scrophulariaceae	Herb	Dicot	**LC**
73	*Phyllanthus urinaria L.*	Sirukeelanelli	Euphorbiaceae	Herb	Dicot	**LC**
74	*Physalis minima L.*	Sodakku thakkali	Solanaceae	Herb	Dicot	**NE**
75	*Polygala arvensis Willd.*	-	Polygalaceae	Herb	Dicot	**NE**
76	*Pupalia*	Adai-otti	Amaranthaceae	Herb	Dicot	**LC**

S.N	Botanical name of the Tree	Local name	Family	Growth habit	Division	*Conservation status
	lappacea (L.) Juss.					
77	*Rungia pectineta (l.) Nees.*	-	Acanthaceae	Herb	Dicot	**NE**
78	*Scoparia dulcis L.*	Neernangai	Scrophulariaaceae	Herb	Dicot	**NE**
79	*Sida mysorensis Weight &Arn.*	-	Malvaceae	Herb	Dicot	**NE**
80	*Tribulus terrestris L.*	Nerungi	Zygophyllaceae	Herb	Dicot	**LC**
81	*Triumfetta rhomboidea Jacq.*	Puramutti	Tiliaceae	Herb	Dicot	**NE**
82	*Andrographis paniculata* (Burm. F.) Wall. Ex Nees	Siriyanangai	Acanthaceae	Herb	Dicot	**LC**
83	*Arundo donax L.*	Mudampullu	Poaceae	Grass	Monocot	**LC**
84	*Bambusa arundinacea* (Retz.) Roxb.	Mungil	Poaceae	Grass	Monocot	**NE**
85	*Bothriochloa pertusa (L.) A. Camus*	-	Poaceae	Grass	Monocot	**NE**
86	*Brachiaria reptans (L.) Guard &Hubb.*	Shanipullu	Poaceae	Grass	Monocot	**LC**
87	*Cenchrus ciliaris* L.	Kolukkattai pullu	Poaceae	Grass	Monocot	**LC**
88	*Cymbopogon sp.*	-	Poaceae	Grass	Monocot	**LC**
89	*Cynodon dactylon (L.) Persoon*	Arugampullu	Poaceae	Grass	Monocot	**LC**
90	*Paspalidium flavidum (Retz.) A. Camus*	Arisipullu	Poaceae	Grass	Monocot	**LC**
91	*Perotis indica (L.) O. Ktze*	Comet grass	Poaceae	Grass	Monocot	**NE**
92	*Saccharum spontaneum L.*	Naanal	Poaceae	Grass	Monocot	**LC**
93	*Abrus precatorius L.*	Kunnimuthu	Fabaceae	Climber	Dicot	**NE**
94	*Cissampelos pareira L.*	Malaithangivaer	Menispermaceae	Climber	Dicot	**NE**
95	*Cocculus hirsutus (L.) Diiels*	Kattukodi	Menispermaceae	Climber	Dicot	**NE**

S.N	Botanical name of the Tree	Local name	Family	Growth habit	Division	*Conservation status
96	*Cyclea peltata (Lam.) Hook.f&Thom.*	Para	Menispermaceae	Climber	Dicot	**NE**
97	*Mukia maderaspatana (L.) M. Roem.*	Musumusukkai	Cucurbitaceae	Climber	Dicot	**NE**
98	*Stephania japonica (Thunb.) Miers.*	-	Menispermaceae	Climber	Dicot	**NE**
99	*Cardiospermum halicacabum L.*	Sapindaceae	Mudakkathan	Climber	Dicot	**LC**

* Not Evaluated (NE), Date Deficient (DD), Least Concern (LC), Near Threatened (NT), Vulnerable (VU), Endangered (EN), Critically Endangered (CR), Extinct in the Wild (EW) and Extinct (EX)

Palm Tree

Coconut Tree

Teakwood Plantations

Shrubs - Erukku

Economically Important Plant Species

From time immemorial, plants have been a major source of food, timber, shelter, clothing, fruits, fibre, gum, resin, oil and other miscellaneous purposes. Several species are often used for more than one purpose and some are more useful or popular than the others for the same purpose. The traditional knowledge regarding use of plant species for various purposes depends on the surrounding plants. The list of economically important plant species and their values are enumerated in Table 25.

Table 25: List of economically important plant species recorded from the study area

S. No	Plant species	Local name	Family	Economic value	*Conservation Status
1	*Acacia nilotica Willd. Ex Delile*	Karuvelam	Mimosaceae	Fuelwood	CR
2	*Albizia lebbeck (L.) Willd.*	Vagai/ Kona	Mimosaceae	Timber, Fuelwood	LC
3	*Amaranthus viridis L.*	-	Amaranthaceae	Green vegetable	LC
4	*Anacardium occidentale L.*	Cashew nut/ Mundiri	Anacardiaceae	Nut edible	LC
5	*Bambusa arundinacea (Retz.) Roxb.*	Mungil	Poaceae	Agroforestry/ Household	NE
6	*Borassus flabellifer L.*	Toddy palm / Panai	Arecaceae	Sugar/Mat making	EN
7	*Carica papaya L.*	Pappali	Caricaceae	Fruit edible	DD
8	*Cassia fistula L.*	Sarak konnai	Caesalpiniaceae	Timber, Ornamental	LC
9	*Cenchrus*	Kolukkattai	Poaceae	Fodder grass	LC

S. No	Plant species	Local name	Family	Economic value	*Conservation Status
	ciliaris L.	pullu			
10	*Cocos nucifera L.*	Thennai / Coconut	Arecaceae	Fruit edible/ Mat making	NT
11	*Cymbopogon sp.*	-	Poaceae	Fodder grass	LC
12	*Eucalyptus sp.*	-	Myrtaceae	Timber/Plantation	EN
13	*Hibiscus tiliaceus L.*	Nirparathi	Malvaceae	Ornamental	LC
14	*Mangifera indica L.*	Maa/ Mango	Anacardiaceae	Fruit edible / Timber	DD
15	*Musa bulbisiana Colla*	Vazhai	Musaceae	Fruit edible / serving food	LC
16	*Pongamia pinnata (L.) Pierre.*	Pungan	Fabaceae	Medicinal / Ornamental	LC
17	*Prosopis juliflora (Sw.) DC.*	Seemai karuvai	Mimosaceae	Hedge	LC
18	*Saccharum spontaneum L.*	Naanal	Poaceae	Soilbinder	LC
19	*Syzygium cumini (L.) Skeels*	Naval	Myrtaceae	Fruit edible/Forage	LC
20	*Tamarindus indica L.*	Puli	Caesalpiniaceae	Fruit edible/Timber	LC
21	*Tectona grandis L. f.*	Thekku	Verbenaceae	Timber	EN
22	*Thevetia peruviana (Pers.) K. Schum*	-	Apocynaceae	Ornamental	NE
23	*Ziziphus mauritiana Lam.*	Ellandai	Rhamnaceae	Fruit edible/Hedge	LC

* Not Evaluated (NE), Date Deficient (DD), Least Concern (LC), Near Threatened (NT), Vulnerable (VU), Endangered (EN), Critically Endangered (CR), Extinct in the Wild (EW) and Extinct (EX)

Medicinally Important Plant Species

The list of medicinally important plant species found in the project area and their uses are given in Table 26.

Table 26: List of medicinally important plants recorded from the study area

S. N	Botanical name	Local name	Parts used	*Conservation Status
1	*Abrus precatorius L.*	Kunnimuthu	Leaf, root & seeds	NE
2	*Acalypha indica L.*	Sirusinni	Whole plant	NE
3	*Albizia amara (Roxb.) B. Boivin*	Usilai	Stem bark	LC
4	*Alstonia scholaris (L.) R. Br.*	Ezhilai palai	Leaf & latex	LC
5	*Andrographis paniculata (Burm. F.) Wall. Ex Nees*	Siriyanangai	Whole plant	LC
6	*Azadirachta indica A. Juss*	Vembu	Leaf, stem bark	LC
7	*Bambusa arundinacea (Retz.) Roxb.*	Mungil	Leaf, terminal buds	NE
8	*Boerhavia diffusa L.*	Mukaratte	Leaf, root	NE
9	*Calotropis gigaantia (L.) R. Br.*	Erukku	Flower, root, latex	NE
10	*Calotropis procera (Aiton) R. Br.*	Vellerukku	Leaf, root, latex	LC
11	*Cardiospermum halicacabum L.*	Mudakkathan	Leaf	LC
12	*Cassia fistula L.*	Sarakkonnai	Root bark, flower, leaf, fruit	LC
13	*Centella asiatica (L.) Urban*	-	Whole plant	LC
14	*Chamaecrista absus (L.) H.S.Irwin & Barneby*	-	Leaf, seed	LC
15	*Cissampelos pareira L.*	Malaithangivaer	Leaf	NE
16	*Cissus quadrangularis L.*	Perandai	Leaf, stem	LC
17	*Clerodendrum inerme L.*	Changukuppi	Leaf	NE
18	*Croton bonplandianum Baill.*	Reilpoondu	Leaf	NE
19	*Mangifera indica L.*	Maa/Mango	Endosperm, Bark	DD
20	*Moringa oleifera Lam.*	Murungai	Flower, leaf	LC
21	*Mukia maderaspatana (L.) M. Roem.*	Musumusukkai	Leaf, shoot	NE
22	*Pongamia pinnata (L.) Pierre.*	Pungan	Leaf, seeds	LC
23	*Scoparia dulcis L.*	Neernangai	Leaf	NE
24	*Senna auriculata (L.) Roxb.*	Aavarai	Flower, stem	NE
25	*Synedrella nodiflora (L.) Gaertn*	-	Entire plant	NE
26	*Syzygium cumini (L.) Skeels*	Naval	Seeds, bark	LC
27	*Tribulus terrestris L.*	Nerungi	Whole plant	LC

* Not Evaluated (NE), Date Deficient (DD), Least Concern (LC), Near Threatened (NT), Vulnerable (VU), Endangered (EN), Critically Endangered (CR), Extinct in the Wild (EW) and Extinct (EX)

Following the IUCN Red list of threatened plant, no rare and critically endangered species are observed within the project area. There are also no traces of endemnic species in the study area.

Fauna

Mammals

The mammals reported from the area belong to wild animal and domesticated categories. The list of mammal species reported in the Study Area are shown in Table 27

Table 27: List of mammal species reported in the Study Area

Family	Species Name	Common Name	WPA 1972 / IUCN Status
Order: Primates			
Cercopithecidae	*Macaca radiata*	Bonnet macaque	Schedule II
Order: Insectivora			
Soricidae-Tupaiidae	*Suncus murinus*	Grey Musk-Shrew Chachunder	Schedule IV
Order: Chiroptera			
Pteropodidae	*Cynopterus sphinx*	Short nose fruit bat	Schedule V/ LC
Pteropodidae	*Rousettus leschenaulti*	Fulvous Fruit Bat	-
Order: Carnivora			
Felidae	*Felis chaus*	Jungli Cat	Schedule II/ LC
Herpestidae	*Herpestes edwardsii*	Common Mongoose	Schedule IV/ LC
Herpestidae	*Herpestes fuscus*	Brown mongoose	-
Order: Rodentia			
Sciuridae	*Funambulus palmarum*	Three Striped Palm Squirrel	Schedule IV/ LC
Sciuridae	*Funambulus sublineatus*	Dusky striped squirrel	Schedule IV/ LC
Sciuridae	*Funambulus tristriatus*	Jungle palm squirrel	Schedule IV/ LC
Muridae	*Bandicota bengalensis*	Lesser Bandicoot Rat	Schedule V/ LC
Muridae	*Golunda ellioti*	Indian Bush Rat	Schedule V/ LC
Muridae	*Rattus rattus-refescena*	Indian house rat	Schedule V/ LC
Muridae	*Millardia meltada*	Soft-furred field rat or metad	-
Muridae	*Mus booduga*	Indian Field Mouse	Schedule V/ LC
Muridae	*Mus Platythrix*	Spiny Field Mouse	Schedule V/ LC
Muridae	*Mus musculus*	House mouse	-
Order: Lagomorpha			
Leporidae	*Lepus nigricollis*	Indian Hare	Schedule IV/ LC

*Note: –Veiwed from the locals only, however, not direct cited, LC – Least Concern, NT- Near Threatened, VU- Vulnerable

Domestic animals

Most of the faunal species among mammals are general in nature and domesticated. The domestic animals like cows and buffalos, sheep, goats, pigs, donkeys, dogs and fowls are prominent. Cows are found all over the region. The list of domesticated mammalian fauna found in the Study Area is given in Table 28

Table 28: List of domesticated mammalian Fauna found in the Study Area

S. No	Local Name	Zoological Name	Family	*Conservation Status
1	Cow	*Bos indicus*	Bovidae	LC (Domesticated)
2	Buffalo	*Bubalus indicus*	Bovidae	LC (Domesticated)
3	Dog	*Cains familiaris*	Canidae	LC (Domesticated)
4	Goat	*Capra hircus*	Bovidae	LC (Domesticated)
5	Horse	*Equus caballus*	Equidae	LC (Domesticated)
6	Mule	*Equus mulus*	Equidae	LC (Domesticated)
7	Ass	*Equus hermionus*	Equidae	LC (Domesticated)
8	Cat	*Felis domesticus*	Canidae	LC (Domesticated)
9	Sheep	*Ovius polic*	Bovidae	LC (Domesticated)

***Least Concern (LC) (Domesticated: no immediate threat to the survival of the species)**

Avifauna

The totals of 45 species of birds belonging to 18 families were recorded in the project area as listed in Table 16. The migratory status of avifauna revealed that 25 species of the avian are resident (R), 16 species are resident migrant (RM) and four species are migrant (M). The habiats of avifauna showed that 32 species of birds are aquatic and remaining 13 species of birds are terrestrial. The Migratory season for the birds in the study area starts from October till end of December. Based on the IUCN status it was found that 40 species comes under the least concern and four species is Near Threatened. The list of Avifauna reported in the study area is given in Table–29.

Table 29: List of Avifauna reported in the study area

S. No	Family	Scientific Name	Common Name	Aquatic/ Terrestrial	Residents/ Migratory	IUCN Status
1	Ardeidae	*Egretta garzetta (Linnaeus)*	Little Egret	Aquatic	R	LC
2	Ardeidae	*Casmerodius albus (Linnaeus)*	Large Egret	Aquatic	RM	LC
3	Ardeidae	*Bubulcus ibis (Linnaeus)*	Cattle Egret	Aquatic	RM	LC
4	Ciconiidae	*Mycteria leucocephala (Pennant)*	Painted Stork	Aquatic	RM	NT
5	Ardeidae	*Ardea cinerea (Linnaeus)*	Grey Heron	Aquatic	RM	LC
6	Ardeidae	*Ardea purpurea (Linnaeus)*	Purple Heron	Aquatic	RM	LC
7	Pelecanidae	*Nycticorax nycticorax (Linnaeus)*	Black-crowned Night-Heron	Aquatic	R	LC
8	Phalacrocoracidae	*Phalacrocorax niger (Vieillot)*	Little Cormorant	Aquatic	RM	LC
9	Anhingidae	*Anhinga melanogaster (Pennant)*	Darter or Snake-bird	Aquatic	RM	NT
10	Threskiornithidae	*Threskiornis melanocephalus (Latham)*	Oriental White Ibis	Aquatic	R	NT
11	Podicipedidae	*Tachybaptus ruficollis (Pallas)*	Little Grebe/ Dabchick	Aquatic	R	LC
12	Rallidae	*Amaurornis phoenicurus (Pennant)*	White-breasted Waterhen	Aquatic	R	LC
13	Alcedinidae	*Alcedo atthis (Linnaeus)*	Small Blue Kingfisher	Aquatic	RM	LC
14	Charadriidae	*Vanellus indicus (Boddaert)*	Red-wattled Lapwing	Aquatic	R	LC
15	Alcedinidae	*Ceryle rudis (Linnaeus)*	Lesser (Black) Pied Kingfisher	Aquatic	R	LC

S. No	Family	Scientific Name	Common Name	Aquatic/ Terrestrial	Residents/ Migratory	IUCN Status
16	Rallidae	*Fulica atra (Linnaeus)*	Common Coot	Aquatic	RM	LC
17	Anatidae	*Anas poecilorhyncha (J.R. Forster)*	Spot-billed Duck	Aquatic	RM	LC
18	Charadriidae	*Actitis hypoleucos (Linnaeus)*	Common Sandpiper	Aquatic	RM	LC
19	Ardeidae	*Plegadis falcinellus (Linnaeus)*	Glossy Ibis	Aquatic	RM	LC
20	Accipitridae	*Hydrophasianus chirurgus (Scopoli)*	Pheasant-tailed Jacana	Aquatic	R	LC
21	Ardeidae	*Anastomus oscitans (Boddaert)*	Asian Openbill-Stork	Aquatic	R	LC
22	Threskiornithidae	*Dendrocygna javanica (Horsfield)*	Lesser Whistling-Duck	Aquatic	R	LC
23	Recurvirostridae	*Himantopus himantopus (Linnaeus)*	Black-winged Stilt	Aquatic	R	LC
24	Ardeidae	*Ardeola grayii (Sykes)*	Indian Pond-Heron	Aquatic	R	LC
25	Anatidae	*Anas crecca (Linnaeus)*	Common Teal	Aquatic	M	LC
26	Pelecanidae	*Pelecanus philippensis (Gmelin)*	Spot-billed Pelican	Aquatic	RM	NT
27	Charadriidae	*Sterna hirundo (Linnaeus)*	Common Tern	Aquatic	RM	LC
28	Anatidae	*Anas acuta (Linnaeus)*	Northern Pintail	Aquatic	M	LC
29	Anatidae	*Anas clypeata (Linnaeus)*	Northern Shoveller	Aquatic	M	LC
30	Anatidae	*Aythya ferina*	Common pochard	Aquatic	RM	VU
31	Charadriidae	*Tringa glareola (Linnaeus)*	Wood Sandpiper	Aquatic	M	LC
32	Rallidae	*Porphyrio*	Purple	Aquatic	R	LC

S. No	Family	Scientific Name	Common Name	Aquatic/ Terrestrial	Residents/ Migratory	IUCN Status
		porphyrio (Linnaeus)	Moorhen			
33	Dicruridae	*Dicrurus macrocercus (Vieillot)*	Black Drongo	Terrestrial	R	LC
34	Psittacidae	*Psittacula krameri (Scopoli)*	Rose- ringed Parakeet	Terrestrial	R	LC
35	Cuculidae	Cuculus canorus (Linnaeus)	Common Cuckoo	Terrestrial	RM	LC
36	Dicruridae	*Corvus splendens (Vieillot)*	House Crow	Terrestrial	R	LC
37	Dicruridae	*Corvus macrorhynchos (Wagler)*	Jungle Crow	Terrestrial	R	LC
38	Columbidae	*Colmuba livia (Gmelin)*	Blue Rock Pigeon	Terrestrial	R	LC
39	Dicruridae	*Acridotheres tristis (Linnaeus)*	Common Myna	Terrestrial	R	LC
40	Pycnonotidae	*Pycnonotus cafer (Linnaeus)*	Red-vented Bulbul	Terrestrial	R	LC
41	Accipitridae	*Francolinus pondicerianus (Gmelin)*	Grey Francolin	Terrestrial	R	LC
42	Accipitridae	*Pavo cristatus (Linnaeus)*	Indian Peafowl	Terrestrial	R	LC
43	Accipitridae	*Milvus migrans (Boddaert)*	Black Kite	Terrestrial	R	LC
44	Accipitridae	*Haliastur indus (Boddaert)*	Brahminy Kite	Terrestrial	R	LC
45	Columbidae	*Streptopelia chinensis (Scopoli)*	Spotted Dove	Terrestrial	R	LC

R- Residential**;** **M**- Migratory**;** **R/M**- Residential Migratory**;**

LC- Least Concern and **NT**- Near Threatened **VU**- Vulnerable

Reptiles and Amphibians

The agriculture fields in the study area provide an ideal habitat for many snakes and reptiles. Reptiles such as cobra, and python were found occasionally in the dense vegetation areas as per-narrated by local people. Moniter Lizard was observed along the roadside during the survey. Cobra (*Naja naja*), viper (*Echis carinata*), rat snake and semi aquatic snake (*Natrix stolatus)* are prominent. Lizards are insectivorous and snakes are carnivorous and feed on rats, mice, frogs, toads, lizards, worms, insects and eggs. Among snakes, cobra is protected under schedule II of Indian Wildlife Protection Act (1972). None of the reptile species is present in the IUCN Red List of threatened animals (2013). The list of common reptiles and amphibians found in the study area is given in Table 30 and 31

Table 30: List of Reptiles reported in the study area

S. No	Scientific Name	Common Name	Family	Schedule	*Conservation Status
1	*Hemidactylus flaviviridis Ruppell*	Green House lizard	Gekkonidae	-	LC
2	*H. brookii Grey*	Brook's house gecko	Gekkonidae	-	DD
3	*Calotes versicolor*	Common Garden Lizard	Agamidae	-	LC
4	*Varanus bengalensis*	Moniter Lizard	Varanidae	-	NT
5	*Mabuya carinata*	Common skink	Scincidae	-	LC
6	*Ptyas mucosu*	Rat Snake	Colubridae	IV	LC
7	*Dendrelaphis grandoculis*	Rat Snake /Dhaman	Colubridae	-	LC
8	*Naja naja**	Indian cobra / Nag	Elapidae	II	LC
9	*Bungarus caeruleus*	Krait	Elapidae	-	LC
10	*Vipera russelli*	Russels viper /Asriya*	Viperidae	-	LC
11	*Typhlina bramina*	Common worm snake or Blind snake	Typhlopidae	-	LC

* Not Evaluated (NE), Date Deficient (DD), Least Concern (LC), Near Threatened (NT), Vulnerable (VU), Endangered (EN), Critically Endangered (CR), Extinct in the Wild (EW) and Extinct (EX)

Table 31: List of Amphibians reported in the Study Area

S. No	Zoological Name	Common Name	Family	*Conservation Status
1	*Bufo melanostictus*	Common indian toad	Bufonidae	LC
2	*Bufo spp.*	-	Bufonidae	LC

S. No	Zoological Name	Common Name	Family	*Conservation Status
3	*Bufo viridis*	Common toad	Bufonidae	LC
4	*Kaloula sp*	Painted frog	Microhylidae	LC
5	*Microhyla ornate & M. rubra*	-	Microhylidae	LC
6	*Euphlyctis cyanophlyctis*	Skipping frog	Ranidae	LC
7	*Rana spp*	-	Ranidae	LC
8	*Tomopterna rolande*	Burrowing frog	Ranidae	LC
9	*Indirana spp.*	-	Ranidae	LC
10	*Limnonectes spp*	-	Ranidae	LC
11	*Micrixalus spp*	-	Ranidae	DD
12	*Nyctibatrachus spp.*	-	Ranidae	DD
13	*Philautus spp.*	-	Rhacophoridae	LC
14	*Polypedates maculatus*	-	Rhacophoridae	LC
15	*Uraeotyphlus malabaricus*	-	Uraeothyphlidae	DD

* Not Evaluated (NE), Date Deficient (DD), Least Concern (LC), Near Threatened (NT), Vulnerable (VU), Endangered (EN), Critically Endangered (CR), Extinct in the Wild (EW) and Extinct (EX).

4.3.2 Aquatic Ecology

A total of 20 locations were selected which spread across the main canal and representative locations along the branch canals (17 along main canal and 3 along branch canals). The details of locations are presented in Table – 32. Details of aquatic organisms present in these 20 locations are presented in Table – 33 and Figure -16.

The composition and abundance of phytoplankton and zooplankton in water in almost all the locations of the Canal clearly indicates the healthy status of the water body. Major part of this canal is found constructed with cement walls and floorings. Trees, shrubs, herbs, creepers, and wild plants are present on the banks.

Table 32: Details of Sampling Locations for Aquatic Ecology in Grand Anicut Canal

Station	Location	Block	District	Landmark	Latitude	Longitude	km
1.	GA Canal-Kallanai	Thiruverumbur	Tiruchirappalli	Bridge	10.828388	78.816867	0.0
2.	Indalur	Budular	Thanjavur	Bridge	10.822879	78.881818	8.0
3.	Ayyarnapuram	Budular	Thanjavur	Bridge	10.781832	78.938404	12.0
4.	Vairaperumalpatti	Thanjavur	Thanjavur	Regulator	10.779251	79.005145	9.0
5.	Allakudi	Thanjavur	Thanjavur	Bridge	10.750581	79.053832	8.0
6.	Reddipalayam	Thanjavur	Thanjavur	Bridge	10.779216	79.10583	9.0
7.	Irupathu Kanpalam	Thanjavur	Thanjavur	Bridge	10.773052	79.148246	8.0
8.	Neivasal-Thenpathi - Branch canal	Thanjavur	Thanjavur	Bridge	10.763582	79.968508	8.0
9.	Soorakottai Bridge	Thanjavur	Thanjavur	Kalyana odai kalvai Bridge	10.734131	79.180701	8.0
10.	Thekkur	Orathanudu	Thanjavur	Bridge	10.677207	79.16912	7.0
11.	Chellampatti	Orathanudu	Thanjavur	Bridge	10.624255	79.168733	8.0
12.	Vettikadu	Orathanudu	Thanjavur	Bridge	10.56594	79.193615	7.0

Station	Location	Block	District	Landmark	Latitude	Longitude	km
13.	Uranipuram	Thiruvonum	Thanjavur	Bridge	10.496585	79.187694	8.0
14.	Thoppanayagam	Thiruvonum	Thanjavur	Bridge	10.437603	79.178672	7.0
15.	Edayathi palam – Pannavyal Branch Canal	Pattukottai	Thanjavur	Bridge	10.41966	79.1777	7.0
16.	Puthupattinam Branch canal - Echan viduthi	Pattukottai	Thanjavur	Bridge	10.383936	79.164221	7.0
17.	Avanam kaikatti	Peravurani	Thanjavur	Bridge	10.324688	79.144832	7.0
18.	Merpannai Kadu - PT1 Branch canal	Aranthangi	Pudukottai	Bridge	10.259821	79.129098	6.0
19.	Arasar kulam	Aranthagi	Pudukottai	Bridge	10.108076	79099821	8.0
20.	Nagudi	Aranthagi	Pudukottai	Bridge	10.156350	79.103891	8.0
21.	Mumbalai Eari	Manalmelkudi	Pudukottai	Sluice	10.067605	79.226486	20.5

Table 33: Details of aquatic organism in Grand Anicut Canal (including selected Branch Canals)

Location Number	Benthos		Macrophytes		Macro Invertebrates		Fishes		Zooplankton		Phytoplankton	
	Name	Qty	Name	Qty	Name	Qty	Name	Qty	Name	Qty	Name	Qty

Location Number	Benthos		Macrophytes		Macro Invertebrates		Fishes		Zooplankton		Phytoplankton	
	Name	**Qty**	**Name**	**Qty**	**Name**	**Qty**	**Name**	**Qty**	**Name**	**Qty**	**Name**	**Qty**
1	Earthworm	1		-	Crab	2	Jalebi	2	Protozoans	111	Bacillariophyceae	189
	Sand Fly Larvae	1		-	Gilled Snails	6	Uzhuva	7	Crustaceans	78	Cyanophyceae	114
				-	Clam	5	Cat Fish	18	Rotifers	89	Fragilariophyceae	89
				-	Apple Snail	7	Mooku Meen	9	Copepods	41	Coscinodiscophyceae	78
				-	Mussel	2	Mayila	6	Ostracots	23	Euglenoidea	49
											Nostocaceae	23
											Ciliates	12
											Chlorophyceae	109
	Total	**2**		**-**		**22**		**42**		**342**		**663**
2	Tubifex	3		-	Crab	2	Jalebi	6	Protozoans	103	Bacillariophyceae	71
	Earthworm	1		-	Gilled snails	6	Kurung kendai	7	Crustaceans	43	Cyanophyceae	56
	Chironomus larvae	2		-	Clam	5	Cat fish	12	Rotifers	48	Fragilariophyceae	26
				-	Apple snail	7	Labeo	8	Copepods	29	Coscinodiscophyceae	13

Location Number	Benthos		Macrophytes		Macro Invertebrates		Fishes		Zooplankton		Phytoplankton	
	Name	**Qty**	**Name**	**Qty**	**Name**	**Qty**	**Name**	**Qty**	**Name**	**Qty**	**Name**	**Qty**
							rohita					
				-	Mussel	2	Mayila	2	Ostracots	12	Euglenoidea	142
				-	Pila	26	Mirgal	14			Nostocaceae	62
				-	Mayfly	2	Kendai	31			Ciliates	36
				-	Dragonfly	1	Kuravai	14			Chlorophyceae	92
				-			Vera	9				
	Total	**6**		**-**		**51**		**103**		**234**		**498**
3	Tubifex	2		-	Crab	7	Jalebi	12	Protozoans	68	Bacillariophyceae	101
	Earthworm	1		-	Gilled snails	14	Kurung kendai	2	Crustaceans	57	Cyanophyceae	78
	Sand fly larvae	1		-	Clam	3	Cat fish	7	Rotifers	38	Fragilariophyceae	46
				-	Apple snail	8	Labeo rohita	2	Copepods	32	Coscinodiscophyceae	9
				-	Mussel	7	Mayila	1	Ostracots	9	Euglenoidea	119
				-	Pila	31	Mirgal	8			Nostocaceae	71

Location Number	Benthos		Macrophytes		Macro Invertebrates		Fishes		Zooplankton		Phytoplankton	
	Name	**Qty**	**Name**	**Qty**	**Name**	**Qty**	**Name**	**Qty**	**Name**	**Qty**	**Name**	**Qty**
				-			Mirgal	19			Ciliates	31
				-			Kuravai	7			Chlorophyceae	86
				-			Vera	3				
				-			Panjala kendai	2				
	Total	**4**		**-**		**70**		**63**		**204**		**541**
4	Earthworm	4		-	Gilled snails	56	Jalebi	37	Protozoans	34	Bacillariophyceae	52
	Sand fly larvae	1		-	Clam	32	Kurung kendai	12	Crustaceans	47	Cyanophyceae	39
				-	Apple snail	16	Cat fish	17	Rotifers	29	Fragilariophyceae	79
				-	Mussel	52	Labeo rohita	7	Copepods	16	Coscinodiscophyceae	32
				-			Mirgal	16	Ostracots	12	Euglenoidea	86
				-							Nostocaceae	26
				-							Ciliates	25
				-							Chlorophyceae	92
	Total	**5**		**-**		**308**		**89**		**138**		**431**

Location Number	Benthos		Macrophytes		Macro Invertebrates		Fishes		Zooplankton		Phytoplankton	
	Name	**Qty**	**Name**	**Qty**	**Name**	**Qty**	**Name**	**Qty**	**Name**	**Qty**	**Name**	**Qty**
5	Tubifex	1			Crab	1	Jalebi	11	Protozoans	118	Bacillariophyceae	123
	Earthworm	1			Gilled snails	23	Kurung kendai	9	Crustaceans	96	Cyanophyceae	56
					Clam	201	Cat fish	7	Rotifers	252	Fragilariophyceae	46
					Apple snail	12	Labeo rohita	7	Copepods	24	Coscinodiscophyceae	39
					Mussel	2	Mirgal	12	Ostracots	27	Euglenoidea	71
					Pond snail	27					Nostocaceae	38
											Ciliates	7
											Chlorophyceae	37
	Total	**2**				**266**		**46**		**517**		**417**
6	Earthworm	1			Gilled snails	15	Jalebi	4	Protozoans	118	Bacillariophyceae	225
	Chironomus larvae	6			Clam	8	Kurung kendai	19	Crustaceans	96	Cyanophyceae	145
					Apple snail	2	Cat fish	9	Rotifers	252	Fragilariophyceae	56
							Labeo	4	Copepods	24	Coscinodiscophyceae	47

Location Number	Benthos		Macrophytes		Macro Invertebrates		Fishes		Zooplankton		Phytoplankton	
	Name	**Qty**	**Name**	**Qty**	**Name**	**Qty**	**Name**	**Qty**	**Name**	**Qty**	**Name**	**Qty**
							rohita					
							Mirgal	2	Ostracots	27	Euglenoidea	66
											Nostocaceae	9
											Ciliates	27
											Chlorophyceae	176
											Bacillariophyceae	225
	Total	**7**				**25**		**38**		**517**		**751**
7	Tubifex	8			Crab	2	Jalebi	126	Protozoans	231	Bacillariophyceae	335
	Earthworm	2			Gilled snails	21	Uzhuva	87	Crustaceans	107	Cyanophyceae	220
	Chironomus larvae	16			Clam	11	Cat fish	2	Rotifers	260	Fragilariophyceae	96
	Larvae of prawn	38			Apple snail	9	Mooku meen		Copepods	35	Coscinodiscophyceae	47
	Sand fly larvae	2			Mussel	14	Mayila	12	Ostracots	9	Euglenoidea	101
					Pila	32	Saar mutti	4			Nostocaceae	44
					Mayfly	6	Velicha	18			Ciliates	27

Location Number	Benthos		Macrophytes		Macro Invertebrates		Fishes		Zooplankton		Phytoplankton	
	Name	**Qty**	**Name**	**Qty**	**Name**	**Qty**	**Name**	**Qty**	**Name**	**Qty**	**Name**	**Qty**
					Dragonfly	2	Valai	22			Chlorophyceae	278
							Kurung kendai	7				
							Labeo rohita	30				
	Total	**66**				**97**		**308**		**642**		**1148**
8	Earthworm	2			Crab	3	Jalebi	22	Protozoans	91	Bacillariophyceae	145
					Gilled snails	21	Uzhuva	16	Crustaceans	86	Cyanophyceae	98
					Clam	45	Cat fish	12	Rotifers	186	Fragilariophyceae	52
					Apple snail	4	Mooku meen	1	Copepods	23	Coscinodiscophyceae	23
					Mussel	2	Mayila	3	Ostracots	9	Euglenoidea	66
					Pond snail	30	Saar mutti	7			Nostocaceae	22

Location Number	Benthos		Macrophytes		Macro Invertebrates		Fishes		Zooplankton		Phytoplankton	
	Name	**Qty**	**Name**	**Qty**	**Name**	**Qty**	**Name**	**Qty**	**Name**	**Qty**	**Name**	**Qty**
					Mayfly	2					Ciliates	14
					Dragonfly	6					Chlorophyceae	117
	Total	**2**				**113**		**61**		**395**		**537**
9	Tubifex	2			Crab	18	Jalebi	30	Protozoans	142	Bacillariophyceae	236
	Earthworm	1			Gilled snails	25	Uzhuva	14	Crustaceans	98	Cyanophyceae	79
	Chironomus larvae	1			Clam	49	Cat fish	12	Rotifers	147	Fragilariophyceae	42
	Larvae of prawn				Apple snail	47	Mooku meen	4	Copepods	25	Coscinodiscophyceae	27
	Sand fly larvae	1			Mussel	27	Mayila	2	Ostracots	12	Euglenoidea	38
					Pond snail	30	Saar mutti	3		424	Nostocaceae	11
					Mayfly	4	Velicha	7			Ciliates	22
					Dragonfly	6	Valai	4			Chlorophyceae	220
						206	Kurung kendai	12				675
							Labeo	26				

Location Number	Benthos		Macrophytes		Macro Invertebrates		Fishes		Zooplankton		Phytoplankton	
	Name	**Qty**	**Name**	**Qty**	**Name**	**Qty**	**Name**	**Qty**	**Name**	**Qty**	**Name**	**Qty**
							rohita					
							Panjala kendai	5				
							Mirgal	14				
							Keluthu	2				
							Rocket fish	1				
	Total	**5**				**206**		**136**		**424**		**675**
10	Tubifex	2			Crab	12	Jalebi	52	Protozoans	224	Bacillariophyceae	325
	Earthworm	3			Gilled snails	32	Uzhuva	14	Crustaceans	112	Cyanophyceae	225
					Clam	101	Cat fish	30	Rotifers	201	Fragilariophyceae	98
					Apple snail	56	Mooku meen	12	Copepods	46	Coscinodiscophyceae	57
	Sand fly larvae	1			Mussel	78	Mayila	2	Ostracots	13	Euglenoidea	88
					Pond snail	79	Saar mutti	4		596	Nostocaceae	35
					Mayfly	2	Velicha	21			Ciliates	11
					Dragonfly	1	Valai	1			Chlorophyceae	265

Location Number	Benthos		Macrophytes		Macro Invertebrates		Fishes		Zooplankton		Phytoplankton	
	Name	**Qty**	**Name**	**Qty**	**Name**	**Qty**	**Name**	**Qty**	**Name**	**Qty**	**Name**	**Qty**
						361	Kurung kendai	12				1104
							Labeo rohita	9				
							Panjala kendai	7				
							Mirgal	15				
							Keluthu	5				
							Rocket fish	3				
							Kendai	16				
							Kuravai	4				
							Murral	8				
							Vera	7				
							Eel	2				
	Total	**6**				**361**		**224**		**596**		**1104**
11	Tubifex	3			Crab	12	Jalebi	156	Protozoans	265	Bacillariophyceae	360

Location Number	Benthos		Macrophytes		Macro Invertebrates		Fishes		Zooplankton		Phytoplankton	
	Name	**Qty**	**Name**	**Qty**	**Name**	**Qty**	**Name**	**Qty**	**Name**	**Qty**	**Name**	**Qty**
	Earthworm	3			Gilled snails	40	Uzhuva	79	Crustaceans	119	Cyanophyceae	118
					Clam		Cat fish	64	Rotifers	128	Fragilariophyceae	86
					Apple snail	44	Mooku meen	67	Copepods	74	Coscinodiscophyceae	39
	Sand fly larvae	2			Mussel	25	Mayila	1	Ostracots	12	Euglenoidea	79
					Pond snail	70	Saar mutti	79		598	Nostocaceae	46
					Mayfly	4	Velicha	78			Ciliates	21
					Dragonfly	7	Valai	89			Chlorophyceae	265
						202	Kurung kendai	102				1014
							Labeo rohita	59				
							Panjala kendai	102				
							Mirgal	122				
							Keluthu	86				

Location Number	Benthos		Macrophytes		Macro Invertebrates		Fishes		Zooplankton		Phytoplankton	
	Name	**Qty**	**Name**	**Qty**	**Name**	**Qty**	**Name**	**Qty**	**Name**	**Qty**	**Name**	**Qty**
							Rocket fish	36				
							Kendai	132				
							Kuravai	98				
							Murral	79				
							Vera	68				
							Eel	7				
	Total	**8**				**202**		**1504**		**598**		**1014**
12	Tubifex	1			Crab	20	Jalebi	6	Protozoans	98	Bacillariophyceae	117
	Earthworm	1			Gilled snails	47	Uzhuva	7	Crustaceans	75	Cyanophyceae	65
					Clam	117	Cat fish	16	Rotifers	108	Fragilariophyceae	47
					Apple snail	26	Mooku meen	4	Copepods	42	Coscinodiscophyceae	11
					Mussel	14	Mayila	12	Ostracots	14	Euglenoidea	79
					Pond snail	38	Saar mutti	5		337	Nostocaceae	45
					Mayfly		Velicha	7			Ciliates	24

Location Number	Benthos		Macrophytes		Macro Invertebrates		Fishes		Zooplankton		Phytoplankton	
	Name	**Qty**	**Name**	**Qty**	**Name**	**Qty**	**Name**	**Qty**	**Name**	**Qty**	**Name**	**Qty**
					Dragonfly	262	Valai	6			Chlorophyceae	74
							Kurung kendai	4				462
							Labeo rohita	14				
							Panjala kendai	12				
							Mirgal	22				
							Keluthu	14				
							Rocket fish	8				
							Kendai	22				
							Kuravai	16				
							Murral	13				
							Vera	11				
							Eel	4				
	Total	**2**				**262**		**203**		**337**		**462**

Location Number	Benthos		Macrophytes		Macro Invertebrates		Fishes		Zooplankton		Phytoplankton	
	Name	Qty	Name	Qty	Name	Qty	Name	Qty	Name	Qty	Name	Qty
13	Tubifex	4			Crab	4	Jalebi	4	Protozoans	111	Bacillariophyceae	114
	Earthworm	1			Gilled snails		Uzhuva	3	Crustaceans	74	Cyanophyceae	74
					Clam		Cat fish	15	Rotifers	119	Fragilariophyceae	54
					Apple snail	47	Mooku meen	8	Copepods	28	Coscinodiscophyceae	25
					Mussel	27	Mayila	1	Ostracots	7	Euglenoidea	41
					Pond snail	53	Saar mutti	2		339	Nostocaceae	7
					Mayfly	1	Velicha	4			Ciliates	12
					Dragonfly		Valai	3			Chlorophyceae	79
						1	Kurung kendai	7				406
						133	Labeo rohita	9				
							Panjala kendai	7				
							Mirgal	12				

Location Number	Benthos		Macrophytes		Macro Invertebrates		Fishes		Zooplankton		Phytoplankton	
	Name	**Qty**	**Name**	**Qty**	**Name**	**Qty**	**Name**	**Qty**	**Name**	**Qty**	**Name**	**Qty**
							Keluthu	13				
							Rocket fish	4				
							Kendai	7				
							Kuravai	8				
							Murral	14				
							Vera	14				
	Total	**5**				**133**		**135**		**339**		**406**
14	Tubifex	2			Crab	7	Jalebi	12	Protozoans	154	Bacillariophyceae	229
	Earthworm	1			Gilled snails	12	Uzhuva	4	Crustaceans	111	Cyanophyceae	86
					Clam		Cat fish	7	Rotifers	199	Fragilariophyceae	39
					Apple snail	25	Mooku meen	5	Copepods	38	Coscinodiscophyceae	22
					Mussel	21	Mayila	6	Ostracots	20	Euglenoidea	41
					Pond snail	37	Saar mutti	4			Nostocaceae	22
							Velicha	24			Ciliates	9

Location Number	Benthos		Macrophytes		Macro Invertebrates		Fishes		Zooplankton		Phytoplankton	
	Name	**Qty**	**Name**	**Qty**	**Name**	**Qty**	**Name**	**Qty**	**Name**	**Qty**	**Name**	**Qty**
							Valai	22			Chlorophyceae	197
							Kurung kendai	40				
							Labeo rohita	23				
							Panjala kendai	25				
							Mirgal	28				
							Keluthu	11				
							Kendai	23				
							Kuravai	4				
							Vera	2				
	Total	**3**				**102**		**240**		**522**		**645**
15	Tubifex	2			Crab	6	Jalebi	32	Protozoans	117	Bacillariophyceae	252
	Earthworm	3			Gilled snails	52	Uzhuva	22	Crustaceans	89	Cyanophyceae	114
	Chironomus	3			Clam	41	Cat fish	14	Rotifers	141	Fragilariophyceae	56

Location Number	Benthos		Macrophytes		Macro Invertebrates		Fishes		Zooplankton		Phytoplankton	
	Name	**Qty**	**Name**	**Qty**	**Name**	**Qty**	**Name**	**Qty**	**Name**	**Qty**	**Name**	**Qty**
	larvae											
	Larvae of prawn	1			Apple snail	22	Mooku meen	15	Copepods	52	Coscinodiscophyceae	12
	Sand fly larvae	2			Mussel	14	Mayila	12	Ostracots	22	Euglenoidea	77
					Pond snail	26	Saar mutti	21			Nostocaceae	33
					Mayfly	2	Velicha	22		421	Ciliates	14
					Dragonfly	7	Valai	14			Chlorophyceae	121
							Kurung kendai	26				
							Labeo rohita	24				
							Panjala kendai	12				
							Mirgal	28				
							Keluthu	10				
							Rocket fish	7				

Location Number	Benthos		Macrophytes		Macro Invertebrates		Fishes		Zooplankton		Phytoplankton	
	Name	**Qty**	**Name**	**Qty**	**Name**	**Qty**	**Name**	**Qty**	**Name**	**Qty**	**Name**	**Qty**
							Kendai	16				
							Kuravai	24				
							Murral	10				
							Vera	9				
							Eel	2				
	Total	**11**				**170**		**320**		**421**		**679**
16	Larvae of prawn	23			Crab	22	Jalebi	7	Protozoans	142	Bacillariophyceae	147
					Gilled snails	30	Uzhuva	5	Crustaceans	97	Cyanophyceae	89
					Clam	114	Cat fish	3	Rotifers	108	Fragilariophyceae	56
					Apple snail	52	Mooku meen	7	Copepods	21	Coscinodiscophyceae	78
					Mussel	14	Mayila	5	Ostracots	9	Euglenoidea	59
					Pond snail	220	Saar mutti	7			Nostocaceae	36
					Mayfly	1	Velicha	14			Ciliates	22
					Dragonfly	3	Valai	21			Chlorophyceae	121

Location Number	Benthos		Macrophytes		Macro Invertebrates		Fishes		Zooplankton		Phytoplankton	
	Name	**Qty**	**Name**	**Qty**	**Name**	**Qty**	**Name**	**Qty**	**Name**	**Qty**	**Name**	**Qty**
							Kurung kendai	22				
							Labeo rohita	14				
							Panjala kendai	18				
							Mirgal	26				
							Keluthu	21				
							Rocket fish	4				
							Kendai	11				
							Kuravai	12				
							Murral	15				
							Vera	6				
	Total	**23**				**456**		**218**		**377**		**608**
17	Tubifex	4			Crab	1	Jalebi	25	Protozoans	232	Bacillariophyceae	265
	Earthworm	3			Gilled snails	2	Uzhuva	21	Crustaceans	171	Cyanophyceae	147

Location Number	Benthos		Macrophytes		Macro Invertebrates		Fishes		Zooplankton		Phytoplankton	
	Name	**Qty**	**Name**	**Qty**	**Name**	**Qty**	**Name**	**Qty**	**Name**	**Qty**	**Name**	**Qty**
	Chironomus larvae	2			Clam	12	Cat fish	12	Rotifers	210	Fragilariophyceae	97
	Larvae of prawn	6			Apple snail	32	Mooku meen	2	Copepods	91	Coscinodiscophyceae	78
	Sand fly larvae	2			Mussel	2	Mayila	6	Ostracots	29	Euglenoidea	112
					Pond snail	22	Saar mutti	22			Nostocaceae	51
					Mayfly	1	Velicha	14			Ciliates	32
					Dragonfly	2	Valai	12			Chlorophyceae	179
							Kurung kendai	9				
							Labeo rohita	13				
							Panjala kendai	14				
							Mirgal	7				
							Keluthu	5				
							Rocket fish	6				

Location Number	Benthos		Macrophytes		Macro Invertebrates		Fishes		Zooplankton		Phytoplankton	
	Name	**Qty**	**Name**	**Qty**	**Name**	**Qty**	**Name**	**Qty**	**Name**	**Qty**	**Name**	**Qty**
							Kendai	22				
							Kuravai	17				
							Murral	1				
							Vera	2				
							Eel	1				
	Total	**17**				**74**		**211**		**733**		**961**
18	Tubifex	3			Crab	22	Jalebi	21	Protozoans	174	Bacillariophyceae	212
	Earthworm	3			Gilled snails	21	Uzhuva	3	Crustaceans	114	Cyanophyceae	124
					Clam	22	Cat fish	2	Rotifers	139	Fragilariophyceae	79
					Apple snail	10	Mooku meen	21	Copepods	46	Coscinodiscophyceae	89
					Mussel	9	Mayila	3	Ostracots	21	Euglenoidea	76
					Pond snail	54	Saar mutti	4			Nostocaceae	52
					Mayfly	1	Velicha	3			Ciliates	22
					Dragonfly	1	Valai	7			Chlorophyceae	189

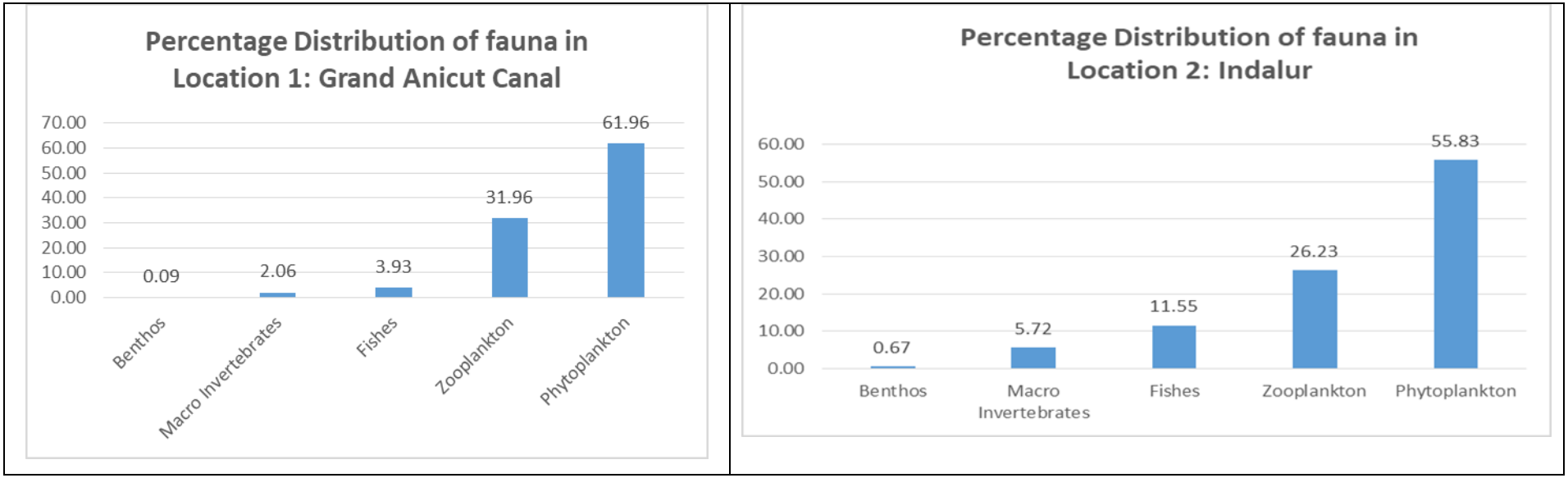
Location Number	Benthos		Macrophytes		Macro Invertebrates		Fishes		Zooplankton		Phytoplankton	
	Name	**Qty**	**Name**	**Qty**	**Name**	**Qty**	**Name**	**Qty**	**Name**	**Qty**	**Name**	**Qty**
							Kurung kendai	14				
							Labeo rohita	24				
							Panjala kendai	12				
							Mirgal	23				
							Keluthu	12				
							Rocket fish	2				
							Kendai	14				
							Kuravai	14				
							Murral	2				
							Vera	1				
							Eel	1				
	Total	**6**				**140**		**183**		**494**		**843**
19	Chironomus	4			Crab		Jalebi	3	Protozoans	101	Bacillariophyceae	260

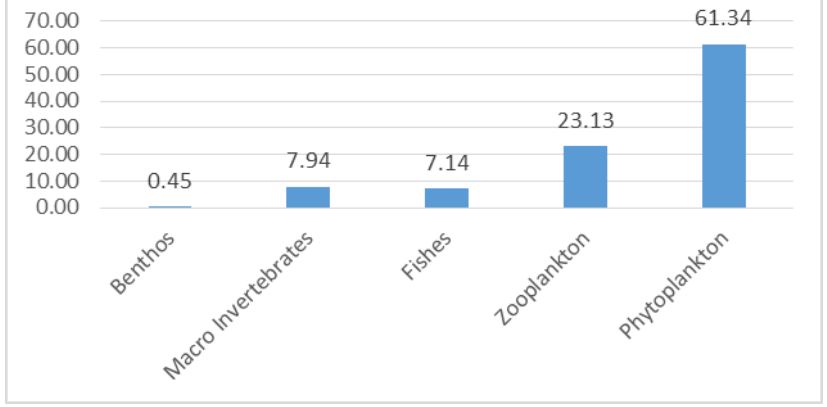
Location Number	Benthos		Macrophytes		Macro Invertebrates		Fishes		Zooplankton		Phytoplankton	
	Name	Qty	Name	Qty	Name	Qty	Name	Qty	Name	Qty	Name	Qty
	larvae											
					Gilled snails	2	Uzhuva	4	Crustaceans	89	Cyanophyceae	174
					Clam	7	Cat fish	1	Rotifers	98	Fragilariophyceae	77
					Apple snail	4	Mooku meen	2	Copepods	52	Coscinodiscophyceae	152
					Mussel	2	Mayila	1	Ostracots	14	Euglenoidea	46
					Pond snail	7	Saar mutti	5			Nostocaceae	29
					Mayfly	1	Velicha	4			Ciliates	14
					Dragonfly	2	Valai	2			Chlorophyceae	214
							Kurung kendai	2				
							Labeo rohita	2				
							Panjala kendai	21				
							Mirgal	9				

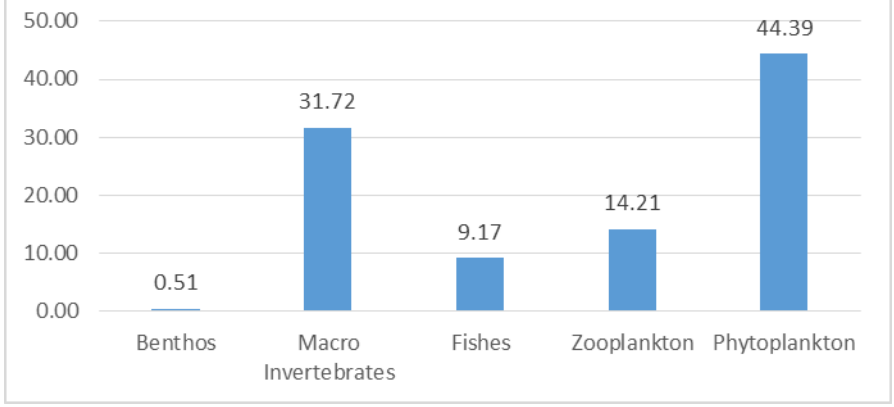
Location Number	Benthos		Macrophytes		Macro Invertebrates		Fishes		Zooplankton		Phytoplankton	
	Name	**Qty**	**Name**	**Qty**	**Name**	**Qty**	**Name**	**Qty**	**Name**	**Qty**	**Name**	**Qty**
							Keluthu	21				
							Kuravai	1				
							Murral	1				
	Total	**4**				**25**		**79**		**354**		**966**
20	Tubifex	3			Crab	2	Jalebi	2	Protozoans	112	Bacillariophyceae	325
	Earthworm	1			Gilled snails		Uzhuva	5	Crustaceans	89	Cyanophyceae	255
	Chironomus larvae	6			Clam		Cat fish	4	Rotifers	147	Fragilariophyceae	147
	Larvae of prawn				Apple snail		Mooku meen	9	Copepods	29	Coscinodiscophyceae	252
	Sand fly larvae	2			Mussel		Mayila	1	Ostracots	12	Euglenoidea	45
					Pond snail		Saar mutti	5			Nostocaceae	22
					Mayfly		Velicha	2			Ciliates	14
					Dragonfly		Valai	7			Chlorophyceae	179
							Kurung kendai	3				

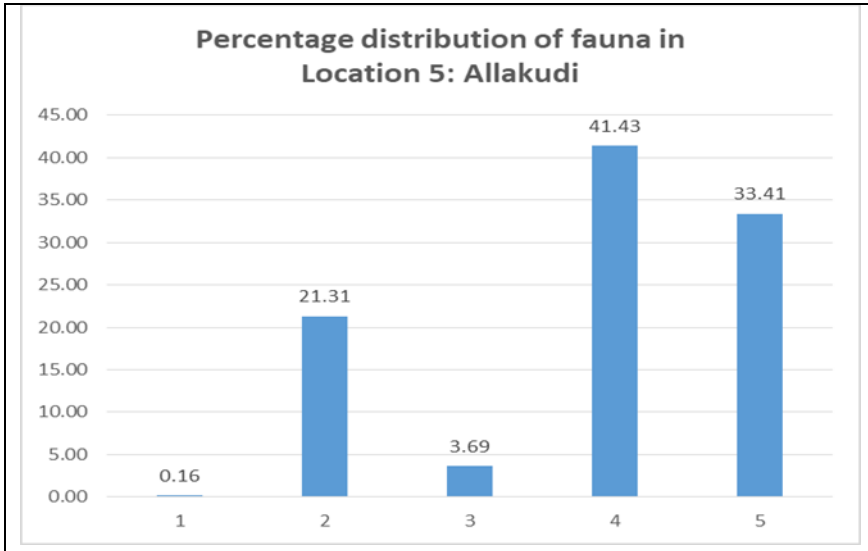
Location Number	Benthos		Macrophytes		Macro Invertebrates		Fishes		Zooplankton		Phytoplankton	
	Name	**Qty**	**Name**	**Qty**	**Name**	**Qty**	**Name**	**Qty**	**Name**	**Qty**	**Name**	**Qty**
							Labeo rohita	4				
							Panjala kendai	6				
							Mirgal	14				
							Keluthu	12				
							Rocket fish	4				
							Kendai	3				
							Kuravai	2				
							Murral	14				
							Vera	11				
							Eel	2				
	Total	**12**				**2**		**110**		**389**		**1239**

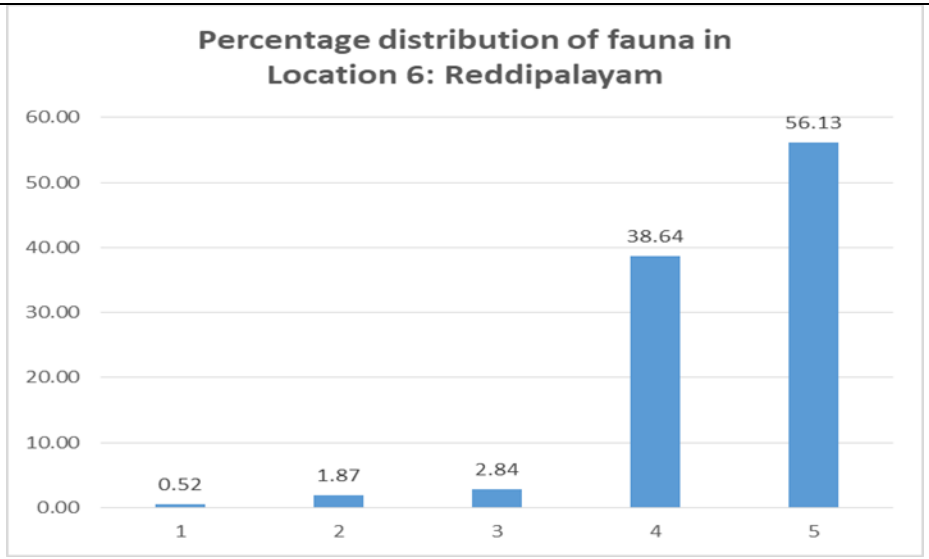
Figure 16: Percentage Distribution of fauna (20 Locations)

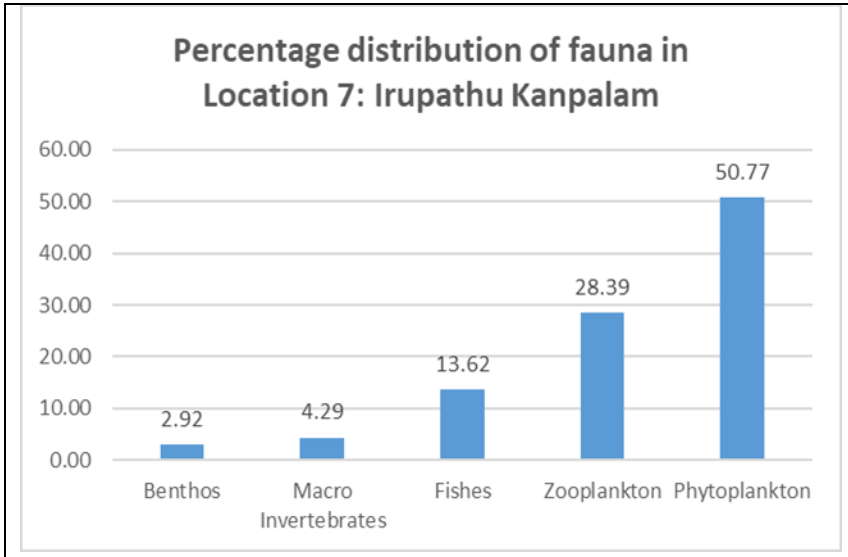


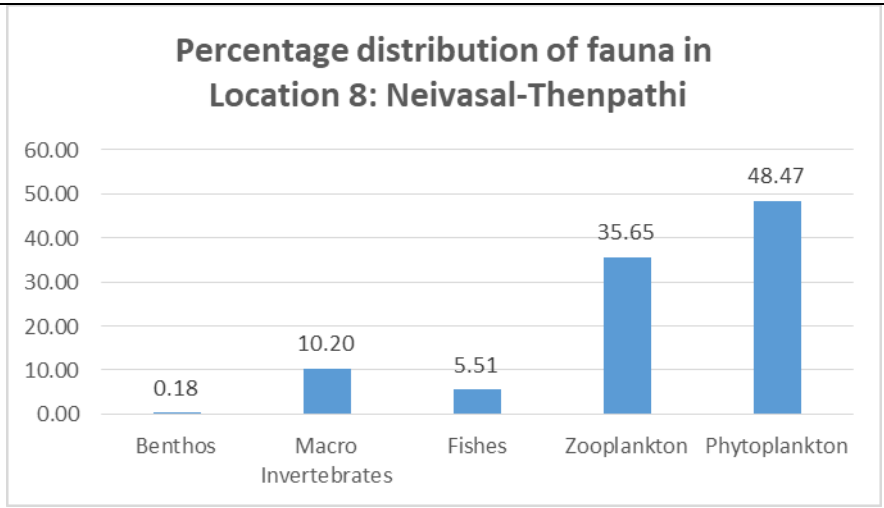

Percentage distribution of fauna in 3: Ayyarnapuram
70.00
60.00
50.00
40.00
30.00
20.00
10.00
0.00
0.45
7.94
7.14
23.13
61.34
Benthos
Macro Invertebrates
Fishes
Zooplankton
Phytoplankton

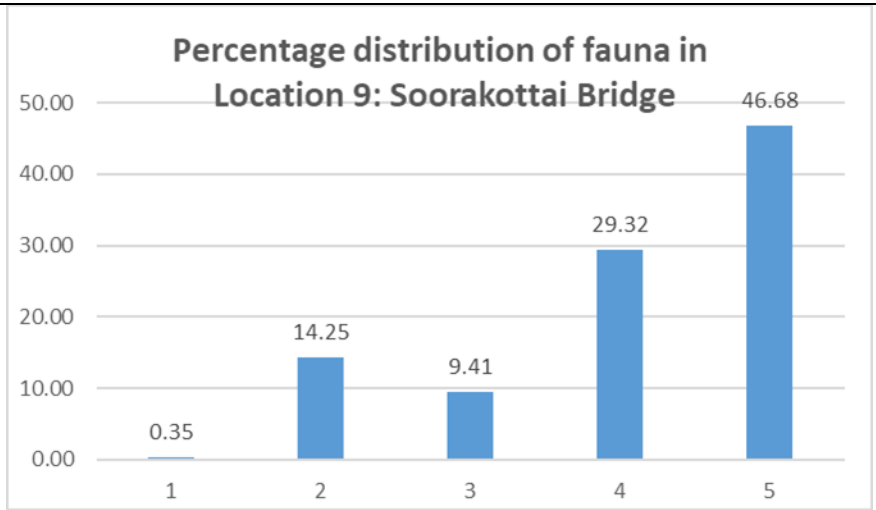

Percentage distribution of fauna in Location 4: Vairaperumalpatti
50.00
40.00
30.00
20.00
10.00
0.00
0.51
31.72
9.17
14.21
44.39
Benthos
Macro Invertebrates
Fishes
Zooplankton
Phytoplankton

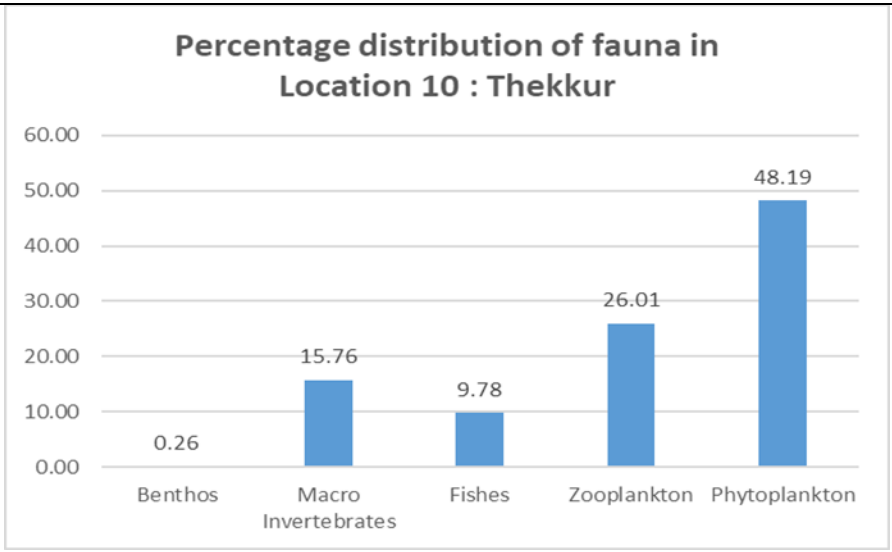

Percentage distribution of fauna in Location 5: Allakudi
45.00
40.00
35.00
30.00
25.00
20.00
15.00
10.00
5.00
0.00
0.16
21.31
3.69
41.43
33.41
1
2
3
4
5

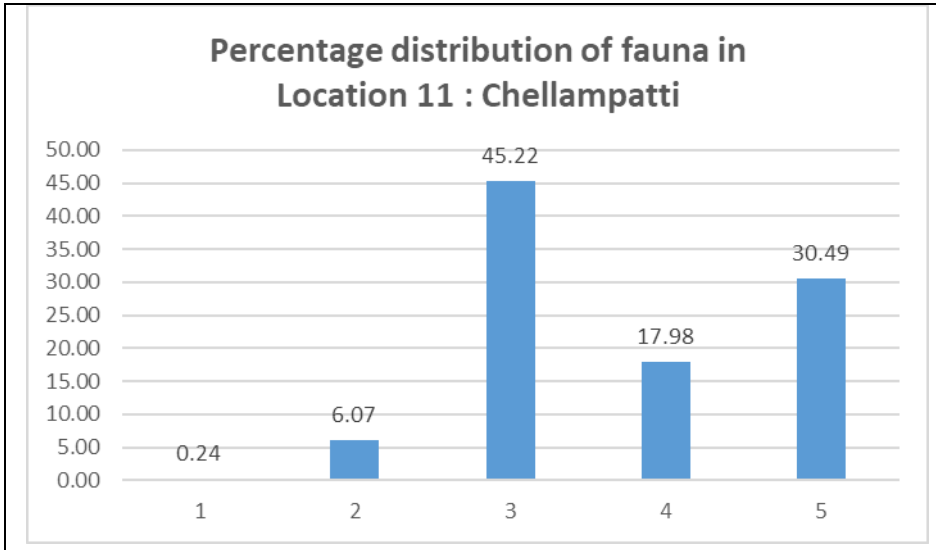

Percentage distribution of fauna in Location 6: Reddipalayam
60.00
50.00
40.00
30.00
20.00
10.00
0.00
0.52
1.87
2.84
38.64
56.13
1
2
3
4
5

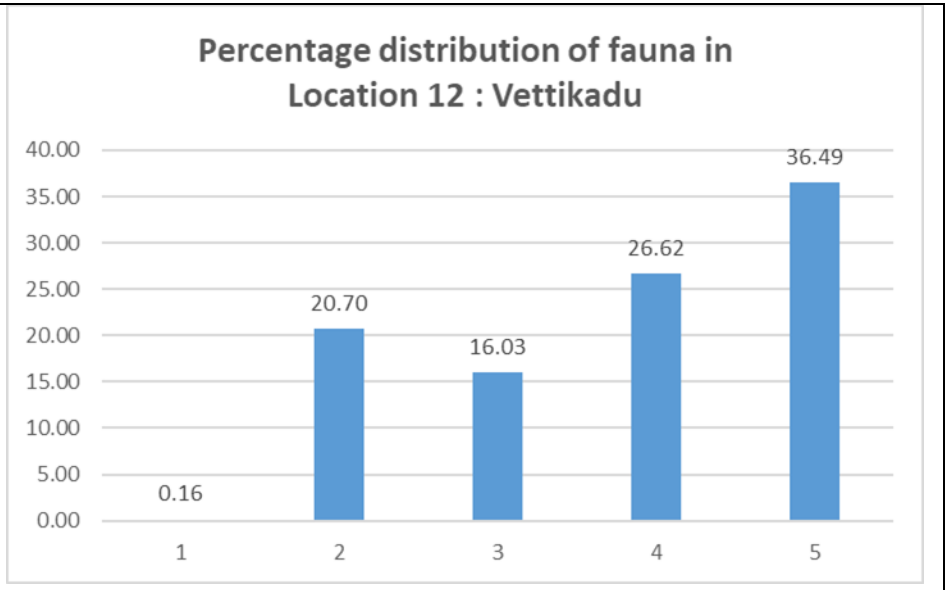

Percentage distribution of fauna in Location 7: Irupathu Kanpalam
60.00
50.00
40.00
30.00
20.00
10.00
0.00
2.92
4.29
13.62
28.39
50.77
Benthos
Macro Invertebrates
Fishes
Zooplankton
Phytoplankton

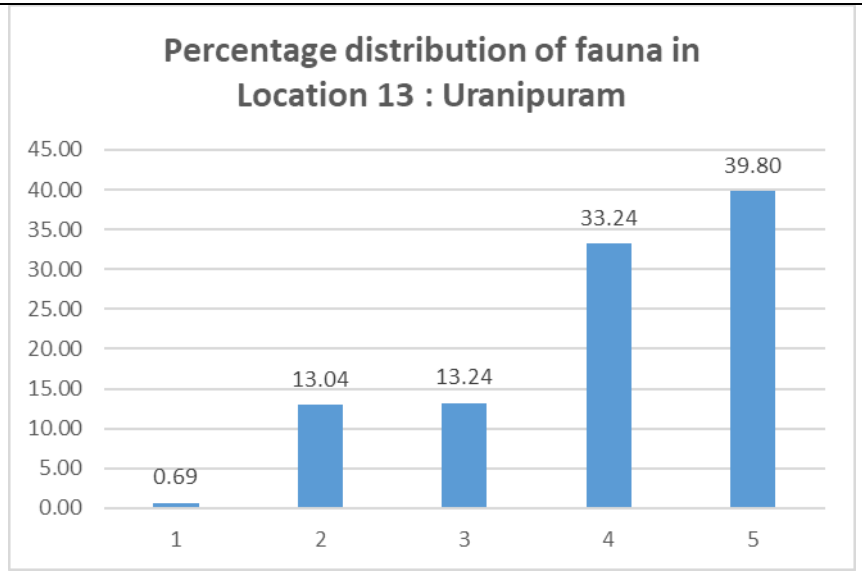

Percentage distribution of fauna in Location 8: Neivasal-Thenpathi
60.00
50.00
40.00
30.00
20.00
10.00
0.00
0.18
10.20
5.51
35.65
48.47
Benthos
Macro Invertebrates
Fishes
Zooplankton
Phytoplankton

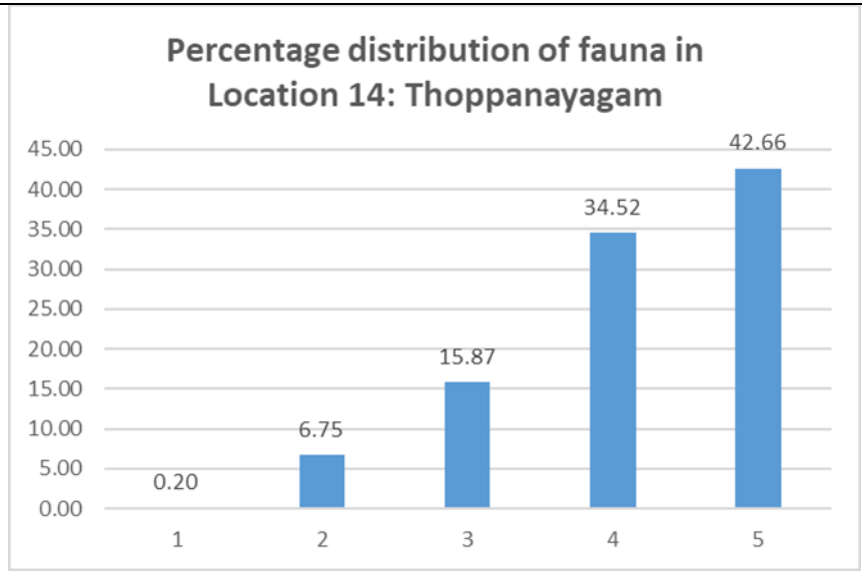

Percentage distribution of fauna in Location 9: Soorakottai Bridge
50.00
40.00
30.00
20.00
10.00
0.00
0.35
14.25
9.41
29.32
46.68
1
2
3
4
5

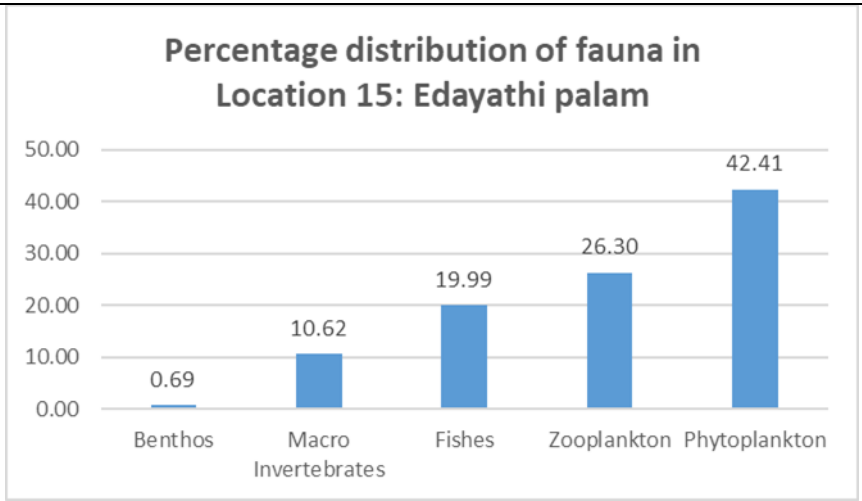

Percentage distribution of fauna in Location 10 : Thekkur
60.00
50.00
40.00
30.00
20.00
10.00
0.00
0.26
15.76
9.78
26.01
48.19
Benthos
Macro Invertebrates
Fishes
Zooplankton
Phytoplankton

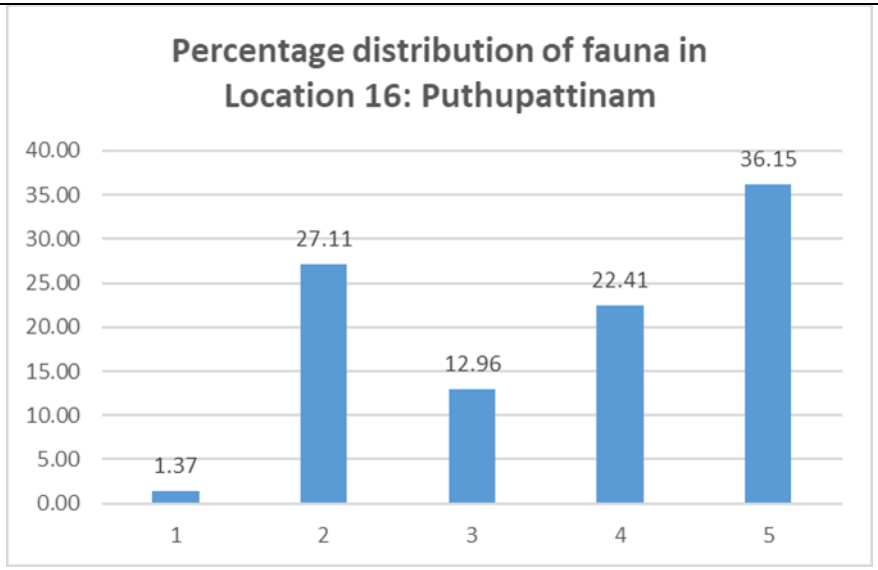

Percentage distribution of fauna in Location 11 : Chellampatti
50.00
45.00
40.00
35.00
30.00
25.00
20.00
15.00
10.00
5.00
0.00
0.24
6.07
45.22
17.98
30.49
1
2
3
4
5

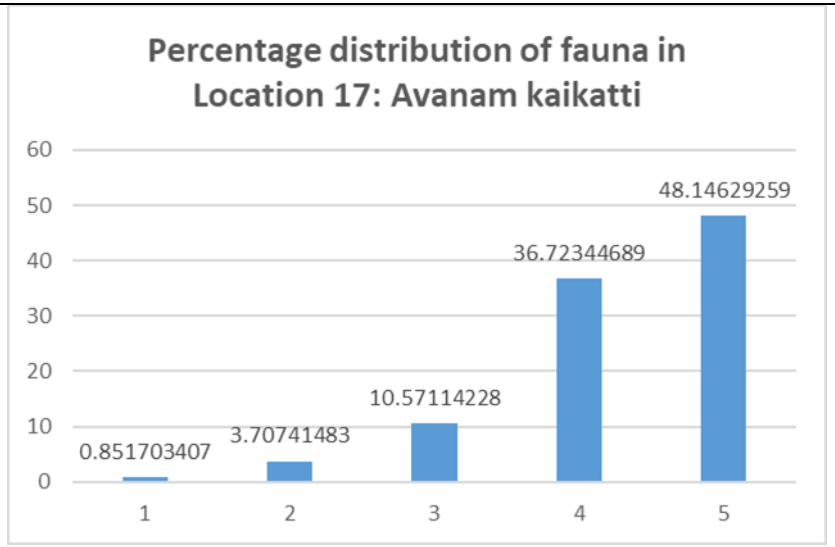

Percentage distribution of fauna in Location 12 : Vettikadu
40.00
35.00
30.00
25.00
20.00
15.00
10.00
5.00
0.00
0.16
20.70
16.03
26.62
36.49
1
2
3
4
5


Percentage distribution of fauna in Location 13 : Uranipuram
45.00
40.00
35.00
30.00
25.00
20.00
15.00
10.00
5.00
0.00
0.69
13.04
13.24
33.24
39.80
1
2
3
4
5


Percentage distribution of fauna in Location 14: Thoppanayagam
45.00
40.00
35.00
30.00
25.00
20.00
15.00
10.00
5.00
0.00
0.20
6.75
15.87
34.52
42.66
1
2
3
4
5


Percentage distribution of fauna in Location 15: Edayathi palam
50.00
40.00
30.00
20.00
10.00
0.00
0.69
10.62
19.99
26.30
42.41
Benthos
Macro Invertebrates
Fishes
Zooplankton
Phytoplankton


Percentage distribution of fauna in Location 16: Puthupattinam
40.00
35.00
30.00
25.00
20.00
15.00
10.00
5.00
0.00
1.37
27.11
12.96
22.41
36.15
1
2
3
4
5


Percentage distribution of fauna in Location 17: Avanam kaikatti
60
50
40
30
20
10
0
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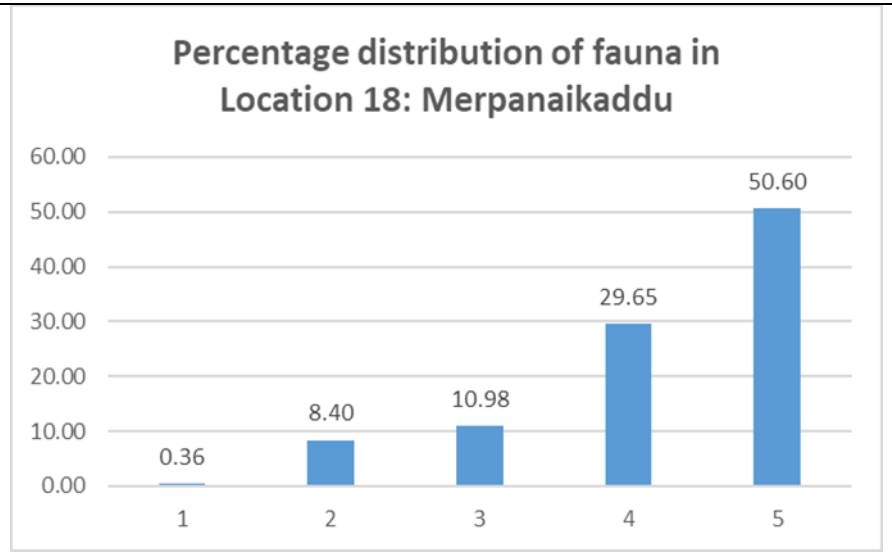
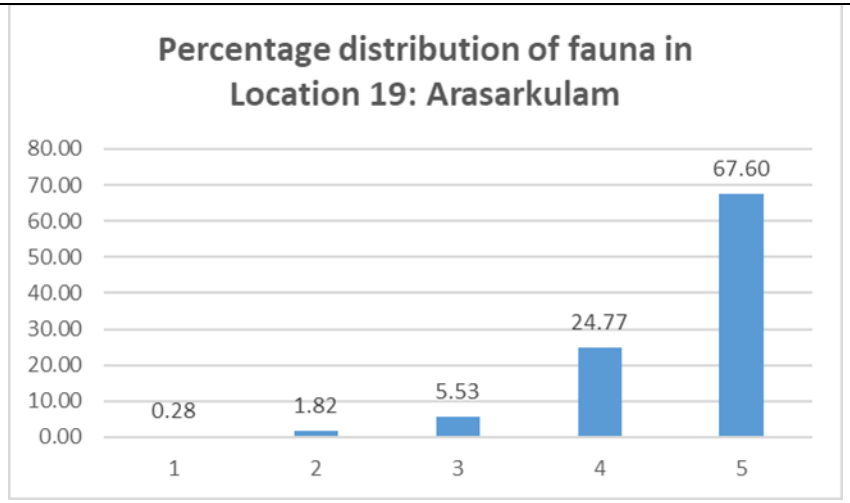
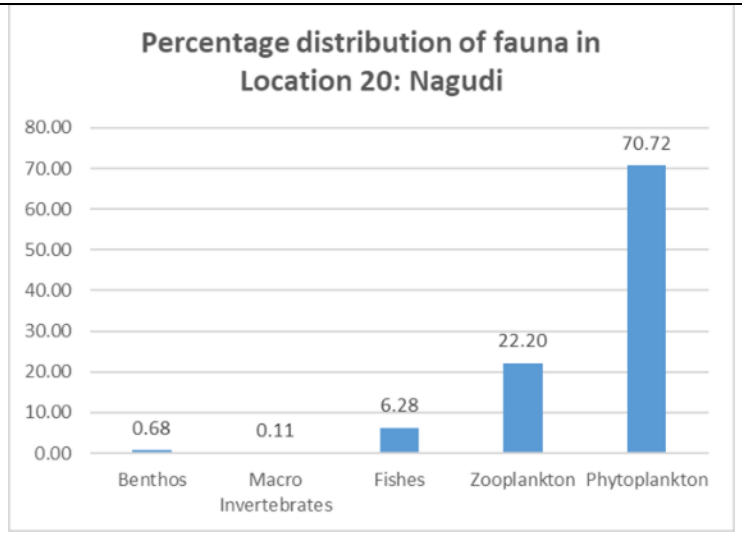
3.70741483
10.57114228
36.72344689
48.14629259
1
2
3
4
5


Percentage distribution of fauna in Location 18: Merpanaikaddu
60.00
50.00
40.00
30.00
20.00
10.00
0.00
0.36
8.40
10.98
29.65
50.60
1
2
3
4
5


Percentage distribution of fauna in Location 19: Arasarkulam
80.00
70.00
60.00
50.00
40.00
30.00
20.00
10.00
0.00
0.28
1.82
5.53
24.77
67.60
1
2
3
4
5


Percentage distribution of fauna in Location 20: Nagudi
80.00
70.00
60.00
50.00
40.00
30.00
20.00
10.00
0.00
0.68
0.11
6.28
22.20
70.72
Benthos
Macro Invertebrates
Fishes
Zooplankton
Phytoplankton

The list of endangered, threatened, vulnerable, Least Concern species of fishes, are presented in Tables 34.

Table 34: IUCN Status of Fish Species

S. No	Name	IUCN Status
1	Jelabi fish (Tilapia)	Least Concern
2	Cat fish (Ictalurus Punctatus)	Least Concern
3	Kendai fish (C. idella)	Least Concern
4	Vaalai fish (Wallago attu)	Vulnerable
5	Kurung kendai (C. idella)	Least Concern
6	Panjala kenda (L. Rohita)	Least Concern
7	Banari Kendai (climbing perch)	Least Concern
8	Kuravai (fingerlings)	Least Concern
9	Vera meen (Adult)	Least Concern
10	Karratan (African catfish)	Least Concern
11	Mooku meen	Least Concern

Assessment of Biotic Resources:

Among overall abundance, 47 species of phytoplankton's, 12 species of zooplanktons, 5 species of benthos, 17 species of fishes and 7 species of Macrophytes were recorded in the study area. However, population fluctuation had seen almost all the locations. Many species of flora and fauna observed are strictly seasonal, preferring set of habitats.

In the 20 locations studied, among the flora and fauna observed, the phytoplankton, *Bacillophyaceae*, *Chlorophyaeae*, *Cyanophyceae* is dominant group, while *Fragilariophyceae*, *Euglenoidea*, and *Coscinodiscophyceae* and were subdominant. Nostocaceae and Ciliates species were also recorded.

The study reveals the presence of zooplankton with protozoans as dominating group. Largest contribution is of zooplankton, the rotifers and crustacean are dominant species found in almost all the samples. The plankton biomass was higher almost all the 20 locations. Macrophytes, Macro Invertebrates and Fishes were lower in few locations. Molluscan diversity was estimated by identification of the collected specimen or shells, class gastropoda

and class bivalvia were observed. The gastropods were more in number than bivalves. Benthos had the least number of representatives in the study sites.

Planktons are important; they serve as food for other organisms at higher trophic levels. They are also good indicators of water quality. Presence of phytoplanktons such as Bacillophyaceae, Chlorophyaeae, Cyanophyceae and zooplankton, the rotifers and crustacean shows highly water contamination in the locations viz. GA canal Head, Reddipalayam, Irupathukanpalam, Idayathipalam – Pannavayal Branch Canal and Nagudi.

Aquatic macro invertebrates and fishes are dependent on planktons as their food. Thus, aquatic organism diversity indirectly reflects overall plankton diversity, especially that of phyto and zoo planktons in the selected locations area.

Benthos organisms need certain minerals and water for their survival. They obtain all these from the bottom of the Riverbed, mud, and bottom soil. Only 5 species of benthos with lowest population were identified due to lack of nutrients, and due to cement flooring of the River bed.

Macro invertebrates such as snail and bivalves are predominant in the Canal. Molluscans are of great significance because they form the food of fishes and their productivity play an important role in the food chain. Molluscans communities are good indicators of localized conditions, including the water quality Snails are important part of freshwater reservoirs.

In the entire canal, 3 locations, viz., Irupathukanpaalam, Puthupattinam and Aavanam were unique among 20 locations due to the presence of shrimp's population which are very rare.

Phytoplankton are autotrophs and belonging to first trophic level. They are important component of aquatic ecosystem. Phytoplankton encountered in the water body reflects the average ecological condition and therefore, they may be used as an indicator of water. Phytoplankton, zooplankton and fish species showed the best representation in almost all locations.

When compared to other locations few habitats such as Vettikad, Thoppanayagam and Thekkuris are found to be more suitable places for fishing due to the presence of shutters. The major threat to fish diversity is cannibalism of African catfish and cement floorings.

Eichhornia, Hydilla, Ipomea, Common Reed, Pistia, Lemna, Salvia, Pond Weed, and Lillium species were recorded as the dominant macrophyte plants which were found in the last four locations. It might be due to water pollution and less flow of water.

Overall, the study revealed that among the biodiversity of flora and fauna in all the 20 different locations, the diversity in first 16 locations was extraordinarily high while last four locations was poor due to low volume of water level.

Biotic resources are found to be susceptible for fluctuations in various environmental factors like temperature, humidity, wind, pressure, etc. Symbiotic association studies highlight food

chain and food web. Soil is one of the most important components of aquatic ecosystem. It provides nutrients as well as substratum to the aquatic organisms. Riverine soil plays an important role in regulating the concentration of nutrients in the River water.

Sediments are indicators of quality of overlying water and its study is a useful tool in the assessment of environmental pollution status The presence of indicator organism, Chironomus in water indicates contamination of the water source with sewage matter but they are under threat of high contamination mainly due to urbanization.

The zooplankton biomass is directly related to phytoplankton abundance. This may result directly from better food availability during this season. The reason for higher amount of degradable organic carbon at the end of the vegetation period may be seen in the higher phytoplankton blooms in the monsoon. This observation is also witnessed in the present study at 20 sites of GAC canals. Algae are generally considered to be the major components in the diet of zooplankton and fishes. Interestingly in our study, zooplanktons have been observed frequently at algal dominated sites.

Anthropogenic activities observed

The following anthropogenic activities were observed during the study that may affect the ecological health of the Grand Anicut Canal:

1. Use of inorganic fertiliziers and organic pesticides by the farmers – this may pollute the Canal (Non-Point Source)
2. Vehicle washing in the Canal.
3. Open defecation by the local community
4. Dumping of wastes
5. Construction of Concrete floors and bunds in the Canal – alter the natural habitat and pose a threat to the diversity of biotic resources. This may affect the breeding of fishes and other animals.

Conservation needs for fish species.

In the present study, 47 species of phytoplanktons, 12 species of zooplanktons, 5 species of benthos, 17 species of fishes, 6 species of migratory birds and 7 species macrophytes were recorded in Grand Anicut Canal.

Among the phytoplankton, Bacillophyaceae, Chlorophyaeae, **Cyanophyceae** were dominant group, while **Fragilariophyceae, Euglenoidea, and Coscinodiscophyceae** were subdominant. **Nostocaceae** and **Ciliates** species were also recorded. Other than Bacillophyaceae, Chlorophyaeae population was represented significantly.

The study reveals the presence of zooplankton with **protozoans** as dominating group. Largest contribution is of zooplankton, the r**otifers and** crustacean are dominant species found in almost all the samples.

The plankton biomass was higher almost all the 20 locations. Benthos, Macrophytes, Macro Invertebrates and Fishes were lower in few locations. The gastropods were more in number than bivalves.

4.4 SOCIO-ECONOMIC ASPECTS

4.4.1 Demographic profile

The study area or the Project Influence Area comprises of about 18 blocks in Thanjavur, Pudukkottai and Thiruvarur District. The total population in the study area villages is of the order of 19,80,960 persons as per Census of India 2011. The distribution of population and demographic profile in the study area villages is outlined in Table –35 and depicted in Figure – 17.

Table 35: Demographic profile in the study area

S. No	Block Name	Total Household	Total Population	Total Male	Total Female	Population < 6 years	Average Family Size	Sex Ratio
1	Thanjavur	56249	230116	114931	115185	21966	4	998
2	Budalur	23052	91552	45519	46033	9409	4	989
3	Orathanadu	40383	160367	77719	82648	15597	4	940
4	Thiruvonam	21163	86953	42685	44268	9141	4	964
5	Ammapettai	24888	100022	49911	50111	9787	4	996
6	Pattukkottai	29419	113231	54227	59004	10994	4	919
7	Madukkur	18484	67113	31414	35699	6393	4	880
8	Peravurani	22786	89164	43813	45351	8613	4	966
9	Sethubhavachatram	23588	91738	44617	47121	9617	4	947
10	Aranthangi	37272	146748	71128	75620	16267	4	941
11	Avudayarkoil	20904	85522	42781	42741	9161	4	1001
12	Gandarvakkottai	20072	86720	43513	43207	9891	4	1007
13	Karambakkudi	21628	95978	47317	48661	11628	4	972
14	Manamelkudi	20208	86552	42901	43651	9741	4	983
15	Thiruvarankulam	35517	148695	73400	75295	15959	4	975
16	Needamangalam	29522	115373	56935	58438	10629	4	974
17	Kottur	28932	107525	53218	54307	9776	4	980
18	Muthupettai	21528	77591	37605	39986	7088	4	940
	Total	**495595**	**1980960**	**973634**	**1007326**	**201657**	**4**	**965**

Source: Primary Census Abstract, 2011

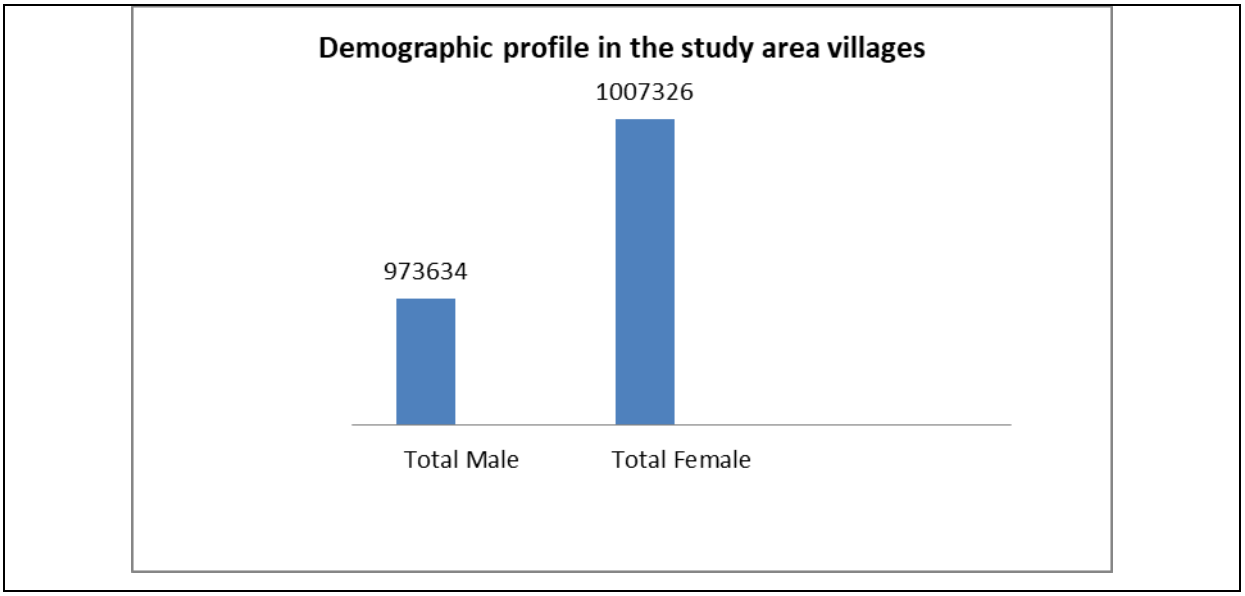


Figure 17: Demographic profile in the study area villages

The male and female population in study area villages comprises about 49.14% and 50.85% respectively of the total population. The population comprising of children below the age of 6 years accounts for about 10.17% of the total population in the study area villages. The sex ratio (no. of females per 1000 males) and average family size in the study area villages is 965 and 4 persons per family respectively.

4.4.2 Caste Profile

The distribution of population in study area villages on the basis of caste is summarized in Table – 36 and Figure – 18. The General Caste is the dominant caste in the study area Schedule Caste accounts 21.75% of the total population.

Schedule Tribe accounts for 0.067 % of the total population in the study area villages.

Table 36: Caste profile in the study area

S. No	Block Name	Total Population	Schedule Caste	Schedule Tribe
1	Thanjavur	2,30,116	52,012	230
2	Budalur	91,552	26,874	43
3	Orathanadu	1,60,367	23,127	55
4	Thiruvonam	86,953	20,434	20
5	Ammapettai	1,00,022	37,148	99
6	Pattukkottai	1,13,231	16,708	94
7	Madukkur	67,113	8,789	25
8	Peravurani	89,164	11,796	179
9	Sethubhavachatram	91,738	9,295	22

S. No	Block Name	Total Population	Schedule Caste	Schedule Tribe
10	Aranthangi	1,46,748	15,647	146
11	Avudayarkoil	85,522	16,502	44
12	Gandarvakkottai	86,720	24,404	10
13	Karambakkudi	95,978	25,859	6
14	Manamelkudi	86,552	11,893	24
15	Thiruvarankulam	1,48,695	22,463	16
16	Needamangalam	1,15,373	31,386	151
17	Kottur	1,07,525	50,118	129
18	Muthupettai	77591	26446	35
	Total	**19,80,960**	**4,30,901**	**1328**

Source: Primary Census Abstract, 2011

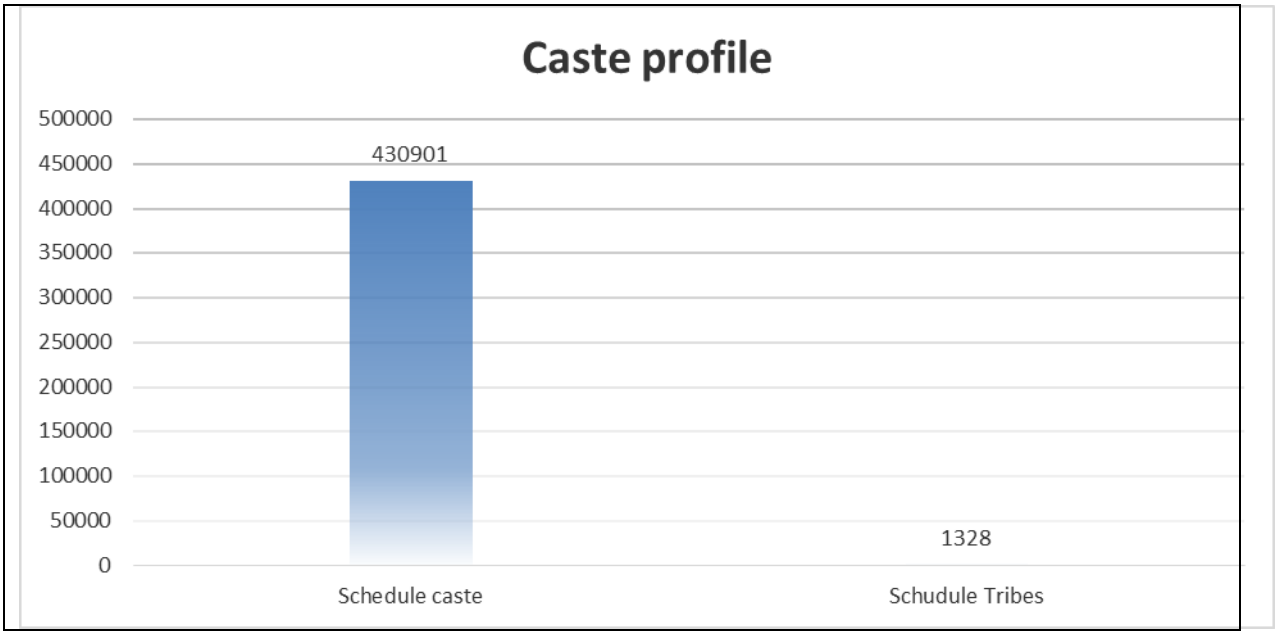


Figure 18: Caste profile in the study area villages

Indigenous Population (IP)

The GACS ERM project covers three districts in Tamil Nadu namely Trichirapalli, Thanjavur and Pudukottai. The major command area of GA canal is in Thanjavur District. According the Census 2011, the project area covers a population of 1980960 persons of which 1328 persons accounting for 0.07 percent are identified as Tribal population.

During the census and reconnaissance surveys and consultations carried out throughout the GA Main Canal there were no groups who had[1] (a) self- identification as members of a distinct indigenous cultural group and recognition of this identity by others; (b) collective attachment to geographically distinct habitats or ancestral territories in the Project area and to the natural resources in these habitats and territories; (c) customary cultural, economic, social or political institutions that are separate from those of the dominant society and culture; and (d) a distinct language, often different from the official language of the country or region. There were no groups identified that had lost collective attachment to geographically distinct habitats or ancestral territories in the Project area because of forced severance.

The tribal population in the project area are primarily engaged as agriculture labourers and are integrated with the main stream population. The tribal population will get positive benefits of the GACS canal along with all the other general population who will get water from this canal.

An exhaustive social impact assessment was undertaken including field visits, focus group discussions, stakeholder's consultations and extensive reconnaissance surveys. There were no affected persons identified in the GA Main Canal Right of Way nor were there any persons identified with indirect negative impacts. The social impact assessment conclusively confirms that the project will not adversely affect the 0.07 % of the tribal population in the project area and will not trigger ESS 3 of AIIBs ESF.

Literacy Levels

The details of literate and illiterate population amongst the total population of study area villages are shown in Table – 37. It is observed that about 70.34% of the total population in the study area villages is literate, while about 29.65% are illiterate (Refer Figure – 19). The literacy rate among male and female population is 53.95% and 46.04% respectively.

Table 37: Distribution of literate and illiterate population in study area

S. No	Block Name	Total Population	Literate Population	Literate Male	Literate Female	Illiterate Population	Illiterate Male	Illiterate Female
1	Thanjavur	230116	176780	93953	82827	53336	20978	32358
2	Budalur	91552	66144	35474	30670	25408	10045	15363

[1] AIIB ESS 2019

S. No	Block Name	Total Population	Literate Population	Literate Male	Literate Female	Illiterate Population	Illiterate Male	Illiterate Female
3	Orathanadu	160367	108813	58984	49829	51554	18735	32819
4	Thiruvonam	86953	57640	31624	26016	29313	11061	18252
5	Ammapettai	100022	69869	38047	31822	30153	11864	18289
6	Pattukkottai	113231	79978	42033	37945	33253	12194	21059
7	Madukkur	67113	46528	23801	22727	20585	7613	12972
8	Peravurani	89164	61461	33706	27755	27703	10107	17596
9	Sethubhavachatram	91738	63646	33987	29659	28092	10630	17462
10	Aranthangi	146748	102810	54886	47924	43938	16242	27696
11	Avudayarkoil	85522	60689	33350	27339	24833	9431	15402
12	Gandarvakkottai	86720	54218	30717	23501	32502	12796	19706
13	Karambakkudi	95978	60681	33805	26876	35297	13512	21785
14	Manamelkudi	86552	63367	34004	29363	23185	8897	14288
15	Thiruvarankulam	148695	104980	57529	47451	43715	15871	27844
16	Needamangalam	115373	81749	44117	37632	33624	12818	20806
17	Kottur	107525	78165	42008	36157	29360	11210	18150
18	Muthupettai	77591	55899	29744	26155	21692	7861	13831
	Total	**1980960**	**1393417**	**751769**	**641648**	**587543**	**221865**	**365678**

Source: Primary Census Abstract, 2011

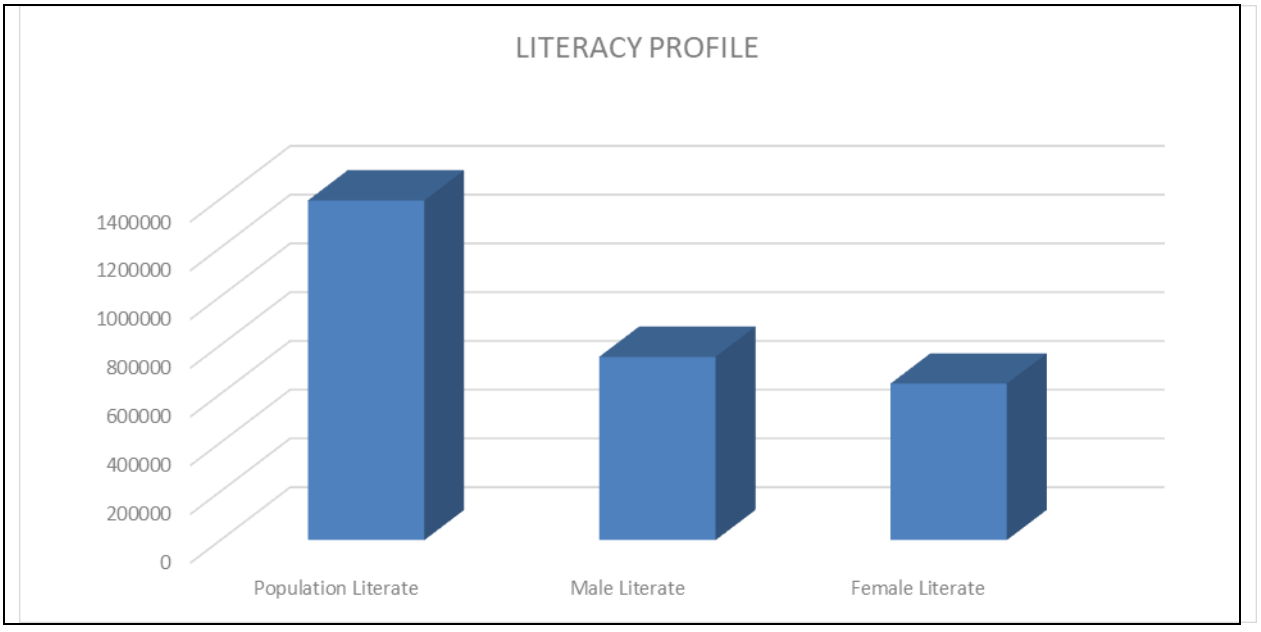


Figure 19: Literacy profile in the study area villages

Occupational profile

The details on occupational profile in the study area villages are given in Table – 38. It is observed that 46.14% of the total population is engaged in some form of economically productive activity or vocational activity, and have been designated as Total Working population. On the other hand, Non-workers or persons who are dependent on the population, which is engaged in economically productive work accounts for about 53.85% of the total population.

Table 38: Occupational profile in the study area

S. No	Block Name	Total Population	Total Working Population	Total Male Workers	Total Female Workers	Main Workers	Marginal Workers	Non-Workers
1	Thanjavur	230116	91349	63507	27842	76900	14449	138767
2	Budalur	91552	39900	26478	13422	30722	9178	51652
3	Orathanadu	160367	76676	46567	30109	64129	12547	83691
4	Thiruvonam	86953	44750	25742	19008	39815	4935	42203
5	Ammapettai	100022	44925	29468	15457	38282	6643	55097
6	Pattukkottai	113231	48658	30611	18047	41569	7089	64573
7	Madukkur	67113	30030	18268	11762	23345	6685	37083
8	Peravurani	89164	41215	25354	15861	32258	8957	47949
9	Sethubhava chatram	91738	40343	26289	14054	35165	5178	51395
10	Aranthangi	146748	70473	42105	28368	59165	11308	76275
11	Avudayar koil	85522	41763	25965	15798	36652	5111	43759
12	Gandarvak kottai	86720	43832	25830	18002	41662	2170	42888
13	Karambak kudi	95978	49797	27182	22615	43113	6684	46181
14	Manamel kudi	86552	37301	25529	11772	30161	7140	49251
15	Thiruvaran kulam	148695	72619	43017	29602	64582	8037	76076
16	Needa mangalam	115373	51612	33895	17717	42422	9190	63761
17	Kottur	107525	52107	31822	20285	34674	17433	55418
18	Muthupettai	77591	36823	22333	14490	22673	14150	40768
	Total	**1980960**	**914173**	**569962**	**344211**	**757289**	**156884**	**1066787**

Source: Primary Census Abstract, 2011

Figure – 20 represents the occupational profile of the study area on the basis of gender. It is observed that total male workers are 62.34% and female workers constitute 37.65% of the total population of the study area.

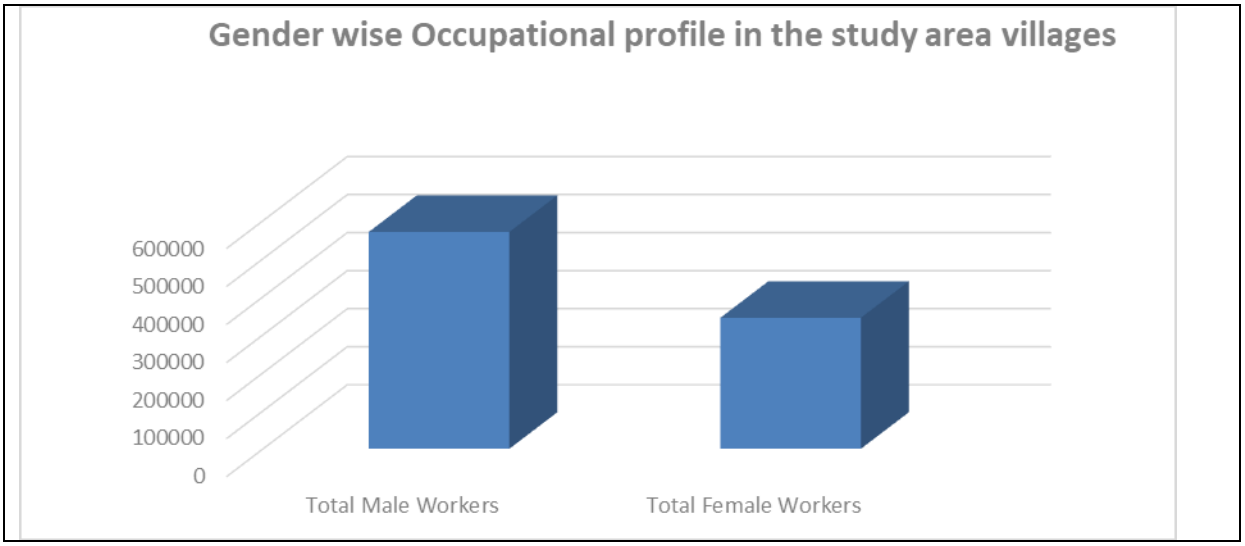


Figure 20: Gender wise Occupational profile in the study area villages

Among the population that is working about 82.83% has been designated as Main workers while the remaining 17.16 % has been designated as Marginal workers. Figure – 21 describes the occupational profile of the study area.

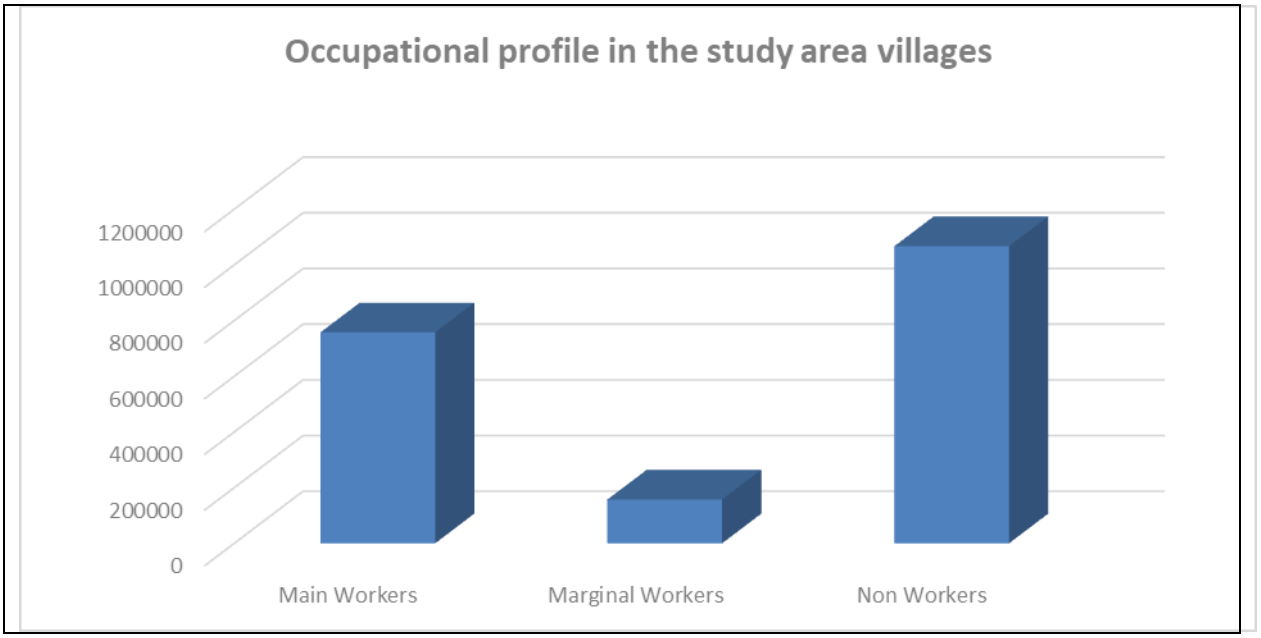


Figure 21: Occupational profile in the study area villages

The land holding details show 309674 ha owned by small, marginal, medium and big farmers. Paddy, millets, pulses and oil seeds are the major crops cultivated. The total area of cultivable land in Mettur taluk is 41252 ha owned by 39163 farmers.

CHAPTER 5: ANALYSIS OF ALTERNATIVES

5.1 ALTERNATIVES AND KEY ASPECTS CONSIDERED

The present project envisages, Extension, Renovation and Modernization (ERM) components of the existing project to optimize the benefits in view of the technical advancement and to rectify the deficiencies experienced in operation and maintenance of the project over the past years. One of the major intervension is lining of Canal and Canal Automation.

5.2 LINING

The main aim of lining with impermeable material is to stop seepage, thereby saving valuable irrigation water.

The lining type was selected based on the following considerations:

- ✓ Economy
- ✓ Durability
- ✓ Maintenance
- ✓ Stability
- ✓ Erosion resistance
- ✓ Impermeability
- ✓ Hydraulic efficiency
- ✓ Local costs
- ✓ Availability of materials; and
- ✓ Availability of local skills

Various types of linings compared:

Cement Concrete Lining

The Cement Concrete lining method is selected for the ERM of Grand Anicut Canal system based on the following parameters.

- As cement, gravel and sand are relatively cheap and locally available, concrete lining was chosen. Although, the initial investment in concrete lining is generally high compared to other types of lining, it could last for many years, which thus offsets the high initial cost.
- Previous experience has shown that this type of lining is very durable. It is capable of reducing the previous losses due to seepage by about 95 percent.
- Cement concrete lining has the longest proved life with least maintenance.

- Possibility of weed growth is very less and hence the flow can be kept smooth, clear and uninterrupted.
- The construction materials are locally available & hence, it is economical

The CC lining shall have least operation and maintenance charges, easy reparability and economical cost. In case of tile brick lining and precast concrete (Paver block linings), maintenance cost is high.

Concrete lining is most resistance to abrasion compared to other linings.

- Contractors are very much experienced in executing this Cement Concrete lining who are locally available and all the necessary equipment are need available.
- Success experience of Cement Concrete lining method for Canal projects (Amaravati Canal and Krishnagiri Reservoir Canal) IAMWARM Project aided by World Bank in Tamil Nadu

Reinforced Concrete Lining

The reinforced concrete lining is selected under extreme conditions, such as high back pressures, high flow velocities in the canal, unstable sub-grade and in reaches where failure would endanger life and property outside the canal.

Shotcrete lining

This lining is rich in cement and hence its cost is high. It is more costly than Cement concrete lining of same thickness. Further, it is suitable mainly for Lining of small sections, placing linings on irregular surfaces, Placing linings around structures.

Precast concrete lining

Precast concrete slabs are not locally available. Large amounts of cement are required for mortar and plastering. Operation and maintenance charged are high.

Cement mortar lining

In this type of lining, it is very essential to have well graded sand. The sand should range from fine to coarse to meet the requirements of durability and appearance. The amount of cement required is more and hence the cost is also more. This type is not durable.

Brick Lining

It has been experienced that the brick lining generally fails due to:

- ✓ Spilling of water
- ✓ Settlement of weak subgrade
- ✓ Pressure of water behind lining

Further, the good qualities of bricks are required for this type of lining and also the construction of this type of lining requires more labour than other type of lining

Plastic Lining

The plastic lining is easy to install. However, plastic linings are easily damaged by vegetation, machines, people or animals. When exposed to strong sunshine over prolonged periods, the plastic may disintegrate.

Weed growth and soil erosion could also continue. Hence, based on the above parameters and on the success experience of other Canal projects (Amaravati canal and Krishnagiri Reservoir canal of IAMWARM project of World Bank funded) implemented in Tamil Nadu, based on fulfilling every objective of lining, functional success, Structural stability, Hydraulic efficiency, durability, Less O&M expenditure, the Cement Concrete lining method is selected for the ERM of Grand Anicut Canal system.

5.3 SCADA

Earlier canal automation was restricted to the scheduling of the water flow through main canals on rotation basis. Now due to technological developments, it is possible to control the end gate, which gave rise to the concept of Service Operational Management (SOM), which aims towards making the water available to the water user as per demand of quantity, flow and time. This could be achieved by introducing SCADA system and automating the operation process.

The farmers, being the end users should be kept informed about the anticipated benefits which is likely to accrue. In the present scenario of automating the existing canal system, the cost of the same cannot be compared with that of a new project as the built-in constraints in the existing project not only limit the degree of automation but also increase the cost by way of remodelling the existing canal systems.

It is necessary to arrive at the time and volume of water needed for a most effective irrigation. This schedule forms a basis for controlling the canal conveyance and delivery system for optimizing the utilization of available water.

The automation of a canal system would help in release of water on a scientific basis and allows for more flexible operation of it.

5.4 ENERGY CONSERVATION

To provide an alternate for the energy requirement of the workers, which in turn discourage from illegal tree felling and removal of fuel wood and timber from the adjoining forests. Further, community kitchen facilities would also be provided to the labourers by the contractors. In addition to above, efforts would be made towards energy conservation by installing non-conventional energy sources such as Use of CFL lights up to maximum possible extent during construction period.

5.5 ALTERNATIVE BY PROJECT SCENARIO

The component wise alternatives of the project and comparsoin of loss / benefits No Project and with Project scenario is studied and discussed in Table - 39

Table 39: Comparison of Loss / Benefits under with and without project scenario

Activity	No Project Scenario	With Project Scenario
A. ERM of Irrigation Infrastructure		
1. Dismantling of old structures and reconstruction	• Loss of irrigation water • Due to difficulties in functioning the gates of regulating structures, leakage of water flows continuously in canals • This results in to a water regime favoring paddy cultivation and poses restriction for crop diversification. • Reduced accessibility on either side of the canals • Sudden Collapse of the structures and Flooding of the downstream areas	• Increased irrigation efficiency • Better management of irrigation supply system • Better regulation and control • Improvement in ground water table due to increased recharge • Increase on irrigated area specially and increase on crop productivity • Improved accessibility on either side of the canals
2. Renovation / Reconstruction of cross drainage works, Regulators and bridges		
3. Bed and side lining	• Carrying capacity will further reduce • Actual irrigated area will reduce year after due to reducing canal carrying capacity of different canals	• Risk of breaching of canal banks will reduce • Cross section of canal will be maintained • Reduce leakage and irrigation water loss • Prevents soil erosion and sediment transportation in downstream area.
4. Restoration of carrying capacity	• Decreased carrying capacity of Canal • Actual area that could be irrigated is less than the CCA.	• Canals will carry their designed discharge. • Increase in recharging ground water and ground

Activity	No Project Scenario	With Project Scenario
	• Likely decrease in CCA year after year. (67500 acres command area has water deficit) • Farmers having land within the CCA will not get required water from Canals. • Increase in Ground Water extraction there by substantial expenditure on irrigation	water status will become better. • Ground water extraction will reduce due to increased availability surface water thereby restoring ground water in depleted areas.
5. Providing screw gearing shutters with hoisting arrangements	• Without gates, water flows through outlets to fields, whether it is required or not • Rotational water distribution will not be practiced	• Better control of available canal water • Ease in managing and distribution of available water for irrigation • Automation in canal operation • Increased irrigation efficiency
6. Formation of Service Road, inspection path, farm road etc.	• Difficult to access the canal at regular intervals and major structures for operation and maintenance • Increased expenditure for repairs due to inadequate maintenance	• Increased Accessibility to the canal at regular intervals and major structures for operation and maintenance • Minimal expenditure for repairs due to adequate maintenance
7. Restoration of System Tanks	• Capacity has been considerably reduced due to which irrigated area is reduced. • Due to Some of the Structures are in dilapidated condition, water for irrigation is unable to be supplied. • Due to Bunds of the tanks are not in standard condition, damages may occur especially during monsoons.	• Improvement in ground water table due to increase in tank storage as well as period of storage • Better management in water regulation and control • Due to standardisation of bunds, damages of the bunds will be prevented
8. Construction of steps / ramps	• Due to dilapilated condition of the steps and ramps, public are unable to access the canal for their daily needs. • Unable to reply to the Public representations for providing steps and ramps at many locations for their needs	• Provisions are now made in the project rehabilitation and reconstruction of steps / rams for easy access to the Public for meeting daily needs. • Provision for additional ramps / steps are now given in the project based on Public representations.

Activity	No Project Scenario	With Project Scenario
B. Irrigation Management		
1. Canal Automation Network including SCADA	• Dependency on man force • High operating expenditure • No prior knowledge on water availability and distribution system • Prior planning is difficult and its execution • Wastage due to human errors and inefficiencies	• Centralized Dissemination of information on water scheduling • Automation in canal operation • Real time analysis of water availability and distribution system • Prior planning and efficient execution mechanism
2. Improving Service Delivery in canal command areas through DSS		
3. Improved Multi-sector Water Convergence Agriculture Practices	• Conventional agriculture Practices • Excess usage of fertilizers	• Adopting various techniques of water conservation and judicial use of water by drip irrigation, and other practices such as crop rotation, conservation tillage, and organic farming • Controlled use of fertilizers and pesticides and improved use of bio fertilizers
4. Capacity Strengthening	• Handling with limited capacity in conventional way	• Improvement in skill and knowledge base • Better management capability.

CHAPTER 6 - SOCIAL IMPACT ASSESSMENT

6.1 TRANSECT AND RAPID CONSULTATION HELD ALONG THE GAC SYSTEM

The ESIA team made several visits to the entire project site covering both Thanjavur and Pudukottai Districts. The list given in Table-40 provides the details of the villages visited by the team, where these villages are located and categories of people the team members met and discussed during the visits. The total number of sites visited is around 48, this includes villages located along the main and branch canals, and villages located close to tanks. The visits also covered the quarries from where the project could buy the required gravels for project restoration works in the future and it is observed that there are no impacts due to the project.

Transects walks and informal conversations were held with the available men and women farmers, other villagers, representatives of the farming communities, field level staff, representatives of village panchayats, farmers and agricultural labourers, agriculture field officers etc. Transects were conducted at several places on both sides of the bunds of the main and branch canals, the areas where the canals side walls are not in good condition, the site where major damages of the side walls occurred previously, the bridges constructed to cross the River, places of aqueducts, the sluices, access points to the canals near the villages, rear sides of the bunds, places over the bunds used for dumping solid wastes, inlet canals of the tanks which supply water from the branch canals of GAC. The site visits helped the team to understand the ground situation. The visits also helped to elicit the opinions of the field level WRD officials who accompanied the ESIA team during the visits. Continuous consultations helped the team to collect the basic details about how the GAC system works and the existing agricultural practices and to cross check the information collected. The different perspectives of the experts in the team helped to get a balanced picture about the GAC system and the different agricultural practices of the region.

The discussion with both men and women farmers helped the team to gain gender related opinions and perspectives related to water management and agriculture.

Table 40: Details of the Villages visited by the team

S. No	Canal	Name of the place	Block	District	Date	People met
Main Canal						
1.	Main Canal	GA Canal Head, Kallanai	Thiruvaiyaru	Thanjavur	13.07.2020	Local farmers
2.	Main Canal	Thogur	Thiruvaiyaru	Thanjavur	13.07.2020	Local farmers
3.	Main Canal	Kiliyur	Valangaman	Thanjavur	13.07.2020	Local farmers
4.	Main Canal	Indalur	Thanjavur	Thanjavur	13.07.2020	Local farmers
5.	Main Canal	Katachamangalam	Budalur	Thanjavur	13.07.2020	Local farmers
6.	Main Canal	Ayyanarpuram	Thanjavur	Thanjavur	13.07.2020	Local farmers
7.	Main Canal	Kalverayanpettai	Thanjavur	Thanjavur	13.07.2020	WUA Members, other farmers villagers
8.	Main Canal	Kuruvadipatti	Thanjavur	Thanjavur	13.07.2020	Local farmers
9.	Main Canal	Maharajasamudhram	Pattukottai	Thanjavur	13.07.2020	Local Farmers
10.	Main Canal	Vettuvakottai	Orathanadu	Thanjavur	14.07.2020	Local Farmers
11.	Main Canal	Pannavayal	Pattukottai	Thanjavur	14.07.2020	Local Farmers
12.	Main Canal	Agniyar	Pattukottai	Thanjavur	14.07.2020	Local Villagers
13.	Main Canal	Nagudi	Aranthangi	Pudukottai	14.07.2020	local farmers
14.	Main Canal	Mumpalai	Manalmelkudi	Pudukottai	14.07.2020	local farmers
15.	Main Canal	Sevvapaneri	Thanjavur	Thanjavur	17.07.2020	Local farmers
16.	Main Canal	Arasarkulam	Aranthangi	Pudukottai	16.09.2020	Local farmers
17.	Main Canal	Vettikadu	Thiruvonam	Thanjavur	05.10.2020	Farmer Association Members and Local Villagers
18.	Main Canal	Nagudi	Aranthangi	Pudukottai	06.10.2020	WUA members, local villagers and farmers
19.	Main Canal	Kalverayanpettai	Thanjavur	Thanjavur	10.10.2020	Women farmers, men farmers and other villagers
Branch Canal						
20.	Branch Canal	Thennamanadu	Orathanadu	Thanjavur	13.07.2020	Local farmers
21.	Branch Canal	Rajamadam	Pattukottai	Thanjavur	16.07.2020	Local farmers

S. No	Canal	Name of the place	Block	District	Date	People met
22.	Branch Canal	Kandithampattu	Thanjavur	Thanjavur	05.10.2020	Local villagers and farmers
23.	Branch Canal	Ottangadu	Pattukottai	Thanjavur	06.10.2020	WUA members and local farmers
24.	Branch Canal	Peravurani	Peravurani	Thanjavur	06.10.2020	WUA members and local farmers
Distributaries						
25.	Distribution Canal	Pudupattinam	Thanjavur	Thanjavur	14.07.2020	Local farmers
26.	Distribution Canal	Thelungankudikadu	Orathanadu	Thanjavur	16.07.2020	Settlement Group
27.	Distribution Canal	Chinnakuvalai (Etti Main Channel)			16.07.2020	Local villagers and farmers
28.	Distribution Canal	Thelungankudikadu	Orathanadu	Thanjavur	05.10.2020	Local villagers and farmers
Tanks						
29.	Tank	Myvayal	Aranthangi	Pudukottai	14.07.2020	Local farmers
30.	Tank	Namarangoor	Aranthangi	Pudukottai	14.07.2020	Local farmers
31.	Tank	Arthampoor	Aranthangi	Pudukottai	14.07.2020	Local farmers
32.	Tank	Edayathimangalam	Manalmelkudi	Pudukottai	14.07.2020	Local farmers
33.	Tank	Mumpalai	Manalmelkudi	Pudukottai	14.07.2020	WUA members and Local villagers
34.	Tank	Chokkaneri	Orathanadu	Thanjavur	16.07.2020	WUA members and Local farmers
35.	Tank	Aambalapattu	Orathanadu	Thanjavur	16.07.2020	WUA Members and Local farmers
36.	Tank	Alathur	Madukkur	Thanjavur	05.10.2020	WUA Members and Local farmers
WRD Vacant Land						
37.	Vacant Land	Maharajasamudhram	Pattukottai	Thanjavur	14.07.2020	Local farmers
38.	Vacant Land	Thiruvonam	Thiruvonam	Thanjavur	14.07.2020	Local villagers and farmers
39.	Vacant Land	Edaiyathi	Peravurani	Thanjavur	14.07.2020	Local farmers
40.	Vacant Land	Neivathali	Aranthangi	Pudukottai	14.07.2020	Local farmers

S. No	Canal	Name of the place	Block	District	Date	People met
41.	Vacant Land	Arasakulam	Aranthangi	Pudukottai	14.07.2020	Local farmers
42.	Vacant Land	Kodivayal	Aranthangi	Pudukottai	14.07.2020	Local farmers
43.	Vacant Land	Nagudi	Aranthangi	Pudukottai	14.07.2020	Local farmers
Quarry						
44.	Quarry	Andakulam	Kunnandarkoil	Pudukottai	15.07.2020	Quarry Labours
45.	Quarry	Sembattur	Pudukottai	Pudukottai	15.07.2020	Quarry Labours and Villagers
46.	Quarry	Uppiliyakudi	Kunnandarkoil	Pudukottai	15.07.2020	Quarry Labours
47.	Quarry	Ammasathiram	Kumbakonam	Thanjavur	15.07.2020	Quarry Labours
48.	Quarry	Manjapettai	Gandarvak kottai	Pudukottai	15.07.2020	Quarry Labours and Villagers

6.2 FOCUS GROUP DISCUSSIONS

Focus Group Discussions (FGD) with the local farmers will help to build a common understanding about the topics discussed and to adopt a coordinated approach subsequently to implement the project related development activities. In the context of the present assessment for the current project, it allows the project team to interact more effectively with the local farmers and leaders of the Water User Associations to increase their understanding and elicit the view points of the local communities for the understanding of the situation and issues – also to find solutions.

FGDs in the project area were conducted by the project team with the support of the field staff of the Water Resources Department, the support was mainly to identify the active and interested farmers who are using the canal and tank water for irrigation, and representatives of the WUAs, and women farmers who could actively participated in the FGDs and expressed their opinions. The officials of the Department schedulded the timing and venue of the meeting which is convenient for the local farmers to reach and participate in the discussion.

FGDs were conducted with the conditions of COVID protocols recommended by the State Government particularly avoid mobilizing more members for any meetings and maintain physical distance while conduct any discussions.

Total 13 FGDs (Figure – 22) were conducted along the main and many branch canals as detailed in Annexure 1. Men and women farmers, WUAs association office bearers were the participants of the FGDs. At the beginning of the FGD the project team members briefed the participants about the project objectives, approach and the purpose of the FGD, expected outputs of the FGD to help them to know about the background of the meeting and actively participate in the discussion (Table – 41). Following this the team sought the views of the

local men and women farmers, generated information through discussion, mobilized opinions, and to arrive consensus among the participants. Furthur the details of Public consultations for ESIA disclosure and Community level stakeholders and public consultaitons conducted during implenettion phase are given in Annexure 15 and Annexure 16 respectively.

Table 41: Details of Focus Group Discussion (FGD)

S. No	Date	Village Name	Taluk /Block	District	Number of Participants
FGD-1	05.09.2020	Kandithampattu	Thanjavur	Thanjavur	16
FGD-2	05.09.2020	Soorakottai	Thiruvonam	Thanjavur	19
FGD-3	05.09.2020	Thelungankudikadu	Orathanadu	Thanjavur	17
FGD-4	05.09.2020	Alathur	Madukkur	Thanjavur	18
FGD-5	06.09.2020	Ottankadu	Pattukottai	Thanjavur	16
FGD-6	06.09.2020	Peravurani	Peravurani	Thanjavur	7
FGD-7	14.07.2020	Enadhikkarambai	Peravurani	Thanjavur	5
FGD-8	14.07.2020	Mumpalai	Manamelkudi	Pudukottai	14
FGD-09	16.07.2020	Thelungankudikadu	Orathanadu	Thanjavur	7
FGD-10	16.07.2020	Ambalapattu Therku	Orathanadu	Thanjavur	8
FGD-11	06.09.2020	Nagudi	Aranthangi	Pudukottai	14
FGD-12	10.09.2020	Kalvirayampettai	Thanjavur	Thanjavur	33

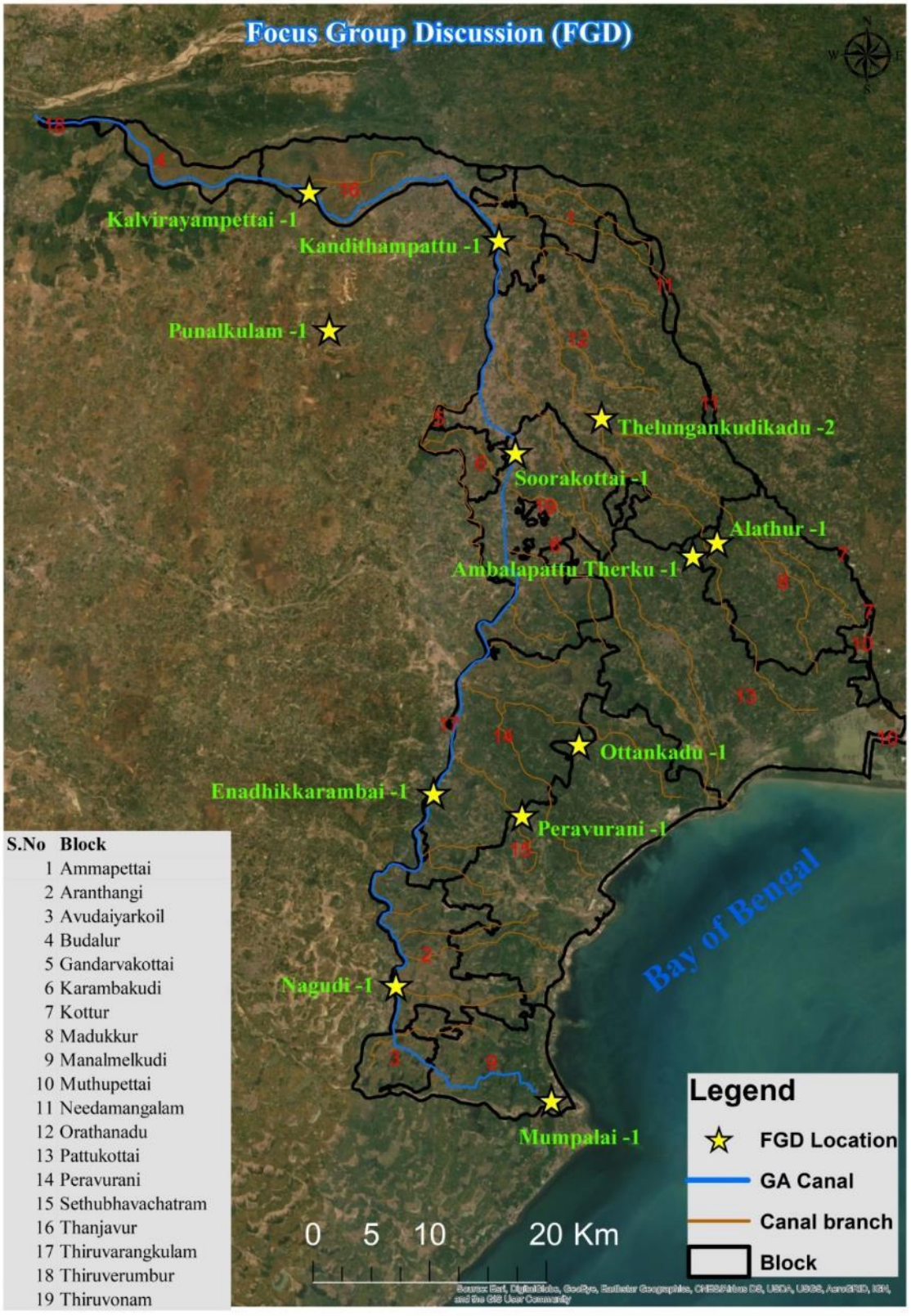


Figure 22 Focus Group Discussion (FGD) Map

6.3 KEY FINDINGS

About farming practices:

- The primary livelihood of the majority of the families in the villages is farming activities and livestock management. Majority of the farmers are small and marginal holders. The non-land-owning families in the villages to support their livelihood depend on agriculture labour and doing other available unskilled and semi-skilled jobs.
- Traditionally farmers cultivate Single Crop season namely Samba (August to January) in Major portion of command area. In some portion of command area, two seasons pattern first season is called *Kuruvai* (June third week to October second week), second season is called *Thaladi* (September first week to January end).
- Farmers cultivate several varieties like: BPT, ADT 32, ADT 39, IR 20,IR 45, CR 1009, CR 37, NLR, QR 51, *Vella Ponni*, *Adhisaya ponni*, and *Maappillai samba*, *Aathur Kichadi Samba* the duration of each variety varies (four months to six months) are grown in the area. For *Kuruvai* mostly farmers cultivate AST 16 and ADT 36 varieties and *Thaladi* the varieties cultivated are BPT and ADT 42.
- Now for the second season due to lack of water availability many farmers shifted to cultivate crops like groundnut, pulse crops like black gram (*ulundu*) red gram (*thuvarai*) and green gram (*paasi*), corn (*makka solam*) and sesame (*Ellu*).
- Very small percentage of farmers cultivate even the third season crop called *Kodai payir* (summer crops), where they have water sources, the crops cultivated are mainly Seasame, Black gram and Chick pea (Kadalai).
- Cash crops like banana and sugar cane are the other plantation crops cultivated by some farmers in a few pockets where water is available throughout the year.
- Coconut is the main tree crop many farmers own in selected pockets, the varieties cultivated are: *Nettai*, *Kuttai*, *Kuttai-Nettai*, Mandia and Malaysian type. Very small number of families cultivates Turmeric as intercrop in the coconut groves.
- Source of irrigation is primarily from the irrigation canal or tanks, certain percentage of farmers also own Bore wells. Bore wells are primarily used to irrigate the second season cash crops and collect water for domestic use. Some of the farmers practice drip and sprinkler irrigation methods for crops like coconut and other tree crops to save water and irrigate more areas.
- Farmers who own land at the tail end area cultivate Groundnut during December (*Maargazhi*) utilising both canal and bore well water; The varieties cultivated predominantly in this region includes Western 44, JL and traditional varieties (*Naatu Vagai*).
- However, farmers are happy when they receive enough water for cultivation and water is released for irrigation on time to start the *Kuruvai* (first season) season.
- Generally the water sharing system – ‘turn – system’ (opening the sluice alternatively each side once in three days) is implemented particularly when the water flow is reduced in the canal.,This is very important for the downstream farmers to get equal benefit, proper

utilization of water and avoid wastage. Also to prevent inter village conflicts among the farmers.

- Farmers use bore wells to support irrigating the fields, when they don't get enough or no water flow in the canal. Bore well is also used for drinking water purpose. The depth of the bore wells varies from place to place. During summer the ground water level goes deep down.
- It was reported certain percentage of farmers in the area have adopted Systems of Rice Intensification (SRI) method of cultivation, which helps the farmers to reduce the inputs consumption, labour days and increase of the yield. Farmers those who are practicing found it useful, according to the SRI practicing farmers more awareness programme will help other farmers to adopt the method and get the benefits.
- About the productivity, it was reported in the discussion generally that the farmers get from average 25 to 30 bags (each bag 60Kg) of paddy per acre.
- Farmers need to dry the paddy after threshing before taking the grains to the procurement centre, the moisture content should be less than 17% when they sell in the market, hence need to dry the grain thoroughly.
- Drying yards is the other need farmers expressed, to quickly dry the paddy after the harvest and sell in the Government procurement centre/regulated market. The existing drying yards in the villages are small, in damaged condition and not in enough numbers hence, farmers drying paddy on roads and other common areas.
- If the water flow in the canal is lesser farmers opt the method of broadcasting instead of making nursery and later transplanting the seedlings in to the field.
- The primary occupation of majority of the women in the villages is farming. Majority of them are from the families of small and marginal holders. To add the family income, they engage in farm labour and other economic activities such as tailoring and small scale livestock management like backyard dairy, goat rearing and poultry.
- In the agricultural fields the tasks women mainly do are removing weeds (K*alai Eduthal*), transplanting (*Naathu Nadavu*) and general assistance for men to carry out all other works.
- In the discussion women told that husband as heads of the household they take all major decisions, women can only suggest to their husbands or share their opinions in the decision making related to farming activities and all other decisions.
- Many of the women farmers in the villages located in the region are members of Self-Help Groups (SHGs) functioning in the villages. A few of the women participants gathered for FGD are the leaders of SHGs functioning in the villages. SHGs support these women farmers through lending loans up to Rs. 40,000/- and interest rate is 2%. Mostly the loans borrowed for Children's education, invest in agricultural support and to meet other family expenses.

Major issues faced by farmers:

- Nearly for the last three decades farmers particularly in tailend areas are experiencing less or no water flow in the canals and facing difficulties in cultivation during monsoon failure., In certain tailend areas farmers have reported nearly for the last ten years they haven't cultivated the crops using canal water.

- Farmers requested to construct bridges across the branch canals at selected points for tractor movement, in the past farmers ploughed the lands with drought animals it was easy to cross the canals, but now tractor ploughing is the only practice, when the tractors crossed the canals at different points without any proper arrangement like bridges often the canal bunds are damaged.
- Pest attack in paddy and coconut is a major issue in which farmers need suitable advice and methods for pest and disease management to avoid yield loss. The common pest and diseases which affect paddy field are Gall midge (anaikomban), Brown plant hopper (pugaiyan), manjuyanai, Root grub (verpoochi), Yellow stem borer (Kuruthupoochi). Rat is another problem which destroys the paddy crop.
- The rough total expense estimated for cultivating paddy for one acre is Rs. 15,000.00. Due to increase in the labour wages as well as hiring charges for the machineries this causes the additional expenditure.
- Labourers prefer other unskilled works and get more than the wage they get from working in the agricultural fields. This is another factor why farmers find difficult to get labour for agriculture.
- Farmers complained about the increasing cost of cultivation and which is one of the main reasons why farming is not profitable now a days. The cost of labour, fertilizer and pest management has increased over the period of time. Most of the farming activities are now mechanized, need to hire farm machineries for land preparation and harvesting and the rate is increasing every year. Availability of the farm machinery on time is also problem to the farmers.
- Farmers reported that they are not aware of many government schemes and subsidies related to agriculture developments meant for them.
- Women farmers feel the credit support they get from the SHGs is a great support to the farming families.
- The women headed families are one of the most vulnerable categories among the participants of the women exclusive FGD, among all participants five women are heading their respective household.
- Many women requested to provide livelihood opportunities such as providing tailoring machines, capital support for buying and managing livestock etc., or any other suitable enterprise to manage and earn additional income.
- Women participated in the FGD requested to renovate the steps/access areas of the GA Canal for bathing and washing of clothes.

GA Canal condition and Management

- Farmers requested that the structures like side walls, bridges, sluices etc., in the main canal and branch canals need to be renovated. Strongly suggested proper lining of bed and side walls.
- Farmers requested to rectify the damages in the bunds, sluices, bridges etc.
- Some villages it was reported that water flow on right side canal is lesser compared to left side canal.

- A common problem reported is that water is not reaching the tail end region and in some places the canals in the tail end area.
- Farmers from various locations requested to construct drops. Drops help for proper flow and utilization of canal water.
- In the branch canal 8/10 - water flow is affected due to the elevated floor made, this need to be rectified.
- Canal is linked with tanks for supply and storage, one such tank is Pudu eri – a tank which was recently renovated with the support from Chief Minister fund, now the tank is receiving sufficient water from GA distribution canal. Water is now being stored even upto the month of May.
- Some places the gravel road on the Left bund is not in good condition, farmers find it difficult to walk or ride vehicles, and requested the Government to improve the condition of the road.
- FGD participants and farmers in the region requested the government to, restore the ponds and tanks in the area for large quantity of water storage as part of the project.
- Ipomea Cornea (Neyveli Kaatamanaku) an invasive weed with other species of weeds has been occupying in some of the distribution channels and bunds, which needs to be removed for easy flow of the water.
- The local farmers approach the luscar or the field engineers, for issues like sharing of waterwhen the water flow in the canal is reduced, bund leakage, damage of structures etc.

Farmer's participation in canal/tank management:

- As per the existing system of canal management farmers are just users, WRD manages the canals and water sharing system, if the local farmers need any support or any complaint, they approach the WRD officials. In some of the villages there are no Water User Assocaitions functioning at Canal level.
- In a few villages, farmers using the tank water have formed WUA for eg. in the village Alathur a WUA was formed and called Alathur Pudueriyinai Payanpaduthuvor Sangam. Around 1000 farmers have joined as members, but only 15 are women members. The association was formed during year 2018. The association members meet regularly and discuss about water sharing and management. The association works with WRD for water management. During the discussion, it was informed that the members of WUA are responsible for the Operation and Maintenance (O&M) of water supply to the entire command area, this helps to avoid any misuse of water in the middle of supply channel.
- In general membership of female farmers in WUAs is very limited, and no one is occupying the office bearers' position/responsibility. But while discussing about the issue the male farmers responded positive and told that they will make more women farmers as members and leaders of WUAs in the future.
- One FGD was conducted exclusively for women farmers. The women formers informed that they are not aware of Water User's Association (WUA's), its objectives and functions. They also showed their willingness to be involved in the formation and functioning of the WUAs.

6.4 GENDER SAFEGUARDS

Gender safeguards foster and strengthen potentials for gender equity and women empowerment. The project will avoid negative impacts on women farmers, minimize and mitigate negative impacts on women. To achieve this, it is important to ensure inclusive and effective women participation including the most vulnerable women like women headed households, women from small and marginal households, women from socially and economically under privileged sections. A separate Gender Action Plan has been prepapred for the Project, given in Annexure 17.

The project has ensured and will continue to ensure meaningful participation of women from different groups in the discussions and consultations. The gender specific concerns expressed during the consultations are as follows:

1. At present the women mainly work in the agricultural fields removing weeds (K*alai Eduthal*), transplanting (*Naathu Nadavu*), cleaning and drying the grains in the drying yard apart from these tasks they also provide general assistance to men to carry out other works.
2. Women informed that they are not owners of the agricultural land, traditionally men are the land owners, this deprives some of them benefits like taking loan, getting govt schemes etc.
3. The women said that the husband as head of the household are the decision makers women can only suggest to their husbands or share their opinions to make the decisions.
4. The women headed families is one of the most vulnerable categories according to the participants in the FGDs they should be given priority if there is any employment opportunity in the project.
5. Trees that are hindrance to the proposed work will be removed. To compensate, saplings will be planted in the ratio of 1:10 as per the tree plantation plan. It is important to include women in the consultation for species selection and also take the support of women members in the post care management of the plants.
6. Women farmers should aware of the project components before the public hearing is organized and it will help them to actively participate in the public hearing.
7. The women workers involved in the project implementation activities are the most vulnerable groups. Therefore safe and healthy working conditions to avoid the risk of accidents and injuries.
8. Provide information about labour rights of women and other vulnerable groups.
9. Involve women representation in Grievance Redress Mechanism (GRM) and formulate certain specific guidelines to support women victims.
10. Consider women's inputs to provide a better access point in the canal near the settlements for domestic use.
11. Involve the most vulnerable groups in the area includes farmers, farm labourers, aged farmers, physically challenged farmers, women headed households etc., and create a conducive environment for them to participate and play role in the decision making process.

6.5 RoW OF THE MAIN CANAL SYSTEM

The GA canal survey was carried out all along the length within the RoW of the canal to identify non-title holders (encroachers and squatters) for their temporary loss of livelihood due to project activities and impact on residential structures.

Based on the survey it is observed that the project does not involve any loss on residential structures due to project activities and no encroachers and squatters etc. are observed and no additional land acquisition is required for the purpose of implementation of the project. The project will be executed within the RoW and the land that belongs to WRD. A tentative RoW cross section at L.S. 30.430 km and L.S.30.790 are shown in Figure 23. The package wise details of entire RoW along the canal are given in Annexure 20.

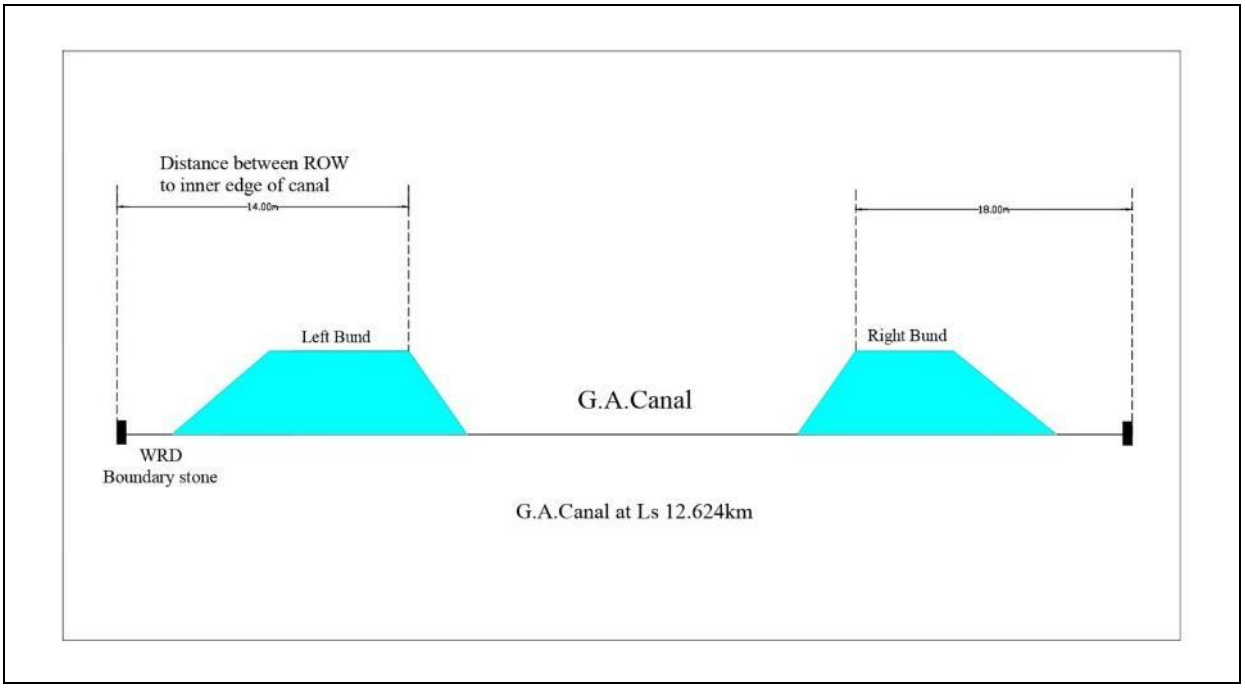


Figure 23: GA Canal section with RoW at L.S. 12.624 kms

6.6 IMPACT IDENTIFICATION & MITIGATION MEASURES

The general impacts have been assessed from field visit observations, transect walks and FGDs conducted. The possible positive and negative impacts, short term and long term impacts at various stages of the project such during, before and after construction of the canal have also been assessed and feasible and cost effective mitigation measures are suggested in Table 42.

6.7 WUA-Water Users Association:

WUAs are groups of farmers along a canal that select a leadership and a set of rules to manage water deliveries and also provide sufficient support in water regulation, operation and maintenance of water resources to the WRD.

The importance of water user association:

Water User Associations (WUAs) are user-based and participatory ways to manage water resources. The objectives of WUAs are to improve water delivery, increase crop production and provide the farmers with the chance to be involved in the process of irrigation management.

Functions of Water Users Associations:

1. WUAs shall assist the WRD in making assessment of demand as well as release of water for irrigation at field level.

2. To support the WRD in undertaking O&M works of the system covering the following activities at field level.
    a. Maintaining field level channel
    b. Jungle clearance in the system
    c. Minor repairs for the embankment of the distributary channel
    d. Cleaning and oiling of screw gears and gate groves at field levels
    e. Emergency breach closing works
3. Support to WRD in the Improvement and Management Plan to carry out restoration and revival of the system at field level.
4. Actively participate the implementation of works at field level.
5. Organize WUAs members meeting to discuss about distribution of water among all the users equitably.
6. Create an awareness on economic use of water and promote efficient water usage technologies & practices among the canal users.
7. Assisting WRD in prepareing water use and agricultural plans for each irrigation season at field level.
8. Arbitrate and resolve any disputes, if any over distribution of water among the users.

9. Protection of canal and tanks in the system from encroachment.

10. Every farmers' organization shall extend such co-operation or assistance, as may be required by the competent authority, for carrying out O&M activities as well as in water distribution at field level.

Current status of WUAs in the Project Area

There are more than 500 Villages in the GA Canal System Area. WUAs were formed in some of the villages and are functioning well. However, WUAs are yet to be formed in the remaining Villages.

The Budgetary provision for formation of WUAs and Capacity building is provided in the ESMP which shall be imeplemneted as per govnerment decision.

Table 42: Activities and potential impacts and suggested mitigation measures

Activity	Potential Impact	Suggested mitigation measures
Restoration of canal bed, side walls and canal buds		
1. Complete concrete flooring will not help for water recharging and improvement of water table in the area. It will affect the water availability in the summer months, which is important to supply water particularly for the cattle population	No negative impact	Flooring will be made with intermittent gaps and these gaps will allow water to recharge and improvement of water table in the area. Also perforated pipes are laid below the bed at random to percolate water for recharging.
2. Dumping of C&D materials in the fields	No negative impact	Land utilised is owned by WRD. Arrangements will be made to immediately remove the C&D materials.
3. In the past the farmers ploughed the lands with drought animals it was easy to cross the branch canals, but now tractor ploughing is the only practice, when the tractors crossed the branch canals the canal bunds are damaged	Negative impact	Construct bridges across the branch canals at selected points for tractor movement
Livelihood – Agriculture	Positive: Restoring of canals and other infrastructures will help the farmers for improved irrigation system, crop productivity and enhanced income	-

Activity	Potential Impact	Suggested mitigation measures
Crop damage/loss due to interruption of water for irrigation	No negative impact	The project work will be carried out only during the canal closure period i.e., from February to May. However, WRD and the contractor will prepare a work plan during the project period for the restoration of each canal and intimate the farmers in advance to plan for the cropping season. Farmers will be adequately informed in advance. Arrangements will be made to inform the farmers' thorough notice boards at Panchayat and block offices.
Employment opportunities	Positive: Community members (both skilled and unskilled labour) will get labour opportunities during the restoration works	-
Felling of trees located on the bunds	No negative impact	Compensatory plantation in the ratio of 1:10 will be done as per the tree plantation plan.
Public health system	Minimal impact	Provision of onsite health care, health camps, Awareness programs etc., will be conducted regularly.
Communication and electric system	No negative impact	-
Disruption or demolition of social infrastructures – public facilities / utilities	No negative impact	No Disruption or demolition of social infrastructures public facilities is envisaged in the project.

Based on the outcome of SIA, it is ascertained that the project involves no acquisition of lands, loss of crops which includes tree crops in the private lands or eviction of any house

sites or temporay structures. Instead, the project will improve the irrigation system and help large number of farmers to irrigate more areas of land and enhance their income. The project doesn't trigger ESS-3 and there are no IP impacts identified. Since ESS-3 is not triggered and there are no adverse involuntary impacts identified, the findings of SIA has been included in this ESIA and a separate resettlement plan has not been prepared.

The proposed ERM works of GACS will not involve any land acquisition. The existing WRD land shall be utilized during construction phase for siting of construction equipment's, storage area and labour camps. Shifting of social infrastructure such as community / religious structure(s) and electrical utilities may be necessitated during the execution of ERM works. However, anticipating the issues related to land acquisition and livelihood impact during the execution of the project and Resettlement Planning Framework (RPF) has been prepared as a standalone document which shall be utilized for mitigating potential impacts of the project.

The RPF and the ESIA will be disclosed on the official website of AIIB and WRD websites after approval.

CHAPTER 7: POTENTIAL ENVIRONMENTAL AND SOCIAL IMPACTS AND MITIGATION

7.1 GENERAL

The ESIA is a process to forecast the future environmental and social conditions in the project area that might occur due to the implementation of the project activities. Based on the project details and the baseline environmental and social status, potential impacts as a result of the activities for the ERM works of GACS have been identified and suitable mitigation measures have been suggested.

7.2 APPROACH AND METHODOLOGY

The basic approach envisaged for conducting the ESIA study for the proposed project is essentially a process to forecast the future environmental conditions of the project area that might be expected to occur considering the existing environmental scenario in and around the project area, components and the proposed activities of the project having significant environmental impacts and analysis of the project proposals with respect to prevailing institutional and legislative framework of the Government of India (GoI), Government of Tamil Nadu (GoTN) and AIIB ESP and ESSs.

The main approach for the process includes the following:

- Identification and analysis of positive and negative impacts, direct and indirect impacts, and short-term and long-term impacts likely to result from project intervention;
- Identification and analysis of positive and negative impacts through Focus Group Discussion and Public Consultatations
- Identifying the possibilities towards the opportunities for environmental enhancement;
- Identification of feasible and cost-effective mitigation measures to minimize negative impacts and enhance positive impacts by incorporating in the engineering design.
- Preparation of Environmental and Social Management Plan for effective implementation of environmental and social mitigation measures at different stages of the project.

7.2.1 Criteria for determining degree of importance of Impacts

Many social and environment components cannot be reliably quantified due to inherent association of complex inter-relationships. Most impacts have been predicted qualitatively justifying its relevance for the project aspects. The significance of impacts based on the degree of importance are as follows:

- Area of Impact
- Duration

- Intensity and
- Reversibility factors

7.2.2 Environmental Screening

The screening process are carried out to delineate the potential environmental and social impacts due to the project activities and defining the scope for further assessment depending upon its significance and extent of the impacts. The screening of impacts for the ESIA study is considered for pre-construction, construction & operation phases. The steps followed for screening are detailed below.

7.2.3 Categorization of Projects

The categorization of projects is essential in identifying the environmental and social consequences with regards to the following which ultimately necessitates feasible approach for deciding suitable mitigation measures or long-term management measures:

- Severity
- Significance
- Duration

Table 43: Categorization Criteria as per AIIB ESF 2019

S. No.	Categories	Criteria
1	Category-A	Project which has significant adverse environmental & social impacts that are irreversible, cumulative, diverse or unprecedented, impacts may affect an area larger than the sites or facilities subject to physical works and may be temporary or permanent in nature. Requires preparation of an environmental and social management plan (ESMP) or environmental and social management planning framework (ESMPF) which is included in the ESIA report for the Project.
2	Category-B	Project which has: (i) it has a limited number of potentially adverse environmental and social impacts; (ii) the impacts are not unprecedented; (iii) few if any of them are irreversible or cumulative; (iv) they are limited to the Project area; and (v) they can be successfully managed using good practice in an operational setting. Requires to onduct an initial review of the environmental and social risks and impacts of the Project. On the basis of this review, determine the appropriate instrument to assess the Project's environmental and social risks and impacts, on a case-by-case basis. The Bank may determine that an ESIA or another similar instrument is appropriate for the Project. Commonly used instruments for Category-B include an ESMP or an ESMPF.
3	Category-C	Project which has 'minimal' or 'no' adverse environmental & social impacts.

S. No.	Categories	Criteria
		Does not require an environmental and social assessment, but does require to prepare an analysis of the environmental and social aspects of the Project.
4	Category FI	Project where the financing structure involves the provision of funds to or through a financial intermediary (FI) for the Project, whereby the Bank delegates to the FI the decision-making on the use of the Bank funds, including the selection, assessment, approval and monitoring of Bank supported activities, based on a sound environmental and social management system (ESMS) adopted by the FI.

The ERM GACS project falls under Category-B which has a limited number of potentially adverse environmental and social impacts. Thus, it requires conducting an Environmental and Social Impact Assessment (ESIA) including preparation of an Environmental and Social Management Plan (ESMP) in accordance with the AIIB's Environmental and Social Policy (ESP), under the Environmental and Social Framework (ESF, 2019)

7.2.4 Screening of Environmental and Social Impacts

The objective of environmental and social screening is to identify all potential environmental and social impacts and critically examine to identify the major impacts which are beneficial as well as adverse and the same shall be analyzed in detail. Based on the existing environmental settings of the project area and the proposed project activities, a scientific evaluation on various impacts that are likely to influence the environment is presented in this chapter. To minimize or enhance the identified environmental and social impacts, suitable mitigation measures have been suggested in the Environment and Social Management Plan (ESMP).

Due to the proposed project activities, the likely impacts and its extent on various environmental and social parameters have been studied by assessing the baseline environmental status of the area and estimations were made as how this will change with commencement of project activity. The potential environmental impacts due to the project have been studied for different phases of the project, i.e., pre-construction phase, construction phase and operation phase.

In the evaluation process, the severities of impacts is assigned to each project activities on a cogent basis and are classified as C.1, C.2 & C.3 as given in the table 44 based on high, moderate and low / negligible impacts respectively.

The proposed ERM works of GACS will not involve any land acquisition. The existing WRD land shall be utilized during construction phase for siting of construction equipment's, storage area and labour camps. Shifting of social infrastructure such as community / religious structure(s) and electrical utilities may be necessitated during the execution of ERM

works. Based on the anticipated impacts due to the above mentioned activities, the impacts can be classified as C.2.

Remaining activities, based on the assessed impacts are classified as 'C.3' category which is common attributes during the operation phase of the project.

The screening of environmental and social impacts and its impact areas is given in Table 44 and 45 respectively.

Table 44: Screening of Environmental and Social Impacts

S. No	Activities	Purpose	Anticipated Impacts	Impact Cat.	Remarks / Significance
	Pre-Construction Phase				
1.	Felling of trees	Required for ERM activities such as embankment strengthening, renovation / reconstruction, storage area, side lining, service road etc.	• hange in landscape	Negative (C.1)	• Felling of 23,183 trees outside forest area. WRD – 14,015 trees Forests* – 9,168 trees *These are planted on WRD land as part of social forestry initiatives by Forest Dept., GoTN • Impact would be direct, long term and irreversible in nature; • Compliance to Management

S. No	Activities	Purpose	Anticipated Impacts	Impact Cat.	Remarks / Significance
					Plan
2	Demolition / shifting of social infrastructure such as electrical utilities	Required for ERM activities such as embankment strengthening, storage area, side lining, service road	Impact on religious aspects and public utilities	Negative (C.2)	• Direct, short term impact • Medium severity • Reversible impacts • Compliance to Management Plan
	Construction Phase				
3	Establishment of Labour Camps	Housing of labours for construction works	• Loss of trees for fuelwood; • Hygiene and health of labours • Waste disposal	Negative (C.2)	• Direct, short term impact • Low severity • Reversible impacts
4	Operation of Heavy Machinery	Levelling of canal bed and compaction of embankment	• Air and Noise pollution • Oil Spillage	Negative (C.2)	• Direct and short-term impact • Low severity • Implementation of mitigation measures
5	Vehicular Movement	Transport of Construction materials and Haulage of heavy machinery	• Increased Traffic	Negative (C.2)	• Direct and short-term impact • Low to

S. No	Activities	Purpose	Anticipated Impacts	Impact Cat.	Remarks / Significance
			• Air and Noise pollution, • Exposure of local habitations		Medium severity • Implementation of mitigation measures
6	Material Handling and Storage	Stacking of different construction materials; Storage of C&D materials; Sheds for equipment & construction materials	• Water and Soil Pollution • Exposure of workers	Negative (C.2)	• Direct and short-term impact • Low severity • Implementation of mitigation measures
7	Operation of Batching Plants and Hot Mix plant	Concrete mix for construction works i.e., side and bed lining, reconstruction works etc. Bitumen topping of roads	Air, Noise and Soil Pollution	Negative (C.1)	• Direct and short-term impact • Low severity • Implementation of mitigation measures
8	Generation of Construction and Demolition (C&D) Waste	Demolition of existing structures Renovation / Reconstruction of cross drainage works and bridges Construction of Regulator across Canal Lining of Canals Compaction of embankments	• Landscape degradation • Air and Water Pollution	Negative (C.3)	• Direct and short-term impact • Low severity • Implementation of mitigation

S. No	Activities	Purpose	Anticipated Impacts	Impact Cat.	Remarks / Significance
					measures
Operation Phase					
9	Use of agro chemicals	To boost crop yields	Reduces soil fertility, Pest Resistance towards insecticides, creating Health and Environmental Risks	Negative (C.2)	• Long term impact • Moderate severity • Implementation of Integrated Pest Management Plan • Organic Farming
10	Trapped Silt	To prevent silt being carried to the downstream and tailend portion of the canal	Risks to environment and human health if the silt is contaminated and not properly stored or disposed	Negative (C.2)	• Long term impact • Moderate severity • Implementation of silt management plan.

Table 45: Impact Areas of Project

Pollution Aspects	Biological Aspects	Social Aspects
• Air Pollution due to construction activities • Noise Pollution due to construction equipments • Water Pollution due to construction activities in canals and tanks • Soil pollution due to sediment transport in canals from material storage site and construction equipments • Air and water pollution from C&D wastes • Pollution from labour camps	• Loss of Green Cover due to felling of trees • Changes in land use pattern • Landscape degradation & soil erosion	• Temporary labour camps • Shifting of social infrastructure such as electrical utilities • Gender inclusion and equity issues • Livelihood, local economy & employment • Occupational Health and Safety • Exposure Risks • Spread of communicable diseases.

7.3 ENVIRONMENTAL AND SOCIAL EXCLUSION LIST

The project will not support following activities which may have severe, irreversible, long-term, adverse environmental impacts in accordance with the AIIB's Environmental and Social Exclusion List of ESF, 2019 which are given below:

- Forced labor or harmful or exploitative forms of child labor.
- The production of, or trade in, any product or activity deemed illegal under national laws or regulations of the country in which the Project is located, or international conventions and agreements, or subject to international phase out or bans like PCBs, pharmaceuticals, pesticides / herbicides *(Rotterdam and Stockholm Convention)*, Ozone Depleting substances *(Montreal Protocol)*.
- Trade in wildlife or production of, or trade in, wildlife products regulated under the *Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES).*
- Trans-boundary movements of waste prohibited under *Basel Convention.*
- Production of, or trade in, weapons and munitions, including paramilitary materials.
- Production of, or trade in, alcoholic beverages, excluding beer and wine.
- Production of, or trade in, tobacco.

- Gambling, casinos and equivalent enterprises.
- Production of, trade in, or use of unbonded asbestos fibers.
- Activities prohibited by legislation of the country in which the Project is located or by international conventions relating to the protection of biodiversity resources or cultural resources, such as, *Bonn Convention, Ramsar Convention, World Heritage Convention and Convention on Biological Diversity*.
- Commercial logging operations or the purchase of logging equipment for use in primary tropical moist forests or old-growth forests.
- Production or trade in wood or other forestry products other than from sustainably managed forests.
- Marine and coastal fishing practices, such as large-scale pelagic drift net fishing and fine mesh net fishing, harmful to vulnerable and protected species in large numbers and damaging to marine biodiversity and habitats.
- Shipment of oil or other hazardous substances in tankers that do not comply with IMO requirements *(IMO, MARPOL, SOLAS and Paris MOU)*.
- Thermal coal mining, coal-fired power and heating plants or Projects that are Functionally related to coal.

7.4 IMPACTS AND MITIGATIONS

7.4.1 Impacts during Pre-Construction Phase:

7.4.1.1 Impacts due to Felling of Trees

The baseline survey has identified 23,183 nos. of trees of various species like neem, mango, tamarind, teak etc. of different girth sizes and age on both the canal banks. About 9168 nos. of trees are those over which the WRD has responsibility and about 14,015 nos. of trees are those over which the Forests Department has responsibility respectively. These trees are manmade plantations and are planted on WRD land. These trees are to be felled for embankment strengthening, renovation / reconstruction, storage area, side lining, service road etc. as part of ERM works of GACS. Tree felling is not anticipated for any other activities like canal bed levelleing. This anticipated impact would be long term and irreversible. The significant impacts associated with loss of vegetation are landscape degradation and change in micro-climatic conditions. The baseline study indicates that there is no threatened species of trees found in the project area. The nos. of trees to be felled in the various project packages are given in Table 46.

Table 46: Package wise no. of Trees to be felled

Package	Trees under WRD				Trees under Forests Dept.				Grand Total
	Girth (≥ 0 ≤ 50 cm)	Girth (≥ 50 ≤ 80 cm)	Girth (> 80 cm)	Total	Girth (≥ 0 ≤ 50 cm)	Girth (≥ 50 ≤ 80 cm)	Girth (> 80 cm)	Total	
1	2	43	128	173	23	101	30	154	327
2	0	1	4	5	25	123	47	195	200
3	2	14	31	47	150	333	63	546	593
4	0	12	196	208	553	24	15	592	800
5	20	86	92	198	30	39	33	102	300
6	133	168	58	359	89	58	93	240	599
7	338	744	458	1540	96	230	94	420	1,960
8	16	125	56	197	2793	1586	217	4,596	4,793
9	100	960	420	1480	390	229	101	720	2,200
10	191	580	59	830	130	357	53	540	1,370
11	407	495	312	1214	0	0	0	0	1,214
12	1187	1012	780	2979	0	0	0	0	2,979
13	750	1285	843	2878	0	0	0	0	2,878
14	398	273	191	862	214	487	232	933	1,795
15	286	467	292	1045	65	51	14	130	1,175
Total				***14015***				***9,168***	***23,183***

(Source: WRD (2020))

Mitigation Measures:

1. Permission of tree felling for the trees over which the Forests Department has responsibility, will be obtained by WRD from the Forest Department before start of the construction works;
2. All precautions shall be made to conserve trees by restricting tree felling within the construction sites and storage areas.
3. Priority shall be given for protecting large trees with higher canopy size and locally important trees that are having cultural importance to the local community during construction activity wherever possible.
4. Compensatory plantation will be carried out by WRD in the ratio of 1:10 in and around the project area or based on the availability of land in consultation with the Forests Department. Compensatory tree plantation plan is attached as Annexure 4.
5. Other than compensatory afforestation, plantation along canal banks, plantation around material storage and C&D disposal sites etc. are to be taken up.
6. Mixed plantation with locally grown species will be promoted in consultation with Forest Department and local bodies.

7.4.1.2 Impact due to borrow pits

Borrow areas will have impacts on local topography, landscaping and natural drainage. However, wherever borrow sites are required the following measures are to be followed to mitigate impacts due to borrow pits.

Mitigation Measures:

1. Use only approved quarry and borrow sites as per the TNPCB / Department of Mining and Geology, WRD norms
2. Identify new borrow and quarry areas in consultation with Project Director, if required.
3. Reuse excavated or disposed material available in the project to the maximum extent possible.
4. Store top soil for reinstatement and landscaping.
5. Develop surface water collection and drainage systems, anti-erosion measures (berms, re-vegetation etc.) and retaining walls and gabions where required.
6. Control dust and air quality deterioration by application of watering and implementing mitigation measures proposed under Ambient Air Quality
7. The use of explosive should be used in as much minimum quantity as possible to reduce noise, vibration and dust.

7.4.1.3 Impact on Utilities & Structures

The baseline study has revealed that utility services such as, electrical utilities i.e., electric poles and transformers are located along the canal banks. These utilities will need to be relocated from their present position due to the proposed activities as part of ERM works, which are inevitable. The no. of utilities / structures to be relocated are given in Table 47:

Table 47: Utilities / Facilities to be impacted due to ERM works

S.No.	Utilities / Structures	Nos.
1	Transformers	344
2	Electric Poles	11,175

Mitigation Measures:

1. Shifting and relocating utilities like transformers and electric poles to a safe place before the commencement of the construction works. Concerned line department will be consulted prior to the commencement of work and the project proponent will bear all the costs involved in shifting / relocating these utilities
2. The scheduling of the construction works will be shared with the concerned line departments for ensuring uninterrupted services during construction

7.4.2 Impacts during Construction Phase

Most of the anticipated adverse environmental impacts related to construction works are inevitable, however are manageable through environment friendly good practices. The

negative environmental impacts can be mitigated at an early stage through proper engineering design and implementing the EMP during construction phase.

The ERM works will involve construction activities like site clearance, lining, renovation / reconstruction works, concreting, laying of bituminous mixtures, dumping of C&D materials, transportation of materials from quarry site to construction site, and other construction activities and associated works like setting up of different batching plants, setting up of labour camps, material storage etc. These activities have certain impacts of various magnitudes on different components of environment. The location of construction material storage sites, labour camps etc. will be determined during tendering stage considering various environmental and social factors. The anticipated impacts due to the various construction activities have been discussed below:

7.4.2.1 Impact on Land Resources

The dismantling of various structures will lead to generation of enormous quantum of C&D waste All the C&D waste will be reused to the extent possible to minimize the disposable quantity and balance will be stored in the identified storage sites. It shall be disposed-off in a scientific manner as discussed in the C&D disposal and Silt management plan enclosed as Annexure 2.

The quantity of C&D waste to be generated in the project is estimated to be 1,09,408 cu.m. and no silt is envisaged in the project. As per the disposal plan, C&D waste will be stored in the vacant land of WRD.

Mitigation Measures:

1. Prepare and submit desilting plan including disposal plan with action timeline and risk management plan prior to carrying out desilting operations if desilting needs are envisaged.
2. Sediment trapping system like silt arrestors shall be adopted to arrest sediment release downstream.
3. No stacking of construction material on canal bed or agricultural fields during monsoon period.
4. Considering average disposal height of 1.5 m, a total of 73 ha of land is earmarked for C&D and Silt disposal from the silt traps if deposited.

7.4.2.2 Impact on Top Soil

The site clearance process will involve excavation and vegetation clearance which shall lead to loss of top soil. Since vegetation clearance shall be confined to the minimum area required for construction works such as, reconstruction of structures, the impacts would be limited to the identified sites where the proposed activities shall take place. The activities associated with the site preparation and excavation with movement of vehicles will disturb the surrounding areas. There is possibility of loss to top soil due to various activities taking place in the material sites, storage areas, workshops, and other ancillary sites.

Mitigation Measures:

1. The top soil will be stored separately and will be reused for landscaping, grass turfing and site restoration works based on the condition of the soil.
2. The top soil will be stripped to a specified depth of 6-8 inches and stored in stockpiles of height not exceeding 2 - 4 m and should be stored away from waterways. The heap of the top soil will be covered with tarpaulin cover to minimize air pollution
3. The stored topsoil will be spread in order to maintain the physio-chemical and biological activity of the soil and will be used for restoration of sites in landscaping and plantation as per compensatory plantation plan.
4. The stored top soil should be used as soon as possible to prevent loss of quality and quantity

7.4.2.3 Top Soil management

The Contractor shall

1. Strip the top soil to a depth of 15 cm and store in stock piles of height not exceeding 2 m.
2. Remove unwanted materials from top soil like grass, roots of trees and similar others.
3. The stockpiles will be done in slopes of 2:1 to reduce surface runoff and enhance percolation through the mass of stored soil.
4. Locate topsoil stockpiles in areas outside drainage lines and protect from erosion.
5. Construct diversion channels and silt fences around the topsoil stockpiles to prevent erosion and loss of topsoil.
6. Spread the topsoil to maintain the physico-chemical and biological activity of the soil. The stored top soil will be utilized for covering all disturbed area and along the proposed plantation sites.
7. Prior to the re-spreading of topsoil, the ground surface will be ripped to assist the bunding of the soil layers, water penetration and re-vegetation.

7.4.2.4 Soil Erosion

The problem of soil erosion may arise due to restoration of carrying capacity of canals which may lead to soil and sediment transportation downstream, if the same is not removed after completion of work. The levelled area may face the problem of sediment deposition due to erosion, which may aggravate the soil erosion problem in the area if left unattended.

Mitigation Measures

1. All temporary cross bund / ramp constructed for dewatering or transportation of vehicle/ machineries shall be removed immediately after completion of proposed work and shall be cleared and leveled properly before monsoon season to maintain natural water flow.
2. Lining of canals will be made at all stretches at the earliest.
3. Provision of silt traps in the canal.

7.4.2.5 Soil Contamination

The soil contamination during construction phase is primarily due to construction and allied activities. The sites where construction equipment's and vehicles are serviced are likely to be contaminated because of leakage or spillage of fuel and lubricants. The solid waste generated from temporary labour camps can also contaminate the soil. Unwarranted disposal of construction spoil and debris will add to soil contamination and is likely to be carried over to canals, in case of dumping is done near the canals. This might be a major long-term residual negative impact.

Mitigation Measures:

1. Fuel storage and refilling locations should be kept away from water sources / water bodies and water supply sources and shall be stored in containers and kept in raised impervious platforms, however the spillover fuel from the primary containers will be stored in a secondary container.
2. All spoils shall be disposed-off and the site shall be maintained cleaned.
3. The movement of construction vehicles will be restricted to only the designated routes.
4. Designated storage site with proper signage's for oil, lubricants and similar products.
5. Contractors shall sign an agreement with registered recyclers of used oil and waste oil for disposal of oil, lubricants and similar products (list of registered recyclers of used oil and waste oil is provided in Annexure 3)

7.4.2.6 Impact on Water Resources

The baseline study indicates that the water table in most of the areas falls under overexploited zones. There will be increased load on existing drinking water sources for consumption of workers. However, the same shall be met with the existing water supply sources. The water demands for the construction work will not pose any serious stress on the public water supply as water of the canal will be utilized for construction activities through lifting and storing mechanism. The construction period is from February to May wherein water is sufficiently available in the canal. In case of unavailability of water in canal, water from the lakes and tanks belonging to WRD shall be utilized. The restoration of the tanks in the study area improves the availability of water for irrigation and the improvement of ground water quality and level which is a positive impact.

Mitigation Measures

1. Use of public water supply sources for fetching water for consumptive use will be a requirement and, in such cases, local bodies should be intimated and consulted accordingly
2. Water for construction and other related activities shall be met from existing canal by pumping to the possible extent.
3. Use of ground water for construction purpose shall be avoided to the possible extent.

7.4.2.7 Impact on Water Quality

It is anticipated that there shall not be any permanent impacts on water quality due to the proposed project activities. The various ERM works may temporarily deteriorate surface water quality in and around the construction sites through increase in turbidity as well as oil spill and grease. The water contamination may be caused due to waste discharge from construction sites and labour camps. These short-term impacts will be mitigated with the implementation of following measures.

Mitigation Measures:

1. Lining of canals will be carried out only during closure period of the canal i.e., February to May.
2. The Contractor will not be allowed to dispose wastewater generated during construction works from entering into water bodies viz. Wash water from batching plant and RMC shall be collected in settling tank and used for dust suppression.
3. The solid waste generated from labour camps shall be disposed along with the Solid waste management facility of the local bodies viz. Corporations / Municipalities, Panchayat and construction sites will be properly disposed-off so as to avoid its in-flow to the water source.
4. The construction equipment sites, batching plant sites, material storage sites, servicing centers and labour camps will be established sufficiently away from water sources i.e., canal & nearest water bodies and will be provided with proper drainage system to regulate water flow from such sites.
5. All water and liquid wastes generating from construction activities will be properly disposed-off and will not be discharged into canals around the project area without treatment;
6. No construction materials / spoils will be stored along the water bodies and adequate provision will be made for preventing spillage of materials into these water bodies.
7. All construction vehicle parking location, fuels/lubricants storage sites, vehicles, machinery and equipment maintenance sites are located at least 100 m away from any waterbody. It should be ensured that spillage of fuels and lubricants do not contaminate the soil.
8. Collection and storage of oily wastes and it's handing over to the authorized hazardous waste collector / recyclers as approved by TNPCB enclosed as Annexure 3.
9. Deposition of the C&D material only at the specified site without disturbing the natural drainage.
10. Water quality to be monitored periodically, as per the monitoring plan.

7.4.2.8 Impact on Ambient Air Quality

The various construction activities along the project sites is the main cause for the deterioration in the ambient air quality. However, these impacts are mainly localized and temporary in nature. The anticipated cause of air pollution during construction phase are because of Ground clearance, lining of irrigation canals, Laying of roads, remodeling and reconstruction of structures, operation of batching plant, hot mix plants and other

construction activities like disposal of wastes, construction spoils & debris, movement of vehicles and construction equipment's and operation of batching plant. These activities are expected to generate fugitive dusts which can settle down quickly and will be localized in nature. The construction activities may lead to temporary deterioration of air quality in the habitation areas near the project sites which will have impact on health.

Mitigation Measures:

1. Water will be sprayed frequently during construction phase, in construction sites, batching plant sites areas for suppressing fugitive dust. Extra precautions will be taken when working near sensitive areas like schools, hospitals etc.
2. The batching plants will be located at least one km in the downwind direction from the nearest habitations. The same shall be identified during construction phase and get clearance from WRD and TNPCB.
3. The construction equipment will be fitted with appropriate dust suppression devices
4. All vehicles, equipment and machinery used for construction will be regularly maintained to ensure that pollution emission levels are below the prescribed CPCB standards
5. Pollution Under Control (PUC) certificates will be mandatory for all vehicles / equipment / machinery to be used for the construction works
6. The, C&D materials, debris, and construction waste materials during construction will be covered with tarpaulin cover.
7. Mandatory provision of Personal Protective Equipment/kit (PPE) for workers at the batching plant and other construction sites to reduce the chances of ill effect of emissions
8. Dust emission from storage area of C&D material will be controlled either by covering the storage area or by spraying water over it.
9. As soon as construction is over in a specific site, all the left over and unutilized materials will be removed from the site and disposed off properly.
10. Periodic monitoring of particulate matter i.e., PM_{10}, $PM_{2.5}$, SO_2 and NO_2 will be carried out as per Environmental Monitoring Plan.

7.4.2.9 Impacts on Ambient Noise Level

The generation of noise due to various construction activities is temporary in nature. Each type of activity can generate different levels of noise that can continue for a short period. The operation of construction machineries, movement of vehicles, batching plants, hot mix plants, operation of DG Set, bitumen topping of road, demolition of existing structures generates significant noise which increases the ambient noise level of the immediate surroundings. Since, most of the construction activities will be confined to the project area i.e., canal systems which is away from habitation area which will have negligible impacts.

Likely impact due to noise pollution in the surrounding areas will be insignificant. However, workers working near the noise generating equipment like construction equipment's and batching plants are likely to be exposed to high noise level. Noise generated due to various activities in the labour camps may affect health of the workers if

they are continuously exposed to high noise level. As part of occupational safety, impact of noise should not exceed 140 dB(A) i.e., peak acoustic pressure. In areas of continuous noise exposure for a period of 8-hour shift noise should not exceed 85 dB(A). Proper mitigation measures should be implemented to reduce noise pollution arising due to construction activities.

Mitigation Measures:

1. All construction equipment's and batching plants used for construction shall strictly conform to the CPCB ambient noise level standards
2. All noise generating equipments will be installed sufficiently away from habitations and sensitive areas.
3. Any kind of demolition or other heavy noise generating activity will not be permitted within 100 m radius of sensitive areas / silence zone during active working hours (10 AM to 5 PM); work in sensitive areas / silence zones shall preferably be carried out on weekend and holiday or between 6 AM to 10 AM and 5 PM to 9 PM of other weekdays.
4. Reducing the noise produced from a vibrating machine by vibration damping i.e., making a layer of damping material (rubber, neoprene, cork or plastic) beneath the machine.
5. At all the construction sites within 100 m periphery of the nearest habitation, construction work such as crushing, concrete mixing etc. will be stopped during the night time between 7.00 PM to 6.00 AM.
6. The stationary noise producing sources such as DG sets shall be provided with acoustic enclosures / noise shield around them. The acoustic enclosures / noise shields can either be a brick masonry structure or any other physical barrier which is effective in adequate attenuation of noise levels and shall be as per CPCB guidelines
7. Vehicles and equipment used will be fitted with silencer/ noise barrier and maintained as per the regulation.
8. All the workers working in the construction sites where heavy machineries are used shall be provided with ear-plugs to avoid any ill impacts on their health.
9. Noise levels to be monitored as per monitoring plan and if the noise level at any time found to be higher than immediate measure to reduce noise in that area will be ensured.

7.4.2.10 Impact on Ecological Resources

The project area does not have any significant floral or faunal assemblages. Also, there are no reserve forests or ecologically sensitive areas in the project area. Only Common trees species like neem, tamarind, mango, teak etc. are found in the area. *Macaca radiata* a Schedule II species is observed in the project area for which conservation measures are to be implemented as per the Annexure 5.

About 23,183 trees have been identified to be felled for lining, reconstruction activities as part of ERM works. Many other shrubs and aquatic plants including weeds such as water hyacinth located within the construction sites will be removed.

Vaduvoor Birds Sanctuary and Point Calimere Wild Life and Bird Sanctuary which are located within 5 km from the project area has several migratory bird species. The proposed project activities will be taking place during the non-migratory months of Feb – May. Hence, there will be no impact due to the project activities.

The project activities will lead to loss of vegetation and loss or disturbance to the natural habitat. To mitigate such impacts, the following measures may be taken:

Mitigation Measures:

1. No tree felling will be allowed beyond the identified working zone.
2. All the trees located in labour camps, storage areas, C&D disposal sites and other allied sites will be conserved.
3. The construction and C&D materials will be stored at a safe distance from trees located in such areas to avoid any damage to the trees.
4. In case of felling of trees, prior permission from Forests Dept. shall be obtained and compensatory afforestation at 1:10 ratio shall be done as per the Compensatory tree plantation plan given in Annexure 4.
5. No migration route is reported in the project area, so any impact on migratory route in not anticipated due to the project
6. In case of finding of any fauna during construction, safeguard measures will be taken like i.e., (1) no harm to any fauna by the construction workers, (2) care by the construction vehicles to avoid accidents to fauna, (3) information to Forests Dept. in case of any encounter takes place with wild animals
7. Vibration measures shall be performed before initiation of levelling work to allow species to come out from their burrows and migrate to surrounding places.
8. Weed clearing on canals shall be restricted to active work zone, this will allow faunal species to migrate in nearby bushes.
9. Workers shall not perform hunting of such fauna species for eating or any kind of trading purpose. Conservation and Management Plan for *Macaca radiata* a Schedule II species should be impleneted as given in Annexure 5.
10. The project activities shall be restricted to day time hours and construction activities shall not be carried out during migratory season.

7.4.2.11 Impacts due to labour Influx

During construction phase, significant increase in labour population is anticipated in the project area, which shall lead to various environmental and social issues and stress on host communities.

Mitigation Measures:

To mitigate the probable impacts due to labour influx, stress on host communities labour camp establishmenhment ,shall be done as per the guidelines given in the detailed labour camp management plan in Annexure 2.

7.4.2.12 Generic Impact Mitigation Measures

The mitigation measures which are proposed to address identified negative impacts that may arise due to the implementation of various project activities. The mitigation measures shall be applicable during pre-construction, construction and operation phases. Any adverse impact arising during project implementation stage shall be addressed using appropriate mitigation measures.

Mitigation Measures:

Mitigation measures are measures to remove or reduce the potential adverse environmental and social impacts of the project activities. These include generic mitigation measures as given in Table 48 that are applicable to all project supported activities and specific mitigation measures that are specific to each activity. The mitigation measures are presented as follows:

1. Mitigation measures applicable to all or majority of the project activities based on the activity typology
2. Construction related mitigation measures for all project activities involving construction
3. Mitigation Measures specific to each activity type presented as part of activity-specific ESMP.

Table 48: Generic Mitigation Measures for All Project Activities

Environmental Aspect	Generic Mitigation Measures
Site Selection & Materials	1. The site selected for the activity must not be in areas that are protected areas (National Parks or Wildlife Sanctuaries), archaeological sites, and other sites that are of critical conservation importance. 2. Materials required for construction are of specified quality and are only procured from authorized suppliers.
Resource Conservation	1. Promotion of water conservation measures by the use of efficient irrigation methods such as drip and sprinkler irrigation, mulching, ridge and furrow method etc. based on its field suitability and applicability; 2. Restricted use of ground water and optimizing surface water for irrigation (conjunctive water use); 3. Emphasis on crop diversification; discouraging water intensive crops and encouraging less water consuming crops; 4. Encourage adoption of renewable energy where ever feasible (e.g., solar lights, solar water pumps, etc.); 5. Adopt energy efficient farm equipment / machinery (e.g., BEE 3-5 star rated pumps). 6. Use of PPC cement in all civil measures like concrete lining/ flood wall construction/ renovation of existing structure and construction of new structure.

Environmental Aspect	Generic Mitigation Measures
Pollution Control	1. All vehicles to be used for the work should have a valid Pollution Under Control (PUC) certificate; 2. Use of generator sets (diesel, petrol, kerosene, LPG, CNG) that meet CPCB noise and emission control standards; 3. Meeting CPCB prescribed "Ambient Air Quality Standards"; 4. Avoid release of waste water into water bodies, streams, etc., without any treatment. 5. All waste water meets the 'CPCB General Standards' prior to disposal; 6. Use of construction machinery / equipment that conforms to CPCB noise standards; 7. Dispose toxic and non-biodegradable wastes at locations specified by the government / local body. 8. Proper disposal plan for C&D material and its adherence by the engaged contractor; 9. No burning of generated wastes (crop residues, leaf litter, plastic wastes, etc.).
Biodiversity Conservation	1. Avoid felling of trees in the embankment, work place or camp sites; 2. Obtain permission from Forest Department, GoTN in case tree felling is unavoidable; 3. In case tree felling is unavoidable, compensatory plantation should be done with not less than 10 times of the number of plants cut down / uprooted; 4. Avoid mono species/culture plantation and promote mixed plantation with locally grown species as per Compensatory tree plantaion plan Annexure - 4.
Health and Safety	1. Adopting prescribed safety practices during handling of equipment, manual labour, handling of pesticides, etc. 2. Provision of required safety measures at the work sites and labour camps (fire safety, chemical safety, etc.) 3. Mandatory use of personal protection gears by workers (helmets, safety harness while working at heights, etc.). 4. Adopting minimum requirements for the contractor code of conduct as given in Annexure 6.

7.4.3 Impacts during Operation Phase

The potential negative impacts during operation phase include mainly the impacts due to increased use of fertilizers. To overcome the negative impacts awareness for using organic manure will be made to the farmers through farmers training.

7.4.3.1 Impacts due to increased use of Agrochemicals

Fertilizers boost crop yields, but their excessive usage reduces soil fertility, Pest Resistance towards insecticides, creating health and environmental risks. Most of the fertilizer applied to

the soil is washed away or broken down by bacteria, releasing the strong greenhouse gas nitrous oxide into the environment. Increased use of fertilizers also causes damage to non-target creatures such as plants, birds, mammals, fish, and crops, are the main environmental problems associated with pesticides. It also causes a variety of human health problems, ranging from short-term effects like headaches and nausea to long-term effects like cancer and reproductive harm.

Mitigation Measures

1. Implementation of Pest Management Plan provided as Annexure 7 which shall help in reducing the use of chemical fertilizers and pesticides.
2. Promote wide use of organic inputs, such as, bio-manure, Farm Yard Manure and bio-fertilizers and provide training on use of these alternatives
3. Optimal use of Fertilizers at the right time and use of bio-pesticides
4. Distribution of Green manure seeds, Micro Nutrient Mixture and Distribution of Bio fertilizers in coordination with Agriculture department

7.4.3.2 Silt management

GA Canal head regulator as controlling arrangement is presently existing at the off take point of GA canal to prevent silt and sand from entering the canal. Source of silt and sediment was due to erosion from the existing earthen channel. Instead of existing earthen Canal, it is now proposed to line the bed and sides of the entire GA main canal in this Project. Hence there is no possibility of silt entering into the Canal.

All drainage carriers in the Project area crosses the GA canal through Syphons without confluence with canal water flow. There are no polluting industries in the entire Project area of the GA Canal system. Source of water to the GA canal is only from River Cauvery at Grand Anicut. Hence there is no possibility of silt or sediment being deposited in the canal.

However, silt traps are proposed in the project in the headreaches of the main canal to trap any silt from the offtake point. After completion of the project and during operation, if silt accumulates, same will be collected in the silt traps. The collected silt collected in the silt trap shall be removed during the closure period of the Canal. The same shall be tested for heavy metals and pesticides before disposal. If pesticides and heavy metals are found to be below the standards it will be disposed off by routine methods i.e., giving it to the required farmers or disposing it in the tree plantation area etc. If pesticides and heavy metals are found to exceed the standards, the silt shall be remediated according to the methods viz. (Physical, Chemical and Bio-remediation) as suggested in the Silt Management Plan (Annexure 2). Further, WRD will continue the above process during as well as after completion of the project.

Mitigation Measures:

5. Prepare and submit desilting plan including disposal plan with action timeline and risk management plan prior to carrying out desilting operations of silt traps if

desilting needs are envisaged.

6. No stacking of desilted material from the silt traps shall be done on canal bed or agricultural fields during monsoon period. There is 73 Ha existing vacant WRD land earmarked for storage of silt.
7. The maximum allowable height of the stacked materials shall not 1.5 to 3m as per CPCB norms. Even as a worst case scenario, the annual silt removed from silt trap can be accommodated in the earmarked 73 ha WRD vacant land itself. The silt needs to be tested for heavy metals and pesticides before disposal. If pesticides and heavy metals are found to be below the standards it will be disposed off by routine methods i.e., giving it to the required farmers or disposing it in the tree plantation area etc.
8. If the silt is found to be contaminated by heavy metals it will be remediated depending on the degree of contamination.
9. Depending on the degree of contamination the silt will be remideated by Physical, chemical or biological methods and suitably disposed off.

CHAPTER 8: ENVIRONMENTAL AND SOCIAL MANAGEMENT PLAN

8.1 OVERVIEW

This chapter presents the ESMP for the project specific to various project phases i.e., pre-construction, construction and operation phases. An overview of types of ESMP is given in Table 49. The contract package-wise specific ESMP shall be developed by WRD with support from the environment and social (E&S) specialist of PMC and the Contractor's ESMP shall be prepared by contractor in consultation with the E&S specialist of PMC.

Table 49 Types of ESMP

S. No.	ESMP	Responsibility	Key Features
1	Project	WRD with support from ESIA Consultant and contractor	• Provides mitigation measures specific to each project activity • ESMP includes mitigation plans on the following: ✓ C&D Waste Management Plan ✓ Hazardous Waste Management Plan ✓ Disposal Plan for Desilted material ✓ Labour Camp Management Plan ✓ Management Plan for construction related issues ✓ Road Diversion and Traffic Management Plan ✓ Environment Health and Safety Plan
2	Contract Package	WRD with support from E&S specialist of PMC	• Provides mitigation measures specific to contract package with relevance to the BoQ and to the Contract conditions. • Includes management plans for Activity specific ESMP and Waste Management Plan
3	Contractor's ESMP	Contractor with support from E&S specialist of PMC	• Provides action plan for implementation of mitigation measures including details of quantities, locations, identification of third-party entities etc. • Includes management plans for: - Waste Management - Labour Camp Management - Construction related issues

8.2 MITIGATION MEASURES SPECIFIC TO EACH ACTIVITY TYPE

Based on the project activity, specific ESIA was undertaken for all activities belonging to category 1, and a Rapid assessment was undertaken for all activities belonging to category 2. For these activities of ERM works, a specific mitigation plan has been prepared and given in Table 50. In addition, the following mitigation plans have also been prepared with emphasis on critical issues and are given in Annexure 2:

- Waste Management Plan (C&D Waste Management Plan, Disposal Plan for Desilted material)
- Labour Camp Management Plan
- Management Plan for construction related issues

Table 50 ESMP for ERM Works of GACS

S.No.	Potentialn Impacts	Project Phase	Proposed Mitigation measures	Implementing Institution
ACTIVITIES DURING PRE-CONSTRUCTION PHASE				
1.	Generation of solid waste	Pre-construction	• All solid wastes generated in the labour camp shall be disposed only at the Municipal/Panchayat Solid waste handling facilities • Prohibition of dumping of construction debris in any sites other than the designated disposal sites identified at the detailed design stage. • The metallic waste should be recycled through vendors. • Cover should be provided while transportation, to minimize of the spillage. • Moisture content may cause dripping while transportation. Should be sun dried away from sensitive receptors before transportation.	Contractor (Solid Waste Management including Planning and Disposal of C&D materials will be monitored by the PMC and PMU)
2.	Insufficient / mismanagement of ESHS plan will bring construction nuisances to environment and local community, health and safety (H&S) issues etc.	Pre-Construction	• Based on the ground information collected and final locations of all construction site and ancillary sites, contractor shall prepare the site-specific ESMPs, including but not limited to traffic management plan, site management plan, quarry and borrow area plan, material sourcing plan etc. The ESMPs will be reviewed by Engineer, PMU prior to construction commencement. • Contractor to obtain all the construction related consents prior to mobilization (as mentioned in the ESHS-MSIP). • Contractor to disseminate the construction information to the community and closely coordinate with communities to timely resolve the ESHS issues. • Grievance logs separately for community and workers shall be prepared and well documented at project site.	Contractor (ESMP activities shall be monitored by the PMC and PMU)

S.No.	Potentialn Impacts	Project Phase	Proposed Mitigation measures	Implementing Institution
			• Construction camp and workers camp 1km away from the habitation area to avoid conflicts and stress with the local community. The location, layout and basic facility provision of each camp shall be submitted to WRD prior to construction along with the approvals of Corporation/Local Administration/ Village Panchayat. • Selection of borrow pits should be away from residential area, sensitive locations, and community roads. • Selection of sand, stone and other quarry material will be only government licensed supplier only. • Contractor to identify water supply pipes, electrical poles, cables and access roads and prepare plans for shifting or reconstruction.	
3.	Occupational H&S	Pre-Construction	• Contractor to provide safe drinking water as per IS 10500 standards for drinking water. • Contractor to provide sanitation facilities separately for male and female workers. • Contractor to collection and disposal of solid waste of the worker's camp. • Sufficient PPE distributions and awareness training. • COVID-19 SOP and supervision. The COVID -19 impoacts and mitigation measures are given in Annexure 8.	Contractor (Monitored by the PMC and PMU))
4.	Site clearance activities may increase dust and noise level, cause soil erosion, bring H&S risks and cause ecological damage.	Pre-Construction	• Site clearance activities will be undertaken with due permission from the local authorities. • Contractor to include an annex for the list of utility shifting required for this project • Construction waste and debris shall be disposed as per the Debris Disposal and Management Plan. All areas used for temporary construction operations will be	Contractor (Monitored by the PMC and PMU)

S.No.	Potentialn Impacts	Project Phase	Proposed Mitigation measures	Implementing Institution
			subject to complete restoration to their former condition with appropriate rehabilitation procedures. Pre-construction and post construction photographs will be recorded for all temporary sites.	
ACTIVITIES DURING CONSTRUCTION PHASE				
1	Generation of solid waste	Construction	• All solid wastes generated in the labour camp shall be disposed only at the Municipal/Panchayat Solid waste handling facilities • Prohibition of dumping of construction debris in any sites other than the designated disposal sites identified at the detailed design stage. • The metallic waste should be recycled through vendors. • Cover should be provided while transportation, to minimize of the spillage. • Moisture content may cause dripping while transportation. Should be sun dried away from sensitive receptors before transportation.	Contractor (Solid Waste Management including Planning and Disposal will be monitored by the PMC and PMU)
2.	Air pollution generated through construction activity, construction machinery and vehicular traffic	Construction	• Water spraying should be carried out as per the instructions of the Engineer/as on when required to prevent dust • The location and operation of batching plants needs to be sited as far as possible from residential areas, at least 500 m from downward wind direction of batching plant sites in consultation with the Engineer. • Operators should use PPE such as dust masks, etc. • Vehicles and construction machinery should be properly maintained and comply with BS-VI emission standards. • Regular dust collection, removal and water sprinkling at the batching plants and storage sites of construction	Contractor (Monitored by the PMC and PMU)

S.No.	Potentialn Impacts	Project Phase	Proposed Mitigation measures	Implementing Institution
			materials/ as instructed by the Engineer. • In case of transportation of top soil, tarpaulin cover shall be provided to restrict dust pollution during transportation. • Provide dust curtain or geotextile membrane to cover soil. • Avoid haulage route in residential area and sensitive locations. • Avoid overloading of trucks.	
3.	Water Pollution in canals and water bodies	Construction	• Construction will take place in dry season to avoid de-silting within the flow of water. This will minimize soil erosion and increase in turbidity in the downstream. • In any case, the local water bodies or the area near such a water body is not identified as disposal site.	Contractor (Monitored by the PMC and PMU)
4.	Noise pollution generated through construction activities	Construction	• Operators should use Personal Protective Equipment (PPE). • Periodic maintenance of construction machinery should be undertaken prior to the commencement of work.	Contractor (Monitored by the PMC and PMU)
5.	Contamination of land and water from Hazardous materials and petroleum products	Construction	• Regular servicing and maintenance of construction equipments at a localized point. • All applicable laws, regulations and standards as per TNPCB guidlines for the safe use, handling, storage and disposal of hazardous waste to be followed. • Analysis of Soil / Sediment sample including testing for the presence of herbicides, pesticides and heavy metals should be conducted • Storage sites for petroleum products and soil/ sediment / shoal material (if identified as hazardous) shall be secured and signages will be displayed to include hazard warnings. The details of authorised personnel to be	Contractor (Monitored by the PMC and PMU)

S.No.	Potentialn Impacts	Project Phase	Proposed Mitigation measures	Implementing Institution
			contacted in case of a release (spill), access restrictions shall be displayed.	
6.	Mushrooming of unplanned developments	Construction	• Control haphazard un-planned development of commercial activities such as shops, restaurant, workshops, etc.	Monitored by PIU
7.	Occupational H&S	Construction	• Appropriate signages should be designed in locations where standards are compromised to warn of safety hazards. • Sufficient PPE in use. • Ensure the workers are trained to work on the specific project. For untrained workers, training shall be provided before permission to work on the site. • Contractor shall follow all relevant provisions of the Factories Act, 1948 and the Building & Other Construction Workers (Regulation of Employment and Conditions of Service) Act for construction & maintenance of labour camp. • Safety and sanitation facility should be provided in the labour camp/ worksite. Uncontaminated water shall be supplied to the construction workers at workers camps/ worksite. • Contractor shall arrange for a readily available first aid unit/kits including an adequate supply of sterilized dressing in suitable transport arrangements at all times to take injured or sick person to the nearest hospital. Maintain a fully equipped first aid box in the construction site.	Contractor (Monitored by the PMC and PMU)

S.No.	Potentialn Impacts	Project Phase	Proposed Mitigation measures	Implementing Institution
8.	Community H&S	Construction	• Carry out campaigns applying various IEC methods for prevention of water borne diseases in and around the project areas. • Provide information about the construction schedule and construction activities to community. • Barricading construction site • Display signage of diversion at construction road on embankment in consultation with local authority like traffic police, WRD, and local community. • Implement the traffic management plan. • Conduct a comprehensive awareness campaigns for HIV/AIDS and COVID 19 as specified in Consultation and Participation Plan in Annexure 8.	Contractor (Monitored by the PMC and PMU)
9.	Chance Find	Construction	• While excavating or dismantling any structure if any fossils, coins, articles of value / antiquity and remains of archaeological interest discovered on the site the contractor shall immediately stop work and inform WRD. • Contractor shall take reasonable precautions to prevent the damage or removal of any such articles. • All work shall be stopped and WRD shall seek the direction of Archaeological Survey of India (ASI) before Contractor recommences the work.	Contractor (Monitored by the PIU)

S.No.	Potentialn Impacts	Project Phase	Proposed Mitigation measures	Implementing Institution
10.	Exposure of Top soil due to denudation leading to soil erosion	Construction	• It should be ensured that the cleared areas of the site where ERM works are proposed should not be left exposed over long periods. This will minimize erosion at the project site. The activity should commence immediately after clearing of the project site. • After cutting and filling embankment will be immediately stabilized. • Avoid de-silting within the flow of water.	Contractor (Monitored by the PMC and PMU)
11.	Impact on flora/ fauna during vegetation clearance	Throughout Pre-construction to Construction	• Precaution to prevent construction workers from damaging any flora or fauna of the area • Vegetation clearance shall be limited only to the portions of the canal slope to be lined at a particular time. This will allow any fauna to migrate to adjoining areas. • Clearing of the entire land at a time should be avoided. • Proper weeds removal and disposal to avoid growth back in the canal.	Contractor (Monitored by the PMC and PMU)
12.	Removal of Top Soil	Construction	• Preservation and suitable reuse of the top soil for leveling and back filling purpose. May be temporarily stacked on either side of embankment.	Contractor (Monitored by the PMC and PMU)
13.	Littering on road due to transportation of construction materials from quarries / borrow	Construction	• All transportation vehicles should be provided with tarpaulin lining and also the transportation vehicles should not carry excess materials more than the actual storage capacity to prevent littering	Contractor (Monitored by the PMC and PMU)

S.No.	Potentialn Impacts	Project Phase	Proposed Mitigation measures	Implementing Institution
14.	Dust and air pollution from flying of dried-up muck and other sediment matierials	Construction	• Water sprinkling arrangement on construction and soil material specially during hot-summer season to maintain soil moisture and minimise dust pollution as instructed by the Engineer/when required; • Trucks shall be covered with tarpaulin while transporting construction material; • At canal stretches in proximity of sensitive locations i.e., schools, hospitals etc., the following mitigation measures will be implemented: • The ESMPs will specify the list of locations for monitoring Air quality, Water quality and Noise levels. • Air quality monitoring to be carried out as per the Environmental Monitering Action plan.	Contractor (Monitored by the PMC and PMU)
15.	Spillage during transportation of excavated material	Construction	• All transportation vehicles shall be provided lining arrangement while transporting material to restrict spillage on road.	Contractor (Monitored by the PMC and PMU)
16.	Tree Cutting will increase the flooding risk due to the land erosion	Construction	• Chainage wise requirement of tree felling shall be counted with their species • Compensatory afforestation with suitable local indigenous tree species to be carried out in consultation with Forests Dept., GoTN in the vacant land belonging to WRD. • Cutting of Trees belonging to Forests Dept. shall be commenced only after obtaining permission from them. • Shrubs, stems and roots shall be uprooted properly to eliminate any chance of void under lining. • Re-plantation with ratio of 1:10 to original plantation has to be carried out based on the Compensatory Afforestation Plan prepared during pre-construction phase. As per the information collected, along the	Contractor (Monitored by the PMC and PMU)

S.No.	Potentialn Impacts	Project Phase	Proposed Mitigation measures	Implementing Institution
			project activity area, it is envisaged that 23,183 trees shall be cut i.e., 14,015 trees and 9,168 trees belonging to WRD and Forests Department respectively.	
17.	Exposure of top soil due to inundation leading to soil erosion	Construction	• It should be ensured that the cleared areas of the site where ERM works are proposed should not be left exposed over long periods. This will minimize erosion at the project site. • The activity should commence immediately after clearing of the project site.	Contractor (Monitored by the PMC and PMU)
18.	Impact on flora/ fauna during vegetation clearance	Pre-construction	• Precaution to prevent construction workers from damaging any flora or fauna of the area • Vegetation clearance shall be limited only to the portions of the canal slope to be lined at a particular time. This will allow any fauna to migrate to adjoining areas. • Clearing of the entire land at a time should be avoided.	Contractor (Monitored by the PMC and PMU)
19.	Damage to crops due to interruptions in irrigation supply	Construction	Contractor shall submit work plan with canal closure timeline for each site to WRD with a minimum period of 45 days of crop season, WRD shall take an initiative to complete the task and the cost incurred shall be penalised from contractor. • Restoration plan shall not be approved by WRD, if it is not submitted within the minimum period of 45 days prior to crop season; • Subsequent to approval of work plan, farmers should be informed about canal closure plan with a minimum	Contractor (Monitored by the PMC and PMU)

S.No.	Potentialn Impacts	Project Phase	Proposed Mitigation measures	Implementing Institution
			period of 30 days of crop season. Canal closure notice board shall be displayed at offices of local bodies / WRD, etc.	
ACTIVITIES DURING POST - CONSTRUCTION PHASE				
1.	Dismantling of Labour camp and Batching plants	Post - Construction	• Can cause change in land use pattern, hence contractors are supposed to restore the land as desired by the land owner/ WRD.	Contractor (Monitored by the PMC and PMU)
2.	Use of Agrochemical	Post - Construction	• Implementation of Pest Management Plan provided as Annexure 7 which shall help in reducing the use of chemical fertilizers and pesticides.	PIU and PMU
3	Silt Management	Post Construction	• Implementation of Silt Management Plan as per Annexure 2.	PIU and PMU

Table 51: Budget for Implementation of ESMP

S.No.	Description	Qty.	Unit	Unit Cost (Rs.)	Total Cost (Rs.)	Remarks
A	**Regulatory Clearance**					
A.1	Consent to Establish of hot mixing plant, batching plants, diesel generator etc.	Lump Sum	-	-	31,00,000	To be built into project cost and to be made part of Contractor's contract specifications
A.2	Cost for tree felling	23,183 trees	-	1694.4 / tree	3,92,81,275	To be built into project cost
				Sub-Total (A)	**4,23,81,275**	
B	**Workers Safety and Labour Camp**					
B.1	Labour Camp establishment	Lump Sum			10,00,000	To be built into project cost and to be made part of Contractor's contract specifications
B.2	Workers EHS Measures	Lump Sum			30,00,000	Providing training to workers, engineers, community, along with health camp etc.
				Sub-Total (B)	**40,00,000**	
C	**Compensatory Afforestation**					
	Afforestation	2,31,830 trees		1500 / tree	34,77,45,000	The cost includes cost of sampling and Maintenance for 3 years
	Sub-Total (C)				**34,77,45,000**	
D	**Environmental Quality Monitoring (EQM)**					

S.No.	Description	Qty.	Unit	Unit Cost (Rs.)	Total Cost (Rs.)	Remarks
D.1	EQM by Contractor	Lump Sump			3,75,45,000/- (125,15,000 * 3 years)	To be built into project cost and to be made part of Contractor's contract specifications - Ambient Air Quality, Noise, Water Quality Monitoring, etc.
D.2	Post Project EQM				20,56,000/- (10,28,000 * 2 years)	Recurring Cost
				Sub-Total (D)	**3,96,01,000**	
E	**Manpower**					
	PMU – Environmental Expert	03	-	1,00,000 / month	39,72,000	Rs. 1,00,000 / month with 10% escalation per year for three years during construction period
	PMU – Social & Gender Expert	03	-	1,00,000 / month	39,72,000	Rs. 1,00,000 / month with 10% escalation per year for three years during construction period
	Sub-Total (E)				**79,44,000**	
F	**Capacity Building**					
F.1	Training and Workshops					

S.No.	Description	Qty.	Unit	Unit Cost (Rs.)	Total Cost (Rs.)	Remarks
	PMU	Days - 20 days	-	50,000 / day	10,00,000	Training programme for 20 days in three years during construction & prior to construction for 9 Officials of PMU & PIU includes the Environmental and Social Experts shall be provided as per chapter 10
	Contractors	Days - 15 days	-	25,000 / day	3,75,000	Training programme for 15 days in three years during construction & prior to construction for contractors Environmental and Social Experts shall be provided
F.2	Demonstration - Climate Resilient Farming Technologies - Water Management	1500 farmers	-	10,000 / farmer	1,50,00,000	Training programme for 1500 farmers to cover all Districts for Climate Resilient Farming Technologies shall be provided as per chapter 10
	Sub-Total (F)				**1,63,75,000**	
G	**Awareness Campaigns**					
G.1	Workers / Labour Force	750	-	10,000 / labour	75,00,000	Awareness regarding the work, health and

S.No.	Description	Qty.	Unit	Unit Cost (Rs.)	Total Cost (Rs.)	Remarks
						does and don't in labour camp, emergency response system which includes nearest hospitals, firefighting, police station details and grievances redressal mechanism for labours
G.2	Community	Lump-sum	-	-	10,00,000	Prior construction & during the construction engagement of community through the consultation process, grievance redressal mechanism shall be done.
G.3	IEC Materials	200 IEC activities	-	10, 000 / IEC activities	20,00,000	Through pamphlet, announcement through electronic media, prior to start the work
				Sub-Total (G)	**1,05,00,000**	
H	Implementation of Gender Action Plan	Lump-sum	-	-	22,00,000	To be implemented as per GAP in Annexure 17
I	Formation and Capacity Building of Water User Associations	100 WUA	-	1,50,000 / WUA	1,50,00,000	During Construction and Post Construction Phase
J	**Preparation of Report / Audit**					
J.1	Environmental and Social Monitoring	Quarterly		10,000 / quarter	1,20,000	Total 12 EMR Reports shall be

S.No.	Description	Qty.	Unit	Unit Cost (Rs.)	Total Cost (Rs.)	Remarks
	Report (ESMR)					submitted within three years of construction period.
J.2	Environment and Social Audit	No. 6 (half yearly for three years)	-	1,00,000 / per Audit	6,00,000	Half yearly Environmental Audit during the construction period shall be done
				Sub-Total (H)	**7,20,000**	
				Grand Total (A+B+C+D+E+F+G+H+I+J)	**48,64,66,275**	

*Since, EMP Implementation involves multi-disciplinary activities and hence it should be taken by sectorial experts. Thus, EMP should be implemented by WRD by outsourcing the works to NGOs, Institutes or other premier agencies who are having relevant experience.

CHAPTER 9: ENVIRONMENTAL AND SOCIAL MONITORING ACTION PLAN

9.1 GENERAL

The ERM works of GACS project will involve monitoring and evaluation (M&E) of the ESMP implementation and its output and outcome indicators at various intervals during the project implementation period. The M&E framework is designed to meet the following objectives:

- Quantify the impacts
- Evaluate the performance of the proposed mitigation measures
- Suggest improvements in ESMP, if so required
- Accomplishment of the benefits expected from the implementation of safeguard measures
- Ensure compliance with the legal obligations

The M&E of ESMP implementation shall be conducted on periodic basis to assess the progress and achievements for the identified risks and mitigation measures, which shall enable project proponent to take up mid-course corrections, if required. The M&E is to be undertaken at two levels as mentioned below:

- **Monitoring and Evaluation of the ESMP implementation of the project as a whole**: The effectiveness of ESMP elements including preparation and implementation of Contract Package ESMPs, capacity building and institutional arrangements will be monitored. Besides, environmental and social management aspects of the project will also be undertaken through mid-term and end-term audit by engaging third party M&E agency.

- **Monitoring of Mitigation Measures and Environmental Quality**: The effectiveness of implementation of the identified mitigation measures and the environmental quality parameters relevant to each project package activities will be monitored.

9.2 MONITORING OF STATUTORY COMPLIANCES

The statutory compliances of the contractor for every contract package under the ERM works of GACS will be monitored. The statutory compliances include availability of the following:

- Consent to Establish (CtE) and Consent to Operate (CtO) from TNPCB for erection of batching plants, diesel generator, hot mixing plant etc.
- Permission from local bodies for labour camp establishment
- Permission for felling of trees under Forests Department

WRD shall monitor status of each clearance / approval conditions before implementation of the project.

9.3 ENVIRONMENT AND SOCIAL ASPECTS TO BE MONITORED

The environmental and social components, which have significant impacts at construction sites, have been suggested for periodic monitoring. The following specific environmental parameters should be qualitatively & quantitatively monitored as given in Table 52 and compared over a period of 4 years during construction and operation phases with the baseline status. The impact areas of monitoring would encompass the following:

Table 52: Monitoring of Impact Areas

Monitoring of Environmental Impact Areas	Monitoring of Social Impact Areas
• Water quality (Surface & Ground) • Air quality • Noise levels around sensitive locations • Soil, Silt and Sediment Quality • Compensatory afforestation & plant survival rate • Labour camp management • Waste Management & Debris Removal • Site Restoration	• Safety at Work • Gender participation in works • Awareness program on HIV/AIDS • Awareness program on COVID-19 • IEC activities • Training Programs on Farming tehcnologies • Training Programs on Water Management

9.3.1 Ambient Air Quality

The Ambient Air Quality (AAQ) to be monitored during the construction and operation phases on quarterly basis at selected locations such as construction and material handling sites, sensitive locations viz. schools, temples, residential areas, hospitals etc. in accordance with National Ambient Air Quality Standards (NAAQS), 2009.

9.3.2 Water Quality

The water quality of the water source that is used by the local community shall be monitored on quarterly basis as per Environmental and Social Monitoring Action Plan (ESMAP) as given in Table-53. The sampling locations for monitoring of the water quality will be done at the same locations identified during construction and operation phase (especially within habitations, near construction sites, open water bodies etc.) and shall be monitored for the parameters as specified in IS:10500-2012 for ground water quality and for surface water quality as per CPCB guidelines on Inland Surface Water (Class C - IS: 2296-1982)

9.3.3 Ambient Noise Level

The ambient noise levels to be monitored during the construction and operation phases on quarterly basis at selected locations such as construction & material handling sites, sensitive locations (viz. schools, temples, residential areas, hospitals) etc. and near storage areas in accordance with the CPCB Protocol for Ambient Noise Level Monitoring, 2015. Noise levels shall be monitored using digitized noise monitoring instrument. The

equivalent Noise Level will be recorded for comparison with prescribed limit and baseline data.

9.3.4 Soil Quality

The soil quality shall be monitored during the construction and operation phases on quarterly basis for physico-chemical parameters in the surrounding areas close to the construction sites, machineries cleaning yards and nearby agricultural fields to understand the impact on soil quality.

9.3.5 Silt Quality

The quality of silt trapped during operation will be tested before deciding the proper disposal method. The physico-chemical parameters to be analysed are as follows:

- Physical Parameters: Soil Texture, Grain Size, Gravel, Sand, Silt and Clay (National Standards)
- Chemical Parameters: pH, EC, Ca, Mg, Na, N and SAR (National Standards)
- PCBs, Heavy Metals such as As, Pb, Hg, Cr, Cd and Organo Chlorine pesticides (US EPA Standards)

9.3.6 Erosion Control Measures

During the project construction and operation phases, the inspection of vulnerable areas such as embankment slopes, temporary stacked area, etc. will be carried out on periodic basis once before and after monsoon.

9.3.7 Flora and Fauna

During the construction activities, the impacts on flora and fauna will be monitored during construction phase on quarterly basis. Besides, the monitoring shall also cover afforestation works taken up under these project activities in different locations. The key aspects to be monitored shall be:

- Bio-Diversity and its management
- Water quality and its impact on aquatic flora and fauna
- Fish species and its density, diversity and abundance

9.3.8 Compensatory Afforestation and Plant Survival Rate

The measures for compensatory afforestation and plant survival rates will be monitored to understand the effectiveness for ensuring restoration of the vegetation coverage. The visual observation on quarterly basis. These aspects will be monitored throughout the life of the project, covering all afforestation sites.

9.3.9 Labour Camp Management

The visual inspection of the labour camps will be done every month to check the labour standards and facilities provided in the camp and access to facilities by the workers as provided in the Annexure 2.

9.3.10 Waste Management and Debris Removal

The monitoring of clearance and disposal of C&D wastes will be carried out on weekly basis. The details of the types and quantities of the waste generated, their clearance and disposal mechanisms along with details of residual wastes will be maintained. The waste management registers will be maintained for each package along with photographs along with the visual observation on management of waste and debris at different sites.

9.3.11 Site Restoration

The restoration of all the temporary sites like labour camps, storage areas, local roads utilized for movement of construction equipments and materials etc. will be monitored after completion of project to ensure that appropriate restoration measures are taken to ensure the condition prior to use to the maximum extent possible. The afforestation works will also be monitored if such activity is planned for the sites. Besides, visual observation will also be made to verify the site restoration activities after completion of works.

9.3.12 Safety at Works

To ensure the effectiveness of safety measures at site, regular auditing of safety aspects at construction sites which includes supply and use of PPEs, safe work conditions, first aid facilities, incidence reports, safety trainings, etc. will be performed. At each contract package, safety aspects at the work and labour campsites will be supervised on day to day basis by PIU to ascertain:

- Nos. of labourers including women working at the site
- % of workers using PPEs
- Safe access to worksite and safe working environment
- Availability of first-aid kit
- Display of emergency numbers in a prominently visible place
- Training of workers on safety protocols to be followed at labour camp and work sites
- Periodic health check-up of workers and health issues reported
- Nos. and type of safety incidents including minor & major injuries requiring hospitalization, etc.

9.3.13 Living Standard of Workers

Generally, the labour camps are located for the labours near to the work sites. The conditions of the labour camp sites will be periodically assessed to understand the provisions of basic facilities for the labours, its use and maintenance, including sanitation and hygiene.

9.3.14 Employment of Local Population

The periodic assessment of the labourers engaged against total employment generated for different works will be done to ascertain the percentage of local and migrant labourers. If skilled labours are available, preference will be given only to the local labours. If skilled local labours are not available, then only migrant labours will be engaged. Percentage of local labours can be determined during Project implementation.

9.3.15 Gender Participation

The gender inclusiveness and their participation including labour force participation in the project activities will be assessed at each stage of the project. The verification of labour records followed by random checking at site will be conducted to analyze the gender participation in the work force.

9.3.16 HIV/AIDS Awareness Program

The awareness program on HIV/AIDS will be taken up among the workers periodically for monitoring with regard to participation of no. of persons, days and frequency of orientations conducted etc. Records maintained in this regard will be reviewed and verified.

9.3.17 COVID-19 Awareness Program

The awareness program on COVID-19 will be taken up among the workers periodically for implementation of the protocols for prevention of the disease with regard to wearing masks, ensuring social distancing, thermal scanning and use of sanitizers. Records maintained will be reviewed and verified.

9.4 ENVIRONMENTAL AND SOCIAL MONITORING ACTION PLAN

An Environmental and Social Monitoring Action Plan (ESMAP) has been formulated for construction and operation phases to monitor the major environmental and social parameters along with the frequency of monitoring, methods of monitoring, parameters to be measured and responsibility of monitoring.

9.5 REPORTING SYSTEM OF ENVIRONMENTAL AND SOCIAL MONITORING

The reporting system of environmental and social monitoring will be based on a feedback mechanism from project sites to the project proponent level in the implementation framework

of the project. The Contractor will prepare report on environmental and social safeguards implementation, making it a part of the monthly progress report as per the format provide in Annexure 10. The PIU will prepare report on environmental and social safeguards implementation as per the format provide in Annexure 11 quarterly. The E&S Safeguard Expert at the PMU level and PMC level will review the reports and prepare the action taken report on monthly basis and appraise to the WRD. The WRD, based on the review of the environment and social safeguard measures taken at the project level, should discuss with the PMU and PMC on critical issues for decision making. The experts of PMC will prepare environmental and social monitoring reports on semi annual basis for onwards submission to WRD as per the Annexure 12. After review of the report, WRD may seek further clarifications from PMU on critical aspects, whichever is felt appropriate. The E&S Safeguard Experts at the PMU / PMC will compile the quarterly reports and submit half-yearly progress reports to the WRD and AIIB.

9.6 E&S AUDIT

The Third Party M&E Agency hired by the WRD will undertake audit of the ESMP implementation in order to identify issues, good practices and make recommendations for strengthening the E&S management. The ToR for Third Party Audit / monitoring and Evaluation Agency is given in Annexure 13. The audit will be undertaken semi annually.

- **Preparation of Package Specific ESMP**
  - Has the package specific ESMP, contractors EHS been prepared within stipulated time period? (Template for ESMP is given in Annexure 14)
  - Was ESMP and contractors EHS conditions were included in bid documents and contractor agreement documents?
  - Was cost for ESMP implementation considered in contractors contract packages or BoQ documents?

- **Preparation of Plan Before Implementation**
  - Has contractor prepared OHS plan and vetted it from implementing agency?
  - Was testing of silted material done by contractor before initiation of desiltation of canals and tanks?
  - Was detailed Waste Management Plan prepared and implemented accordingly?

- **Regulatory Compliance**
  - Has contractor/implementing agency obtained and regularly updated all regulatory permissions?
  - Does project violate any related environmental or social laws of State Govt. of Tamil Nadu or Govt. of India?
  - Has contractor obtained permission from Local Bodies before establishment of labour camps or storage of waste material?

- **Implementation of ESMPs**
  - Whether all ESMP measures were followed during project implementation?
  - Whether EHS measures are adopted as per plan?
  - Whether equipment / machineries maintained properly and pollution testing (PUC) done regularly?

- **Monitoring of E&S aspects in project activities**
  - Is the PMU undertaking periodic and regular monitoring of the E&S implementation in the project activities?
  - Has contractor prepared and submitted all monthly reports on ESMP implementation on time?
  - Has PMU prepared and submitted monthly & quarterly report?
  - Was half-yearly assessment done by PMU on ESMP implementation?
  - Was testing of environmental parameters carried out on regular basis?

- **Institutional arrangements for management of E&S aspects**
  - Are the E&S Specialists at the PMU available?
  - Whether M&E agency was engaged for entire project implementation?

- **Capacity building arrangements for management of E&S aspects**
  - What training programs on E&S aspects have been organized for the PMU staff?
  - What training programs on E&S aspects have been organized for the contractors?

Table 53 Environmental and Social Monitoring Action Plan (ESMAP) during different project phases

Performance Indicator		Monitoring Parameters	Standards	Locations	Frequency	Monitoring Method	Corrective Actions in case of deviation	Monitoring Responsibility
Pre-Construction Phase								
1	Dissemination of information on project and social issues	• No. of consultations carried out with local communities; • Location and time of consultation		Various project activity sites i.e., Main Canal, Branch Canals and tributaries	Once	Review of record on community consultation;	Consult with community immediately	WRD
2	Compliance to Statutory Requirements	• Consent to Establish and Operate for erection of batching plants, diesel generator, hot mixing plant etc. • Permission from local bodies for construction of labour camp • Permission for tree cutting	Air, Water, and Labour Act Forests Dept, GoTN	- -	Before Commencement of Work and Expiry of validity Before tree cutting	Availability and Validity of consent / permission letter Tree Cutting NOC from Forests Dept	Stop construction work immediately, Obtain or renew consent/ permission immediately Restrict tree cutting, obtain tree cutting NOC immediately.	WRD

Performance Indicator		Monitoring Parameters	Standards	Locations	Frequency	Monitoring Method	Corrective Actions in case of deviation	Monitoring Responsibility
Construction Phase								
1.	Air quality	$PM_{2.5}$, PM_{10}, SO_2 and NO_2	National Ambient Air Quality Standards (CPCB), 2009	Total 04 Locations / package • Construction site • Material handling site • Sensitive locations like schools, hospitals etc.	Quarterly (3 times a year)	As per CPCB Guidelines for the Measurement of Ambient Air Pollutants, 2013	• Check and modify air pollution control devices in construction equipments • Water sprinklers	M&E Agency through NABL accredited Laboratory
2.	Surface Water Quality	pH, EC, DO, BOD, Total Coliforms, SAR, RSC, Boron, Free Ammonia (as N)	Inland Surface Water (Class C) Quality (IS: 2296-1982)	Total 04 Locations / package GA Main Canal, Branch Canal and distributaries	Quarterly (3 times a year)	As per CPCB Guidelines for Water Quality Monitoring	Check and modify silt fencing devices	M&E Agency through NABL accredited Laboratory
3.	Ground Water Quality	pH, EC, Total Hardness, Ca, Mg, Na, NO_3, SO_4, Cl, K, F, PO_4, SiO_2, Fe, RSC	Ground Water Quality Standard as per BIS: 10500, 2012	Total 04 Locations / package Nearby habitations on GA Main Canal, Branch Canals and distributaries	Quarterly (3 times a year)	As per CPCB Guidelines for Water Quality Monitoring	Reasons for quality variation and taking remedial measures	M&E Agency through NABL accredited Laboratory

Performance Indicator		Monitoring Parameters	Standards	Locations	Frequency	Monitoring Method	Corrective Actions in case of deviation	Monitoring Responsibility
4.	Noise Level	Leq dB (A) (Day & Night) Average and Peak values	Ambient Noise Standard (CPCB)	Total 04 Locations / package • Construction site • Material and Machinery Handling site • Sensitive locations like schools, hospitals etc.	Quarterly (3 times a year)	As per CPCB Protocol for Ambient Level Noise Monitoring, 2015	Check and modify equipment and devices to minimize noise level	M&E Agency through NABL accredited Laboratory
5.	Soil Quality	pH, EC, Texture, Bulk Density, Water Holding capacity, Organic Carbon, Organic Matter, NPK, CEC, Ca, Mg, Na, K, Fe, Cu, Zn, Mn	Soil Quality Standards (IARI)	Total 04 Locations / package • In and around construction site • Near agricultural fields	Quarterly (3 times a year)	Soil Testing Manual, Ministry of Agriculture, GoI	Check and modify The arrangement of containment of oil, drainage to protect soil quality	M&E Agency through NABL accredited Laboratory
6	Erosion Control Measures	Embankment slopes Temporary stacked area Levelling and re-sectioned areas		Each canal site, embankment slopes Temporary stacked area Canal section where Re- sectioning / remodeling done under irrigation	Once before and after monsoon.	Site visit EMR submitted quarterly by contractor Assessment of	Immediately adopt mitigation measures As per plan; Level each resectioned site before monsoon	M&E Agency

Performance Indicator		Monitoring Parameters	Standards	Locations	Frequency	Monitoring Method	Corrective Actions in case of deviation	Monitoring Responsibility
				modernization component		storing and disposal of material		
7.	Safety at Work Place	Use of PPE, Health camps, First aid facilities, Awareness program on HIV/AIDS, COVID 19 Incidents including minor & major injuries	Compliance with National Safety Council (NSC) Safety Standards	Construction site Labour Camps	Daily inspections for PPEs and Safe access and working environment and First-Aid Kits during construction phase. Training on health & safety HIV/AIDS and COVID 19 awareness program	PPE purchase records Daily safety records Issue records Visual observation	Immediate supply of adequate numbers of PPEs Mandatory / Enforcement of use of PPEs Mandatory / Enforcement of use of masks, sanitisers, thermal scanning for COVID 19 prevention First aid kits	WRD
8.	Plant Survival Rate	No. of saplings planted No. of plants survived Plant Growth Rate	Survival Rate – 80%	Alongside the embankments / canal and available vacant areas of WRD	Quarterly till project life	Field Report Visual Observation	Replacement of non-surviving plants with healthy saplings of same species Selection of appropriate plant species as per	WRD

Performance Indicator		Monitoring Parameters	Standards	Locations	Frequency	Monitoring Method	Corrective Actions in case of deviation	Monitoring Responsibility
							agro-climatic conditions Fencing of the individual saplings / area	
9.	Public Safety and Security	Vehicles in proper condition with PUC Certificates and valid registration certificates Valid driving license of the driver Safety Signages Barricades in construction sites		Access roads passing through habitations to construction sites	Weekly during construction phase	Review of Documents Checking of safety signages Barricades around work zones Grievance of Public and its Redressal	Valid Fitness Certificate, Road Permit, PUC Certificate, Registration Certificate Replacement of damaged signages and barricades	WRD
10.	Disposal of Wastes	Type and quantities of C&D wastes generated Clearance and disposal mechanisms along with details of residual wastes Quantity and		Construction and demolition and construction sites	Weekly during construction phase	Vehicle log book Visual observation Waste management register with photographs	Removal of Debris to disposal sites Reusing to maximum extent possible	WRD

Performance Indicator		Monitoring Parameters	Standards	Locations	Frequency	Monitoring Method	Corrective Actions in case of deviation	Monitoring Responsibility
		percentage of C&D material disposed as per the approved Waste Management Plan						
11.	Gender Participation	Involvement of women workers Proportional engagement of women to total workers engaged No. of women engaged from women headed / vulnerable households Income from engagement Period of engagement	Wages as per Minimum Wages Act, 1948	Labour Camp and work site	Monthly	Wage Payment Register Review of record Employee Monitoring Record Consultations with contractor and women workers	Ensure payment of wages as per the Minimum Wages Act, if the same is not being done. Engage women Labour from Different caste/ class Provide equal remuneration Provide separate toilet facilities for women workers	WRD
12.	Labour Camp Facilities	Basic Facility at labour camps & its hygienic	As per BOCW Act, 1996	Labour Camps	Weekly	Visual observation	Restoration of minimum facilities at labour camp	WRD

Performance Indicator		Monitoring Parameters	Standards	Locations	Frequency	Monitoring Method	Corrective Actions in case of deviation	Monitoring Responsibility
		conditions						
13.	Employment	Nos. of local / migrant labour engaged No. of days of engagement Monthly income No. of SC/ST engaged Skill development and no. of trainings organised		Labour camp and worksites	Quarterly	Review of record Employee Monitoring Record (EMR) Consultations with contractor and workers	Employment to be provided to local, women and migrant labour	WRD
14.	Site Restoration	Restoration of all temporary sites like labour camps, storage areas, etc. to ensure the condition prior to use to the maximum extent possible	•	Compensatory afforestation sites, labour campsite, storage areas, local road and construction sites	Once after completion of activities at site	Record checking Visual observation	Restoration to be completed for all the sites before issuance of completion certificate	WRD

Performance Indicator		Monitoring Parameters	Standards	Locations	Frequency	Monitoring Method	Corrective Actions in case of deviation	Monitoring Responsibility
15.	HIV/AIDS and COVID - 19 Awareness Program	Awareness program	As per the prevailing guidelines issued by GoTN and GoI	Labour campsites	Initially once during camp establishment and then onwards, quarterly	Record checking Visual observation	•	WRD
16.	Functioning of GRM	No. of grievances recorded and No. of cases disposed-off % of aggrieved persons satisfied with GRM	-	All project locations and line departments	Quarterly	Consultation with affected communities/ persons No. of grievances received and Addressed Time taken to address grievance No. of litigation in courts	Address all grievances	WRD
17.	Conducting training programs on farming pratices and	Training Programs • No. of participants (Women,	-	Command Area	Quarterly	Record checking Visual		WRD

Performance Indicator		Monitoring Parameters	Standards	Locations	Frequency	Monitoring Method	Corrective Actions in case of deviation	Monitoring Responsibility
	water management	Men)				observation		
Operation Phase								
1.	Surface Water Quality	pH, EC, DO, BOD, Total Coliforms, SAR, RSC, Boron, Free Ammonia (as N)	Inland Surface Water (Class E) Quality (IS: 2296-1982)	Total 06 Locations GA Main Canal, Branch Canal and distributaries	Twice a year (once in pre-monsoon and once in post-monsoon)	Analysis Reports Visual Observation	Clearing of all drains, and vents Regulating the water flow into the canals / tanks	WRD through NABL accredited Laboratory
2.	Ground Water Quality	pH, EC, Total Hardness, Ca, Mg, Na, NO3, SO4, Cl, K, F, PO4, SiO2, Fe, RSC	Ground Water Quality Standard as per BIS: 10500, 2012	Total 06 Locations Nearby habitations on GA Main Canal, Branch Canals and distributaries	Twice a year (once in pre-monsoon and once in post-monsoon)	Analysis Reports Visual Observation	Reasons for quality variation and taking suitable remedial measures	WRD through NABL accredited Laboratory
3.	Soil Quality	pH, EC, Texture, Bulk Density, Water Holding capacity, Organic Carbon, Organic Matter, NPK, CEC, Ca, Mg, Na, K, Fe, Cu, Zn, Mn	Total 30 Locations Soil Quality Standards (IARI)	In and around construction site Near agricultural fields	Twice a year (once in pre-monsoon and once in post-monsoon)	Environmen-tal Monitoring Visual Observation	Check and modify the arrangement of containment of oil, drainage to protect soil quality	WRD through NABL accredited Laboratory

Performance Indicator		Monitoring Parameters	Standards	Locations	Frequency	Monitoring Method	Corrective Actions in case of deviation	Monitoring Responsibility
4.	Survival of Plantations	Visual inspection No. of plants surviving	--	Plantation area near embankment Vacant lands available with WRD	At least one year of gestation period	Survival Record	Replacement of non-surviving plants Application of Manures etc. Fencing repair works	WRD
5.	Silt quality	Heavy metals and pesticides parameters as in the standard	US EPA standard on sediment quality	Silt trap	Before disposal	Analysis reports	Decide on disposal method	WRD through NABL accredited Laboratory

The number of samples/locations described above are minimum and shall be increased based on the sensitivity of the zones in the packages.

9.7 BUDGET FOR ENVIRONMENTAL MONITORING

The budget for environmental monitoring by the M&E agency has been integrated into the overall ESMP budget presented in Chapter 8. One-time sediment quality testing will be in the contractor's scope and the cost for the same is included in contract package. The Budget for Environmental Monitoring is given in Table 54:

Table 54 Budget for Environmental and Social Monitoring (Rough Cost)

Sl. No.	Parameter	Parameters to be monitored	No. of locations	Frequency per annum	Rate per location / Sample (Rs.)	Amount (Rs.) per annum
A.	**Construction Phase**					
(i)	Air Quality	$PM_{2.5}$, PM_{10}, SO_2 and NO_2	4 locations / package	3 times excluding monsoon season	8,000/-	14,40,000.00
(ii)	Surface water quality	pH, EC, DO, BOD, Total Coliforms, SAR, RSC, Boron, Free Ammonia (as N)	4 locations / package	3 times excluding monsoon season	7,000/-	12,60,000.00
(iii)	Ground water quality	pH, EC, Total Hardness, Ca, Mg, Na, NO_3, SO_4, Cl, K, F, PO_4, SiO_2, Fe, RSC	4 locations / package	3 times excluding monsoon season	7,000/-	12,60,000.00
(iv)	Noise level	Leq dB (A) (Day & Night) Average and Peak values	4 locations / package	3 times	5,000/-	9,00,000.00
(v)	Soil quality	pH, EC, Texture, Bulk Density, Water Holding capacity, Organic Carbon, Organic Matter, NPK, CEC, Ca, Mg, Na, K, Fe, Cu, Zn, Mn	4 locations / package	3 times	6,000/-	10,80,000.00

Sl. No.	Parameter	Parameters to be monitored	No. of locations	Frequency per annum	Rate per location / Sample (Rs.)	Amount (Rs.) per annum
(vi)	Sediment Quality	• Physical Parameters: Soil Texture, Grain Size, Gravel, Sand, Silt and Clay • Chemical Parameters: pH, EC, Ca, Mg, Na, N and SAR • Desilted materials: PCBs, heavy metals such as As, Pb, Hg, Cr, Cd and organochlorine pesticides	4 locations / package	3 times	25,000/-	45,00,000.00
			05 (M&E Agency)	3 times	25,000/-	3,75,000.00
(vii)	Other Performance Indicators	• Survival rate of plants • Debris clearance • Safety arrangement for workers • Gender participation			Lumpsum	15,00,000.00
(viii)	Monitoring and Control measures for Contaminated Soil Storage	Desilted materials: PCBs, heavy metals such as As, Pb, Hg, Cr, Cd and organochlorine pesticides			Lumpsum	2,00,000.00
					Sub-Total (A)	**125,15,000.00**
B.	**Operation Phase**					
(i)	Surface water quality	pH, EC, DO, BOD, Total Coliforms, SAR, RSC, Boron, Free Ammonia (as N)	06	2 times	7,000/-	84,000.00
(ii)	Ground water quality	pH, EC, Total Hardness, Ca, Mg, Na, NO_3, SO_4, Cl, K, F, PO_4, SiO_2, Fe,	06	2 times	7,000/-	84,000.00

Sl. No.	Parameter	Parameters to be monitored	No. of locations	Frequency per annum	Rate per location / Sample (Rs.)	Amount (Rs.) per annum
		RSC				
(iii)	Soil quality	Contaminated silt from silt traps: PCBs, heavy metals such as As, Pb, Hg, Cr, Cd and organochlorine pesticides and physico chemical parameters like pH, EC, Texture, Bulk Density, Water Holding capacity, Organic Carbon, Organic Matter, NPK, CEC, Ca, Mg, Na, K, Fe, Cu, Zn, Mn	30	2 times	6,000/-	3,60,000.00
	Monitoring and Control measures for silt from silt traps.	Desilted materials: PCBs, heavy metals such as As, Pb, Hg, Cr, Cd and organochlorine pesticides	5	1 time (Canal closure period)	40,000	2,00,000.00
(iv)	Survival of plantations				Lumpsum	5,00,000.00
					Sub Total (B)	**12,28,000.00**
					Grand Total (A+B)	**137,43,000.00**

Note: *In post construction phase the air quality and noise level monitoring has not been considered because of its insignificant effect.*

CHAPTER 10: CAPACITY BUILDING

The capacity building program for the officials of WRD and other line departments shall be as follows:

- An orientation program to be organized at the district level. The workshop shall be organised once in six months during the project implementation phase, one prior to start of the project and then during the mid-term review.
- The next level of training to be arranged for line department members and sub-basin District line department representatives. This shall be organized once a year to acquaint all experts with the project with respect to environmental and social sensitivity, monitoring and auditing.

A systematic training needs assessment was done by WAPCOS team during the stakeholder's consultations and later when had the meetings with the line department officials during the field visits to the study area. As per the assessment the required Capacity Building Program, the training plan for the target group, implementing and resource organizations of ERM of GA canal are given in Table 55 and 56 respectively.

Table 55: Training Plan for the Target Group

Type of Training	Target Group	Training methods	Frequency
Orientation Program at State level	Decision Makers, Officials of WRD and line Departments	• Lectures • Presentation • Case Studies	• One programme before start of the project • One programme during the mid-term review.
Line Department Level Training program	District line Department representatives	Presentation and Exposure Visits	• Once

Table 56: Implementing organizations, training needs and resource organizations

Organization	Training needs	Resource organization
Specific to Department		
WRD	Purpose and components of ERM for GA canal	Shall be identified based on specific requirements
	Environmental Appraisal process – Screening and Environmental	Shall be identified based on specific requirements

Organization	Training needs	Resource organization
	Appraisal	
	Implementation of Environmental Management Plan Guidelines	Institutions and External Agencies
	Conservation of bio diversity and Eco sensitive hotspots	Shall be identified based on specific requirements
	Afforestation	Shall be identified based on specific requirements
	Environment and Social Indicator Monitering and Preparation of Monitering report.	Shall be identified based on specific requirements
	Institutional arrangement of ESMP	Shall be identified based on specific requirements
	Key aspects for monitoring of ESMP for ERM for GA canal	Shall be identified based on specific requirements
	Environmental issues concerning waste disposal and solid and liquid waste management	Institutions and External Agencies
	Modernization of agriculture like high tech micro irrigation system, solar powered pump sets etc	Shall be identified based on specific requirements
	Impact of Climate variability on crops, importance of adaptation measures, contingency plan etc	Tamil Nadu Agricultural University, Thanjavur
	Updating skills and knowledge on IPM and INM	Tamil Nadu Agricultural University, Thanjavur
	Climate resilient and Organic farming practices	Tamil Nadu Agricultural University, Thanjavur / Departent of Agriculture, GoTN
	Fish farming in farm ponds and value addition of fishery products	Shall be identified based on specific requirements

Organization	Training needs	Resource organization
Common training needs		
WRD	Community mobilization and grass root institution building such as SHGs, Farmers Group	IMTI and other institutions
	Main streaming gender in irrigation and agriculture	IMTI and other institutions
	Participatory Irrigation Management	IMTI and other institutions
	Health and Safety precautions training, Health and sanitation for the community	PHCs and Private Institutions
	General Health and prevention of water brone and non-communicable diseases	PHCs and Private Institutions
	Integrated farming techniques and sustainable development	Tamil Nadu Agricultural University, Thanjavur.

CHAPTER 11: GRIEVANCE REDRESSAL MECHANISM

The GRC is aimed to provide a trusted way to voice and resolve concerns linked to the project, and to be an effective way to address affected person's concerns without allowing it to escalate resulting in delays in project implementation. The GRC will continue to function, for the benefit of the affected persons, during the entire life of the project including the defects liability periods.

At project level GRM will be in place for addressing social, environmental and project related grievances. The GRM will have multi-level structures and processes. At the grassroot level the committee is made up of Assistant Engineer (PIU), Assistant Executive Engineer (PIU) this committee meets on weekly basis. This committee will look after the grievances related to implementation of the mitigation measures, construction practices and issues related to project. It will resolve disputes relating to resource use that may arise between communities, the grievances that may arise with planning measures, or the actual implementation of the project activities. At the next level the Executive Engineer (PIU) convenes the meetings fortnightly ones. The third level is the Superintending Engineer, Executive Engineer (PMU) at the District level as given in Figure 24. The committee organize meetings once in every month.

- **Scope of Grievance Redressal Committee**

The Grievance Redressal Committee (GRC) will receive and redress grievances and complaints that are formally brought to the GRC in writing by the persons and/or group of persons who have a grievance because of the Program's adverse impact on him/her and them. The grievance would, among others, relate to payment of compensation to all project affected persons in accordance with the compensation matrix as given in Annexure 18.

- **Process of GRC**
  - In each District one GRC will function
  - The GRC will receive all grievances/complaints and enter them in the Grievance Register.
  - Effort will be made to create awareness about GRC mechanism to the beneficiaries through use of flyers and pamphlets at the village and Block level.
  - At the grassroot level where ever water user associations are effectively functioning, WUA will take the responsibility to facilitate the submission of complaints to GRC.
  - Where ever there is no WUA, Assistant Engineer, WRD of each section will support the PAPs to reach GRC if any.
  - The GRC will work out a timeframe to redress grievances/complaints if such grievances / complaints are not redressed during the first meeting;

- The GRC will acknowledge receipt of all grievances/complaints, by registered post, within 7 days of receipt at all levels.
- The GRC will consider and redress grievances/complaints through public and transparent process in which all those who have lodged their grievances and complaints in order to facilitate transparency and accountability;
- The GRC will communicate its decisions/redress in writing to the complainants within 4 weeks depending on the nature of complaints and
- The GRC decisions are not the final and the grieved and complainants have the right to seek judicial redress if they are not happy with the decisions of GRC or at any time. But it should not the paraphrase the constitution fundamental rights.

Name, Office Address, Contact number and email id of authorized officer shall be communicated to all the project affected families. The beneficiaries can register complaints in following ways:

- Open House at District level.
- By ordinary/registered/speed post addressed to concerned authorized officer of their area.

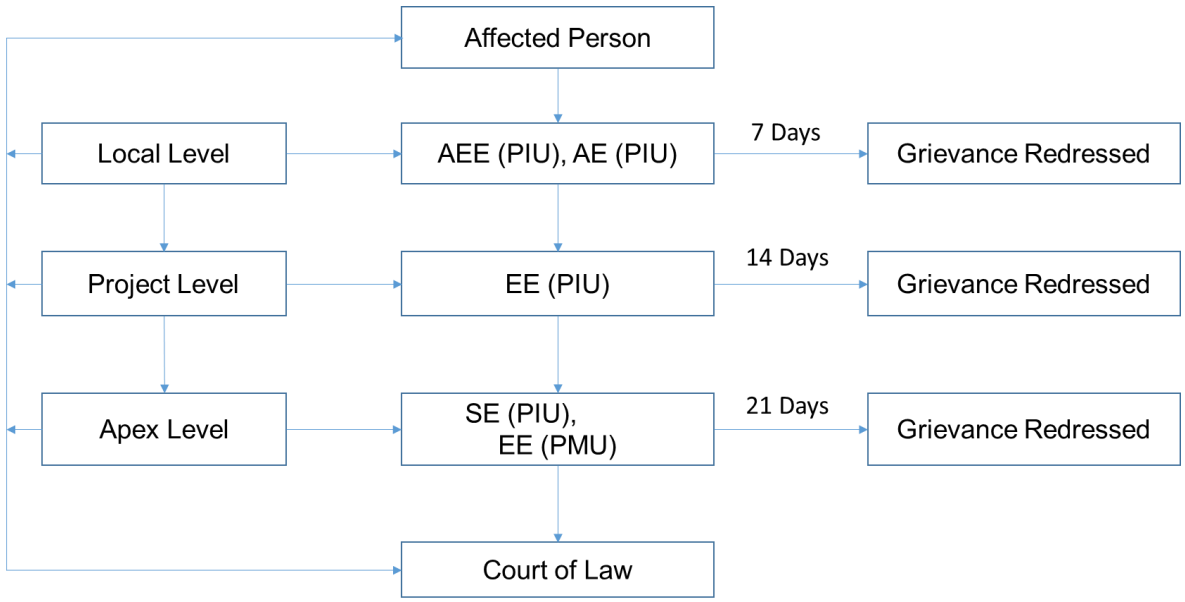


Figure 24: Grievance Redressal Procedure

The GRC will maintain a register of all petitions received with details of date of receipt of the petition, date of hearing and date when it was considered by the committee, along with nature of complaint/concern, action taken, and date of communication sent to petitioner. The complainant's concerns will be redressed in three weeks' time and written communication

will be sent to the complainant about the decision of the committee. The Complaints / Grievance registration form is enclosed as Annexure 19.

The project GRM notwithstanding, an aggrieved person shall have access to the country's legal system at any stage. This can run parallel to accessing the GRM and is not dependent on the negative outcome of the GRM.

In the event that the established GRM is not in a position to resolve the issue, the affected persons can also use the AIIBs Project-affected People's Mechanism (PPM) by directly contacting (in writing) the complaint receiving officer at AIIB headquarters. The complaint can be submitted in any of the official languages of AIIB's Member Countries. The AIIB Project-affected People's Mechanism (PPM) information will be included in the project information document to be distributed to the affected communities, in addition to the project GRM (https://www.aiib.org/en/policies-strategies/operational-policies/policy-on-the-project-affected-mechanism.html) .

Record-keeping. The WRD /DRO will keep records of grievances received, including contact details of the complainant, the date the complaint was received, the nature of the grievance, agreed corrective actions and the date these were affected and the final outcome. The number of grievances recorded and resolved and the outcomes will be displayed/disclosed in the WRD / DRO office, and on WRD/DRO website, as well as reported in monitoring reports submitted to AIIB on a semi-annual basis.

Periodic review and documentation of lessons learned. The PMU will periodically review the functioning of the GRM and record information on the effectiveness of the mechanism, especially on the program's ability to prevent and address grievances.

Costs. All costs involved in resolving the complaints (meetings, consultations, communication and reporting/ information dissemination) will be borne by the WRD.

Workers GRM:

In addition to the GRM which is provided to resolve concerns linked to the project affected person's, a workers GRM as given in Figure 25 shall be functional to resolve the concerns of the workers. The Process and the Committee of GRC for workers shall be the same as to a project affected person's. However, the affected worker shall approach Health and Safety Officer of the contractor at first level and shall be addressed in 3 days. If the greivence is not solved, it shall be automatically diverted to the normal GRM which is functional for the project.

The HSE officer of the contactor shall maintain the record of the grivences of the workers. The concerned Assistant Engineer, PIU, Social Experts of PMU and PMC shall verifiy the register fequently and the escalate to the next level of GRM and process of GRC as described above shall be followed.

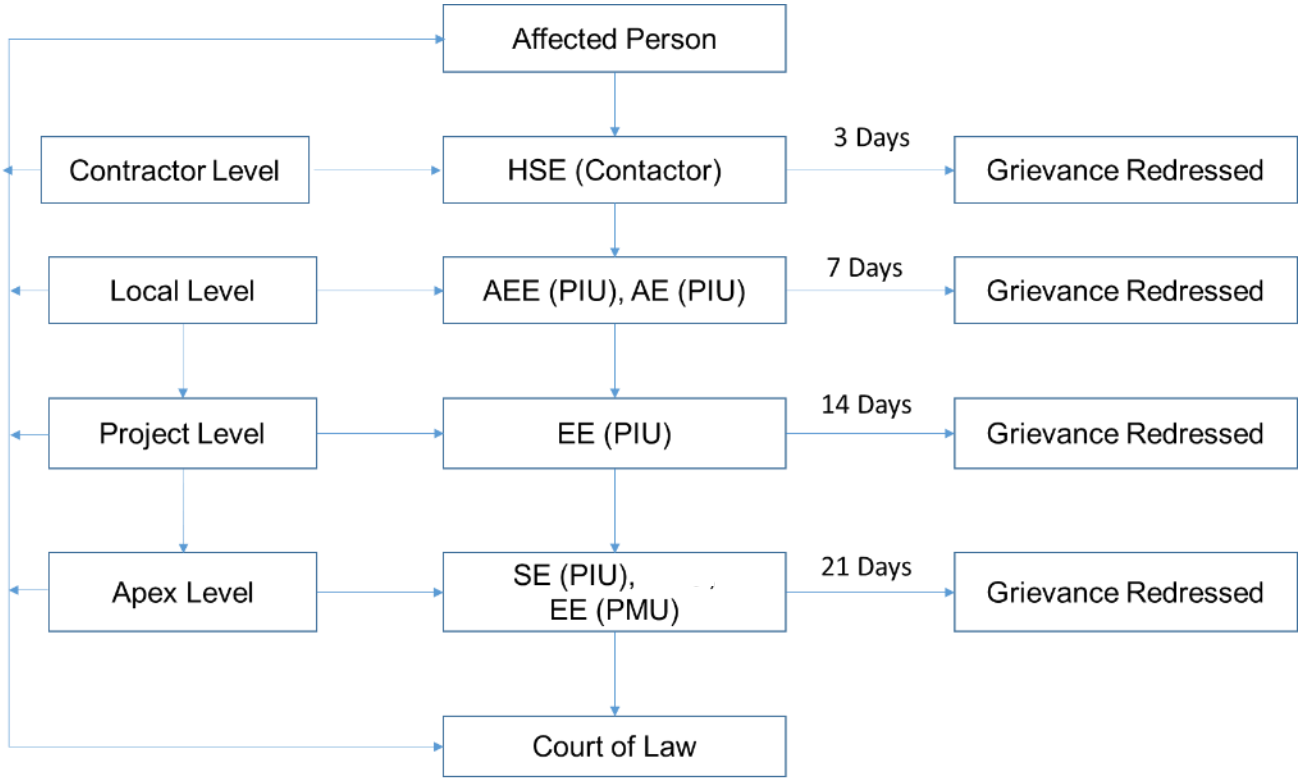


Figure 25: Workers GRM

CHAPTER 12 - INSTITUTIONAL ARRANGEMENT FOR IMPLEMENTATION OF ESMP

The present institutional arrangements in WRD for implementation of the Environmental and Social Safeguards measures in the project area has been reviewed and it is felt that the existing arrangements need to be strengthened to meet the requirements of AIIB Bank which includes adequate staff with specialization in social and environmental management and project institutional structure at different levels. If these issues and concerns are not identified and addressed, it may affect the implementation of the planned activities under the project components.

A community-based approach is proposed in development of various components in the project. To meet this objective, it is essential that from the planning stage i.e., starting from identification process, the community participation is ensured in addressing social and environmental concerns and also are integrated in the overall project framework and plan.

The main objective of the institutional arrangement is to ensure quality assurance and safety structures to apply environmental and social safeguards. The above institutional arrangements for implementation of different project components in the project would be made such that participation of different stakeholder's particularly primary stakeholders and women are ensured. The organization charts for WRD (Fig 26) and ERM GACS Project (Fig 27)

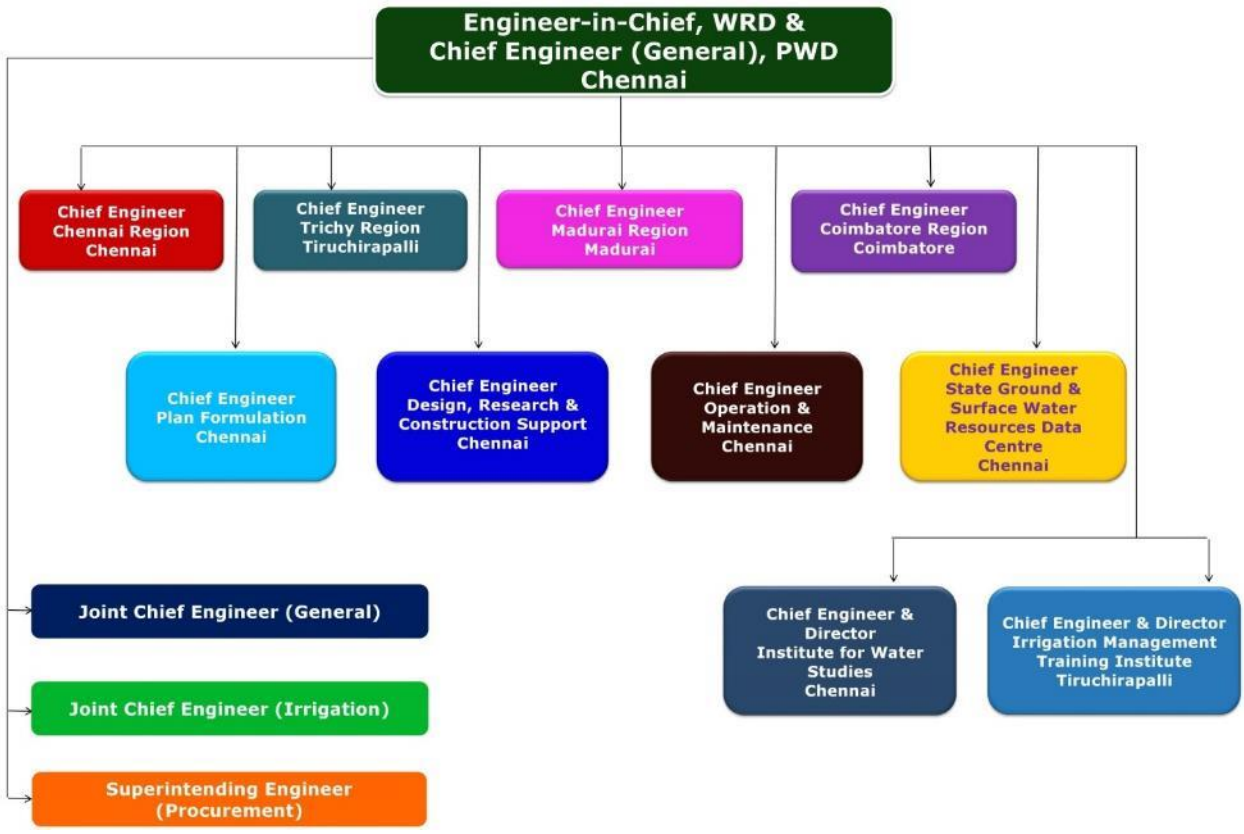


Figure 26: Organization Chart of WRD

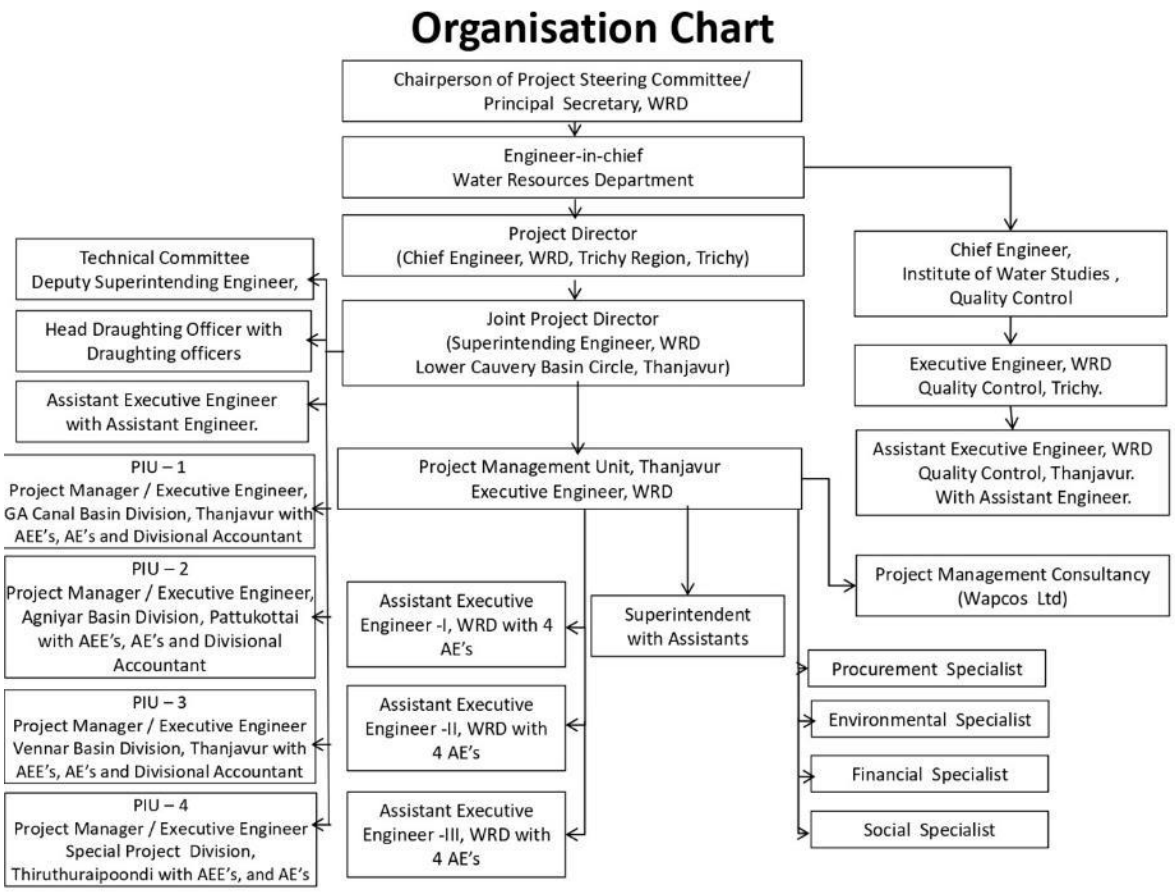


Figure 27: Organization Chart of GA Canal Project

The concerned Executive Engineer (EE) of WRD shall act as Project Implementing Units (PIU's) for all the project activities falling within their domain/responsibility.

It is suggested that a standalone Project Management Unit (PMU) as per the structure suggested in in Fig 12.2 may be formed for management and coordination with all the PIUs, PMC, Bank and other stakeholders headed by Project Director, Joint Project Director and run by Executive Engineer (EE) of WRD with necessary support staff. The PMU should hire a necessary qualified environment and social specialist including procurement, finance etc. In addition, capacity building training on safeguards will be provided to JE, AE, AEE and EE and their equivalents in charge of implementing project activities. Executive Engineer of PMU shall act as nodal officer who will be responsible for monitoring and reporting on the implementation of the environmental and social safeguards arrangements and mitigation actions. An independent audit of implementation of safeguards provisions will be undertaken at end of project. The roles and responsibilities of Environmental and Social Specialists are given in Table-57.

Table 57: Implementation Arrangement – Roles and Responsibilities

Experts	Responsibility
Environmental Specialist (15 Years of Experience)	• Shall be responsible for providing technical inputs on implementation of the different interventions • Shall be responsible for assessing/screening environmental impacts of projects that are being undertaken. • Shall be responsible for supervising the implementation of the Environmental Guidelines • Shall be responsible for coordinating training sessions and awareness programs. • Shall be responsible for supervising the implementation of the HSE • Shall provide necessary inputs towards Formulating training modules and imparting training. • Shall be responsible for coordinating between PIU's of different regions for preparing Environment Information Dissemination Brochures for the interventions. • Shall review the Half yearly Environment Monitoring report and sharing it with the Bank.
Social Specialist (15 Years of Experience)	• Shall provide necessary inputs on social aspects related to the project • Shall prepare Social Management Plans (SMPs) based on assessme carried out for different interventions. • Shall undertake site visits • Shall provide necessary inputs towards formulating training modu and imparting training. • Shall be responsible for supervising the implementation of the Community level HSE • Shall provide inputs for establishing and strengthening of community based organizations. • Shall ensure women's participation and empowerment • Shall assist in conducting workshop and preparing IEC material.

Annexure 1: Stakeholder Consultations

Stakeholder consultations help to identify the key actors and to assess their knowledge, unique experiences, perspectives, interests, possible partnerships, contributions, and the importance of these aspects in relation for planning and management. The consultations would reveal the capacities of different stakeholders to participate in (and benefit from) the project activity. Stakeholder identification and interaction is one of the major activities of the project. The key stakeholder for the current project are the farming communities, elected local bodies, community based groups like SHGs, producer organizations, NGOs actively working in the project area, and a number of government organizations responsible for the management of canals. Field level consultations conducted by a WAPCOS team of experts using participatory methods with the different sections of the farming communities. The details of community level consultations / FGDs conducted and feedback are discussed in this section.

FGD Report - 1

Village : Kandithampattu

Village panchayat : Kandithampattu

Taluk : Thanjavur

District : Thanjavur

Main canal/branch canal/tank irrigation : Main canal & Distribution canal

Number of farmers participated in FGD : 16

Date : 5th September 2020 (Day 01)

Communities	The participants are from Soorakottai, Kasanadu Pudhur, Kandithampattu hamlets. Predominant communities residing in the hamlets are Back ward and Most Backward apart from these considerable number of families belonging to Scheduled caste communities are living.
Livelihoods and resources	Agriculture is the primary livelihoods of majority of the people and are mostly small and marginal holders. Agriculture labour, unskilled and semi-skilled jobs like construction and other works are the other livelihoods. It was reported some families also migrate to urban

	areas for employment.
Farming practices and issues	• Farmers informed that they cultivate paddy crops for Two Periods (Irandu Bogam); Paddy types includes AST-16, AST-36, AST-42. • Previously crops were grown in all the three Seasons (Kuruvai, Samba and Thaladi). In which Kuruvai season crops were grown during June to October; Thaladi season crops were grown for 135 to 145 days starting from October and Samba Season crops is sown in September and harvested in January. • Some farmers informed that they were cultivated for only one period (Oru Bogam); During the interaction, farmers conveyed that they spend the amount earned especially to meet their traditional festival expenses • During the Non-supply period (or) dry period, Sesame (Ellu), Groundnut (Verkadalai), Blackgram (Ulundu) and other Lentils (Payar) types are grown; • Some portion of the project area, Open well Water (Kinathu Paasanam) will be supplied to the crops grown in between January to June months; • The Ground Water Table (GWT) is reduced to 200 Feet below Ground Level due to the existing borewells. **The major issues faced by the farmers are:** • Tail end area is facing water scarcity especially during monsoon failure periods. • Labours shortage was informed during initial crop period • Agricultural crops were infected by rice brown planthopper • Existing harvesting practices are managed by Private Machinaries. • Delay in harvest occurs due to non-availability of machinaries. • Requested to provide drying yards for the crops.
GAC canal condition and suggestions for improvement	• During turn system water is to be supplied for irrigation without any shortage to the crops in all the areas • Farmers requested to restore the carrying capacity of Main Canal. • Farmers requested to provide ramps at suitable locations in order to provide access to domestic animals/farming animals. • The primary requirement of the farmers and villagers is to properly maintain the Canal to prevent future damages and mechanize the turn system for sustainable water management at field level. • Farmers requested to strengthen the bunds of Main and Branch Canals to avoid any issues. • Farmers informed that the Regulator and Sluice shutters is

	operated only by WRD Officials; • Farmers informed that there are no encroachments along the main and distribution canal. • Farmers requested to provide awareness programs on Government schemes and benefits. **Environmental Concerns raised by the villagers**. • Farmers requested not to plant Forest trees near the inner slope of the canal to avoid the blocking the water flow • Women informed that the canal water is used for irrigation and drinking water for cattle.
GAC canal management and farmers participation	• Water User Association (WUA) and FPO (Farmer Producer Organisation) is to be formed in this village to support the department for water and canal management.
Officials Attended	**WRD GA Canal Basin** (i) Th. Murugesan, Executive Engineer (ii) Th. Shanmugavel, Assistant Executive Engineer (iii) Th. Senthan, Assistant Engineer **WAPCOS Limited** (i) Dr. P.Thamizoli, Senior Anthropologist (ii) Th. V. Raghuram, Sociologist (iii) Th. S. Amirtharajan, Engineer

FGD at Kandithampattu Village

FGD Report - 2

Village : Soorakottai

Village panchayat : Vettikadu

Taluk : Thiruvonam

District : Thanjavur

Main canal/branch canal/tank irrigation : Main canal

Number of farmers participated in FGD : 19

Date : 5th September 2020 (Day 01)

Communities	The participants are from Thekkur and Vadakur hamlets Predominant communities residing in the hamlets are Back ward and Most Backward apart from these considerable number of families belonging to Scheduled caste communities are living.
Livelihoods and resources	Agriculture is the primary livelihood of majority of the people and are mostly small and marginal holders. Agriculture labour, unskilled and semi-skilled jobs like construction and other works are the other livelihoods. It was reported some families also migrate to urban areas for employment.
Farming practices and issues	• Farmers cultivate two crops if Cauvery water is released on June 12 the traditional date. Otherwise released late it is restricted to one crop. Paddy is the main crop for the first two seasons, the varieties cultivated are: AST 16 and 32 (120 days crop) • First season is called Kuruvai (June to October) • Second season is called *Thaladi* (November to February) • Some of the farmers cultivate the third crop called *Kodai payir* (summer crops), the crops cultivated are Sesame, Black gram and Chick pea. • Apart from canal irrigation farmers use bore wells. Due to depletion in the ground water at present efficiency of bore wells had been reduced
Major issues faced by the farmers:	• The 'turn system' is to be implemented for proper utilization of water and avoid wastage especially during monsoon failure. • Pest manifestation in paddy is a major issue farmers need suitable advice. • Farmers requested to provide drying yards for the crops since they thrash and dry the paddy on the roads. • Farm labourers prefer other unskilled works as they get more

	wage than wage for agriculture activities. labour. This is another factor why farmers find difficult to get labour for agriculture.
GAC canal condition and suggestions for improvement	• Mostly water does not reach the tail end region due to the existing conditions of the canal system. • It was mentioned that a village tank located at the tail end has not received water due to the dilapidated condition of the inlet channel. • Weak bunds, causing seepage and affects the crops in the fields close to the bunds. • Farmers requested to provide adequate field staff for proper operation and maintenance of the canal. • One stretch of the canal was renovated hence there are not much issues in that particular stretch. • Strongly suggested proper lining of bed and sides of the canals. • Structures damaged like bridges, sluices etc., need to be renovated/restored. • To address any issue local farmer approach the luscars or the field engineers, issues like sharing of water when the flow in the canal is reduced, bund leakage, damage of structures etc.
GAC canal management and farmers participation	• Sharing of water is done among the villages through the traditional methods, like the 'turn system' they practice. No Water User Association (WUA) is functioning in the area but farmers are aware of WUA and shown interests to form a WUA and support the department for water and canal management.
Officials Attended	**WRD GA Canal Basin** (i) Th. Shanmugavel, Assistant Executive Engineer (ii) Th. Anbarasu, Assistant Executive Engineer (iii) Th. Mathiyalagan, Assistant Engineer (iv) Th. Rajamanickam, Assistant Engineer (v) Th. Surendra Mohan, Assistant Engineer **WAPCOS Limited** (i) Dr. P. Thamizoli, Senior Anthropologist (ii) Th. V. Raghuram, Sociologist (iii) Th. S. Amirtharajan, Engineer

FGD at Vettikadu WRD Office

FGD Report - 3

Village : Thelungankudikadu

Village panchayat : Thelungankudikadu

Taluk : Orathanadu

District : Thanjavur

Main canal/branch canal/tank irrigation : Distribution canal

Number of farmers participated in FGD : 17

Date : 5th September 2020 (Day 01)

Communities	The participants are from Thelungankudikadu, Kovilur and Neduvakottai hamlets. Predominant communities residing in the hamlets are Back ward and Most Backward apart from these considerable number of families belonging to Scheduled caste communities are living.
Livelihoods and resources	Agriculture is the primary livelihood of majority of the people and they are mostly small and marginal holders. Agriculture labour, unskilled and semi-skilled jobs like construction and other works are the other livelihoods. It was reported that some families also migrate to urban areas for employment.
Farming practices and issues	• Farmers informed that they cultivate paddy crops for Two Periods (*Irandu Bogam*); *Kuruvai* Season includes AST-16, AST-36 and similarly for *Thaladi* Season PPT, ADP-42 type paddy crops were harvested in this village; • Farmers informed that the Kuruvai crops were planned after 8 years as the adequate water is available this year. • Farmers with Borewells are cultivating three crops (*Moondru Bogam*) with Bore Water • Only Single Crop is planted majorly in this area; However, few farmers also planted Coconut trees along the farm field; • Locals informed that the ground water is available 240 Feet below G.L. **The major issues faced by the farmers are:** • Farmers are facing difficulties in diverting the canal water to (1/10) Distribution canal, it was informed that the water is not diverted often without villager's request; • Machines were used for Crop planting and cutting, however it was unsuccessful and the farmers requested to provide machines

	for the same; • Crop Selling rate has to be increased – Request from Local villagers; • Private procurement with less cost is also a problem faced by the Local Farmers, they informed that they sold at the loss of 5 bags out of 100 bags; • Farmers informed that they are not benefitted with Government Schemes towards Paddy Crop Cultivation (Nerkalanjiyam); • Requested to provide Go-down (Kalam) for storing and drying paddy for all the villages.
GAC canal condition and suggestions for improvement	• Village People informed that the Bed Lining shall affect the Ground Water Recharge, few also informed that they had faced such issues last time. • Farmers requested to relay the gravel road on the Left Bund so that they can easily access the farm field; • Along with the Canal, few suggested to rejuvenate the Lakes and Ponds by renovation and restoration so that the surrounding village shall utilise the stored water in dry season; • Regular maintenance of structures adjacent to the Main and Distribution Canals needs to improve request from locals; • Farmers suggested to construct a Bed Dam across the Distribution Canal so that a sufficient water can be utilised by the nearby villager's; Few recalled that a few Bed Dams were constructed 10 years ago which was utilised by the local people; • Branch Canal (8/10) diverging from K.B Distribution Canal is presently elevated from the intake place, requested to regrade the canal bed; • Requested in strengthening the Bund to avoid water spill; • Few farmers shared their experience that there is no guarantee that through digging bore wells the farmers will get water, the reason is that water table has gone 1000 feet below Ground Level. **Environmnetal Concenrs raised by the villagers**. • Farmers requested to not plant Forest Trees adjacent to the Canal or near the Inner Slope, as it falls into the canals thereby blocking the water. • Women informed that the canal water is not potable used for irrigation and drinking water for cattle.
GAC canal management and farmers participation	Presently Turn System is practised to supply the canal water. No Water User Association (WUA) and FPO (Farmer Producer Organisation) is formed in this village. Farmers encourages in forming WUA towards effective use of

	Canal Water and proper maintenance;
Officials Attended	**WRD GA Canal Basin** (i) Th. Matheswaran, Assistant Engineer **WAPCOS Limited** (i) Dr. P.Thamizoli, Senior Anthropologist (ii) Th. V. Raghuram, Sociologist (iii) Th. S. Amirtharajan, Engineer

FGD at Thelungankudikadu

FGD Report - 4

Village : Alathur

Village panchayat : Alathur

Taluk : Madukkur Block

District : Thanjavur

Main canal/branch canal/tank irrigation : Tank Irrigation

Number of farmers participated in FGD : 18

Date : 5th September 2020 (Day 01)

Communities	The participants are from Alathur and nearby villages; Predominant communities residing in the hamlets are Backward and Most Backward apart from these considerable number of families belonging to Scheduled caste communities.
Livelihoods and resources	Main Occupation is mostly agriculture activities. Other than that agriculture labour, farming domestic animals, unskilled and semi-skilled jobs like construction and other works are the other livelihoods.
Farming practices and issues	Paddy (AST-16) and Coconut (70% and 30% Ratio) are majorly planted in the surrounding villagers; Farmers informed that they have not cropped paddy in Kuruvai season till date as there is no water is available in this year; Presently this Tank is rejuvenated under Chief Minister Scheme (*Kudimaramathu*) and farmers informed that the canal is located at 700 m from the Tank;
The major issues faced by the farmers	• Requested to construct more Bed Dams across the Distributary Canal so that sufficient water can be stored and supplied to the nearby villages; • Farmers informed that the canal water is stored till May Month in the tank for Irrigation and Other activities; requested to renovate other tanks in the nearby villages also. • Farmers informed that they have faced loss from agriculture due to the following reasons: • Increased labour salary • More Intial Investment

	• Insect Attack on the paddy Crops and Coconut (Gaandamiruga vandu). • Only mechanised crop cutting is practised, which is expensive • Female farmers are engaged for crop planting (*Nadavu Naduthal*) and removing weeds (*Kalai*) in the farm field; Few youths are also have taken up agriculture activities temporarily due to COVID-19 outbreak;
GAC canal condition and suggestions for improvement	The Main Water source for some farmers in the surrounding area is from the Alathur Pudhu Eri (Fed from G.A. Distribution Canal); • Requests from Villagers are as follows: • Requested to rejuvenate the Tanks and Ponds in the surrounding villages • Requested for proper maintenance of Supply channel from GA Distribution Canal;
GAC canal management and farmers participation	Presently a Water User Association (WUA) in the name "***Alathur Pudhu Eri Neerinai Payanpaduthuvor Sangam"*** is formed during last year in this village. It was informed that there are 15 Female participants in the WUA as members;
Officials Attended	**WRD GA Canal Basin** (i) Tmt. Sasikala, Assistant Engineer (ii) Th. Matheswaran, Assistant Engineer **WAPCOS Limited** (i) Dr. P. Thamizoli, Senior Anthropologist (ii) Th. V. Raghuram, Sociologist (iii) Th. S. Amirtharajan, Engineer

FGD at Alathur Pudhueri

FGD Report - 5

Village : Ottankadu

Village panchayat : Ottankadu

Taluk : Pattukottai

District : Thanjavur

Main canal/branch canal/tank irrigation : Main, Distribution canal and Tank Irrigation

Number of farmers participated in FGD : 16

Date : 6th September 2020 (Day 02)

Communities	The participants are from Pallakur, Aandikadu, Aandivayal, Sokkanathapuram, Udhayanadu, Marakavalasu, Ottankadu and Pallathur villages. Predominant communities residing in the villages are Backward and Most Backward apart from these considerable number of families belonging to Scheduled caste communities are living.
Livelihoods and resources	Agriculture is the primary occupation of majority of the people and are mostly small and marginal land holders. Agriculture and construction labour, unskilled and semi-skilled jobs and other works are the other livelihoods.
Farming practices and issues	• Farmers informed that the main source of Water is from 'Pudupattinam Main Channel, G.A. No.8 Main Canal (1 – 7 Nos); • Presently one and two periods of cultivation are being practised (*Irandu Bogam*) (Jun to Oct) (i.e.,) after supplying the canal water; • Paddy crops - CR, PPT, ADT 32, ADT 39 (Kalsar), IR 20, CR 1009, *Vella Ponni*, NLR, QR 51, *Aathur Kichadi Samba* and crops with 115 - 160 days of cultivation period are grown in the surroundings; • Coconut Types – *Nettai*, *Kuttai*, *Kuttai-Nettai*, Mandia and Malaysian types of Coconut Trees are planted in these villages; • Few Farmers also cultivate Groundnut in December (*Maargazhi*) utilising both canal and bore water; Types of Groundnut cultivated predominantly in this region includes Western 44, JL and Country types (*Naatu Vagai*) etc., • Dry Crops like Blackgram (*Ulundu*), Sesame (*Ellu*) and Banana were also cultivated in the areas nearby; Some informed that Turmeric plants are also planted along the Tree Cultivation

	(*Oodupayir*); • Mostly all the farmers use chemical fertilizers, very few adopt organic (Regular) fertilizers for all the agricultural crops; • Predominantly machines were used for agricultural works (Power Tiller); Few villagers having own machines while many rent from outside for agriculture activity; • The Canal water reached till Tail End (*Kadai madai*) until 2003, double crops (*Irandu Bogam*) of cultivation were followed till then; Unfortunately, it is reduced to single crop (*Oru Bogam*) later due to less water supply; • The farmers informed that the Branch Canal was repaired last year (2019) and it caused increased water supply for agricultural activities; • Both the Canal and Bore-Well Water is used for agriculture activities in this region; • From 2000 – 2006, only Single crop (*Oru Bogam*) was cultivated due to inadequate water supply; **The major issues faced by the farmers are:** • Non-availability of labours is the main issue faced by many farmers; • Presently adequate water is not available for second & third crop (Irandam & Moondram Bogam) agriculture activities; • Certain diseases spread on Paddy Crops includes Aanaikomban, Pungan, *Kulanoi*; **The request from the farmers are listed below:** • During the discussion few villagers requested that the Tanks under Union Panchayats control/jurisdiction also requires improvement such as Strengthening, Repairing the Inlets and Outlets and maintenance; • To divert the rain water to the nearby village tanks, so that the farmers shall be benefitted;
GAC canal condition and suggestions for improvement	**Requests from Villagers are as follows:** • Proper maintenance of Bund, shutters and Sluice gates; • Requested to clear the fallen trees (Teakwoods) belonging to the forest Department, during Gaja Strom (2 Years ago) which is still not removed in Ottankadu Rajali Eri – Supply Channel;
GAC canal management and farmers participation	Farmers informed that after facing problems in obtaining and using the Canal Water, Water User's Associations (WUA's) were formed which are listed below;

	1. 'Kallanaiyaru Neerpaasanatharar Sangam - 2. 'Pallathur Neerpaasanatharar Sangam 3. 'Rajali Eri Neerpaasanatharar Sangam 4. 'Pallathur Periya Eri Kannudayan Eri Neer Paasanatharar Sangam 5. 'Aandikulam Paasanatharar Sangam 6. 'Sivalingakulam Nochikulam Neer Paasanatharar Sangam WUA's are active in this area except *Pallathur, Aandikulam and Sokkanathapuram*. Female farmers are presently engaged only as members; it was informed that there were no female farmers posted in Executive Levels but all the male farmers are willing to accept the female participation in WUA in future. • During the discussion, it was informed that the members of WUA will perform the Operation and Maintenance (O&M) of water supplied to the village to the nearby villages. In order to avoid misuse of water in the middle of supply channel, this practise is being followed.
Officials Attended	**WRD GA Canal Basin** (i) Th. Anbarasan, Assistant Executive Engineer (ii) Th. Narayanaswamy, Assistant Engineer (iii) Th. Rajamanickam, Assistant Engineer **WAPCOS Limited** (i) Dr. G. Pandiaraj, Social Expert (ii) Th. V. Raghuram, Expert (iii) Th. S. Amirtharajan, Engineer (iv) Th. K. Periyasamy, Junior Engineer

FGD at Ottankadu

FGD Report - 6

Village	: Peravurani
Village panchayat	: Peravurani
Taluk	: Peravurani
District	: Thanjavur
Main canal/branch canal/tank irrigation	: Distribution canal and Tank Irrigation
Number of farmers participated in FGD	: 7
Date	: 6th September 2020 (Day 02)

Communities	The participants are from Ammanyandi Merku, Marakavalasi, Sengamallur, Aavanam, Periyanayagi and Peravurani villages. Predominant communities residing in the hamlets are Back ward and Most Backward apart from these considerable number of families belonging to Scheduled caste communities are living.
Livelihoods and resources	Agriculture is the primary occupation of majority of the people and mostly small and marginal land holders. Agriculture and construction labour, unskilled and semi-skilled jobs and other works (farming domestic animals viz. Cow, Goat and Sheep) are the other livelihoods.
Farming practices and issues	• During the discussion, villagers informed that the Canal Water is supplied at 7-days Interval (Turn System basis). • Presently single crop cultivation is followed (*Oru Bogam*) and only few (near Aavanam Village) involves in double crops cultivation with borewells.

	• Bore water is the main source of drinking water in this region. • Major Crops harvested in the locality includes Paddy, Sugarcane, Groundnut, Blackgram *(Ulundu)*, Sesame (*Ellu)*, Coconut, Banana etc., • Primarily ACM -10, CR, O43, *Athisiya Ponni*, *Kalsar*, *Deluxe Ponni* are the types of Paddy cultivated in this village. • Sugarcane, Coconut and Banana cultivation is reduced in recent cultivation due to Non-Availability of water, very few with Bore wells are still continuing planting. • Farmers informed that there will be difference in production quantity between villagers (i.e.,) between 25 to 30 bags of paddy per acre. **The major issues faced by the farmers are:** • During the discussion farmers informed that there is no common space for drying and storing the paddy. • Farmers informed about the Chemical Fertilizer shortage. **The requests kept forward by the farmers are:** • Farmers requested to construct common drying yard 'Kalam' for all the villages to store and dry the paddy. • Requested to repair all the structures, sluices and proper maintenance. • Farmers are aware about Crop Insurance (Payir Kaapittu Thittam).
GAC canal condition and suggestions for improvement	• Villagers informed that the main water source is from Kallanaivasal Channel, Anandhavalli Channel, Sethuvachathiram Main Channel, Aavanam Tank. • During the discussion, many villagers informed that the present condition of Distribution and Branch canals has to be repaired to effectively utilise the canal water and also to increase the supply level.
Environmental Concerns raised by the Farmers**.**	• Farmers requested to not plant Forest Trees adjacent to the Canal or near the Inner Slope, as it may damge the bunds. • At some places, domestic, agricultural wastes and branches of felled trees were dumped in the canal bund, it has to be cleaned and maintained properly. • Forest Trees (Teak) felled near Kandiyarkulam – Anandhavalli and Kandivaasal Channel is still not removed and presently it blocks the water. • Presently the tanks, lakes and ponds are dilapidated and hence not able to store rainwater. Hence it was requested to renovate and

	rehabilitate the associated structures for better utilisation of canal and rain water.
Farmers requested the following	• Requested to renovate the inner slope of the GA Canal. • "**Neiveli Kaatamanaku**" – a poisonous plant needs to be removed near the canal and tanks and Proper Bund Strengthening also to be made in the downstream portions. • Requested to repair all the Sluices and shutters in the supply channel and Tank (G.A. No:8 Channel, Peravurani Periya Eri); • Requested to improve all the Tanks fed from GA Distribution and Main Canal and Supply channels;
GAC canal management and farmers participation	• Farmers informed that a Water User's Association (WUA) with the name "***Neeranikkam***" is formed to guide local villagers about effective water utilisation during the Dry season; Presently it is diluted in the month of June to October. Villagers also requested to form a WUA and willing to accept female participation in the WUA if women are interested.
Officials Attended	**WRD GA Canal Basin** (i) Th. Prasanna, Assistant Engineer **WAPCOS Limited** (i) Dr. G. Pandiaraj, Social Expert (ii) Th. V. Raghuram, Expert (iii) Th. S. Amirtharajan, Engineer (iv) Th. K. Periyasamy, Junior Engineer

FGD at Peravurani

FGD Report - 7

Village : Enadhikkarambai

Village panchayat : Enadhikkarambai

Taluk : Peravurani

District : Thanjavur

Main canal/branch canal/tank irrigation : Main Canal

Number of farmers participated in FGD : 5

Date : 14th July 2020

Communities	The participants are from Enadhikkarambai village, Thanjavur District on the left bank of Grand Anicut main canal. The focus group discussion was conducted with WRD land lease holders. Multicultural communities reside in this village.
Livelihoods and resources	Agriculture is the primary livelihoods of majority of the people and mostly small and marginal holders. Agriculture labour, unskilled and semi-skilled jobs like construction and other works are the other livelihoods. It was reported some families also migrate to urban areas for employment.
Farming practices and issues	• Paddy is the only crop harvested in this stretch with single crop pattern being adopted. • Varieties of paddy cultivated include (CR, Deluxe, Kalasa, in this stretch). Predominantly CR paddy variety is cultivated when sufficient water is available. • Crop rotation practices are not adopted in the area. • When water is not available for agriculture, people make living by depending on domestic animals viz. cow, goat farming. Very few people make living from skilled work viz. Electrical works and carpentry. Apart from these livelihood activities there are no alternatives for source of income. • Since irrigation of land is regulated by rotation policy, the land is irrigated once in 5 to 10 days.
GAC canal condition and suggestions for improvement	• Due to the reduced carrying capacity of the GA canal, the water reaching tail end fields is less as compared to the

	upper reaches. Even when the regulators are opened water is available only for particular period of time. • During lean flow season fishing activities are carried out in the canal. The Major types of fish available are podi, kendakodi, kelugu and koduva. • Very unique traditional land measurement is being practiced in and around the villages. • For the last three years meager agricultural activities were carried out due to water leakage near the Vembakkudi village, (Veppannai to Paingal Keezpadi stretch) between 2017-18. • The local farmers have requested to rehabilitate the canal so as to increase the water carrying capacity and avoid leakages.
GAC canal management and farmers participation	• Sharing of water is done among the villages through the traditional methods, like the 'turn system' they practice. • No Water User Association (WUA) is functioning in the area but farmers are aware of WUA and shown interests to form a WUA and support the department for water and canal management.
Officials Attended	**WRD, GA Canal Division** (i) Th. Shanmugavel, Assistant Executive Engineer (ii) Th. Prasanna, Assistant Engineer **WAPCOS Limited** (i) Th. A. Stephen Leo, Team Leader (ii) Dr. Pandiaraj, Anthropologist (iii) Th. Thumma Venu Madhav, Engineer (iv) Th. Achal Satish Khilnani, Engineer (v) Th. S. Amirtharajan, Engineer (vi) Th. K. Periyasamy, Junior Engineer
 Focus Group discussion with farmers at Enadhikkarambai village	

FGD Report - 8

Village : Mumpalai

Village panchayat : Mumpalai

Taluk : Peravurani

District : Pudhukottai

Main canal/branch canal/tank irrigation : Main Canal and Tank Irrigation

Number of participants in FGD : 14

Date : 14th July 2020

Communities	• The focus group discussion was conducted with *Maha Ganapathipuram Kadaimadai Paasana Sabai* (Water User's Association) at Mumpalai village, Pudhukottai District on the Tail end of Grand Anicut main canal. • The *Maha Ganapathipuram Kadaimadai Paasana Sabai* consists of ten villages, which are Mumpaalai, kanvenivayal eri, Melasthana eri, Koothadivayal, Pillaiyarthidal, Koothankudi, Mahaganapadhipuram, Chinnaidaiyan eri, Periyaidayan eri, Nemmelivayal eri. • Many communities are living in these villages.
Livelihoods and resources	• Agriculture is the primary livelihoods of majority of the households and mostly small and marginal holders. • Agriculture labour, unskilled and semi-skilled jobs like construction and other works are the other livelihoods. • It was reported some families also migrate to urban areas for employment.
Farming practices and issues	• Two decades ago farmers cultivated Paddy as double crop in a year (*irandu bogam*). But, at present they cultivate only single crop a year due to water scarcity from the canal. • Predominantly high yielding variety of paddy (BPT) is being cultivated in this region. The cultivation period is almost 150 days. • The command area of the Mumpalai tank is around 300 acres. • The GA main canal water reaches its tail end only after 15 days from the date of opening of the head regulator. • During dry season people involve in other livelihood activities like cow and goat farming, also work as agricultural labour in the neighbouring farms, construction labour, and aquaculture farm. • For the last three years farmers face a huge damage due to a disease called gall midges *(Aanaikomban)* in paddy. It was

	brought to the Government notice to interfere and find a permanent solution. • The GA canal water is used only for irrigation purpose. • In one acre of land 25 - 30 bags of paddy is harvested.
GAC canal condition and suggestions for improvement	• It was reported that the farmers of the upstream portion of the canal have damaged the canal which caused reduction of water at tail end of the canal. • The members have requested to strengthen the canal by protecting the bed and side slopes of the canal from erosion, leakages and burrows due to the reptiles and crustaceans. • Farmers requested to operate the sluice gates for equal distribution of water for irrigation.
GAC canal management and farmers participation	• Sharing of water is done among the villages through the traditional methods, like the 'turn system' they practice. • This association was locally formed ten years ago in consultation with the WRD. • The main purpose of this association formation is to use the canal water judiciously. • During the inception of the association a Joint bank account was opened by the association members with the contributions from village people and funds from the government for the maintenance of the canal. • The association consists of 5 women members however there is no women designated as the executive member who can take part in decision making. **Environmental Issues raised by the Villagers** • Farmers requested not to plant trees by the Forest Department nearer to the inner Slope of the canal, as it may block the water flow.
Officials Attended	**WRD GA Canal Basin** (i) Th. Anbarasu, Assistant Executive Engineer (ii) Th. Thennarasu, Assistant Engineer **WAPCOS Limited** (i) Th. A. Stephen Leo, Team Leader (ii) Dr. Pandiaraj, Anthropologist (iii) Th. Thumma Venu Madhav, Engineer (iv) Th. Achal Satish Khilnani, Engineer (v) Th. S. Amirtharajan, Engineer (vi) Th. K. Periyasamy, Junior Engineer

Focus Group discussion with Water users association at Mumpalai Tank

FGD Report - 09

Village : Thelungankudikadu

Village panchayat : Thelungankudikadu

Taluk : Orathanadu

District : Thanjavur

Main canal/branch canal/tank irrigation : Branch Canal

Number of participants in FGD : 7

Date : 16th July 2020

Communities	• The focus group discussion was conducted with the people who reside on the left side of Kalyanaodai Branch Canal, at Thelungankudikadu Village, Thanjavur District.
Livelihoods and resources	• Their primary source of income is as agricultural labourer.
Farming practices and issues	The families own no land. As already mentioned they work as labours in the agricultural fields or any other wage work.
Canal condition, Environmenal Issues and Suggestions for improvement in GACS	• They are not using canal water for drinking purpose. The village has a separate bore well and overhead tank. • They take water from the canal for their domestic activities like washing clothes, vessels, bathing, etc. • According to them the water quality is good for washing purposes.
Officials Attended	**WRD, GA Canal Basin** (i) Th. Shanmugavel, Assistant Executive Engineer **WAPCOS Limited** (i) Th. A. Stephen Leo, Team Leader (ii) Dr. Pandiaraj, Anthropologist (iii) Th. Thumma Venu Madhav, Engineer (iv) Th. Achal Satish Khilnani, Engineer (v) Th. S. Amirtharajan, Engineer (vi) Th. K. Periyasamy, Junior Engineer

FGD Report - 10

Village : Ambalapattu Therku

Village panchayat : Ambalapattu

Taluk : Orathanadu

District : Thanjavur

Main canal/branch canal/tank irrigation : Branch Canal and Tank Irrigation

Number of farmers participated in FGD : 8

Date : 16th July 2020

Communities	The focus group discussion was conducted with the farmers and Water User's Association President, and other members. At *Ambalapattu therku* village, Orathanadu Taluk, Thanjavur District.
Livelihoods and resources	• Their primary source of income is from agriculture and their secondary source of income is through making mats from the fronds of coconuts (*Keethu pinnudhal*) and agricultural labours. • They go for agricultural labour on daily basis for paddy transplanting (*nel nadavu*).
Farming practices and issues	• Three tanks are located in the Village Panchayat. • Name of the tanks – *Kurichchi* tank, *Aandal* tank and *Kurumbai* tank. • *Ambalapattu therku* and *Sembalur* village farmers are highly depended with the *Kurichchi* tank and *Aandal* tank for their agricultural activities. They consider *Aandal* tank as their primary source of water to *Ambalapattu* tank. • During rainy season they predominantly cultivate paddy. Farmers cultivate many paddy high yield varieties like CR, CR 37, IR 20, IR 45, BPT, *Culsar*, *Maappillai samba* and *Adhisaya ponni*. • During dry season they cultivate groundnut, pulses (*ulundu*, *thuvaram*, *paasi*), corn (*solam*) and sesame (*Ellu*). • For irrigation they depend on different sources, such as canal water, tank water, and bore wells.

	• Canal and tank water are the main source for irrigation, a few farmers use drip and sprinkler irrigation for coconut farms and other tree crops. • Rats are damaging the paddy field and they call crab as farmer's friend (Vivasayeen Nanban), crab eats destroys harmful insects from the field such as *vettukkili*. • An average of 25 to 30 bags of paddy is produced per acre of land in one period. • Majority of the farmers are using pesticides for agricultural activities and very few farmers are following the traditional farming techniques and it helps them to reduce the cost of cultivation. • To add their income farmers manage backyard dairy and also rear goats. • Ayacut area of this tank is 250 acres with two hundred farmers. They cultivate both wet land and dry land crops (*Nanjai* and *Punjai*). • Farmers are well aware of the government schemes and subsidies. Also, many of them purchased tractor, drip irrigation pipe, and sprinkler, etc., with the support of the Government schemes. • In the village major farmers have formed their own farmers groups and Women Self Help Group (SHG) are functioning well.
Health, Sanitation and Other Issues raised by the community	• So far, there is no water borne diseases experienced by the village people. They do not use the canal and tank water for their drinking purpose. • They have identified some common diseases in the paddy field such as *yaanaikamban, pugaiyan, manjuyanai, verpoochi, kurathupoochi*.
GAC canal condition and suggestions for improvement	• They are not using the canal water directly for their drinking purpose. They have individual bore wells and panchayat overhead tanks for drinking. • Farmers requested not to plant Forest Trees adjacent to the Canal or in the inner Slope, as it blocks water flow.
GAC canal management and farmers participation	• The Water User's Association is formed four months ago. It is named "*Kurichchi eri neerinai payanpaduthuvor sangam*" preceded by "*Paasanadharargal sangam*" which was

	established two decades ago. This water user's association is formed with around 75 members which include 5 female members • This association used the public contributions and government funds. • They have planted around 1800 trees saplings on the bund and 200 to 250 trees saplings in other area using Miyawaki method. • Palms and coconut are the two species planted more in number. • The main objective of WUA is for proper management of tank water and avoid conflict among the farmers. • Recently the WUA renovated the tank with the support of Government officials. This resulted in increasing the ground water table. GA distribution canal water reaches in 15 days to the tank.
Officials Attended	**WRD, GA Canal Basin** (i) Th. Shanmugavel, Assistant Executive Engineer **WAPCOS Limited** (i) Th. A. Stephen Leo, Team Leader (ii) Dr. Pandiaraj, Anthropologist (iii) Th. Thumma Venu Madhav, Engineer (iv) Th. Achal Satish Khilnani, Engineer (v) Th. S. Amirtharajan, Engineer (vi) Th. K. Periyasamy, Junior Engineer
	

Focus Group discussion with Farmers at Ambalapattu therku village

FGD Report - 11

Village : Nagudi

Village panchayat : Nagudi

Taluk : Aranthangi

District : Pudukottai

Main canal/branch canal/tank irrigation : Main Canal and Extension Canal Number of farmers participated in FGD : 14

Date : 6th September 2020

Communities	Predominant communities residing in the hamlet are belonging to Back ward and Most Backward categoriesapart from these communities considerable number of families from Scheduled caste communities are living.
Livelihoods and resources	• Agriculture is the primary occupation of majority of the families and mostly small and marginal holders. • Agriculture and construction labour, unskilled and semi-skilled jobs and other works are the other livelihoods, some of the families also rear domestic animals such as poultry, Sheep, Goat, Cow and Buffalo etc., • Farmers informed that sufficient farmlands is not available to own many domestic animal.
Farming practices and issues	• During 1934 to 1985, farmers cultivate for three crops (*Moondru Bogam*). Then during 1985 to 2000, it is reduced to two crops (*Irandu Bogam*). Currently, the farmers cultivate single crop (*Oru Bogam*), this change is due to the drastic decrease in the water supply in GA Canal and othe distribution Channels. However, some of the farmers own bore wells cultivate two crops. • Paddy is the main crop cultivated by the farmers, crops like Groundnut (*Verkadalai*) and Sesame (*Ellu*) are cultivated during

	the lean season by some farmers. Some farmers own coconut trees. • BPT, NLR, CR 1009, KO 51, Kalsar are the different varieties of Paddy cultivated in the area. • Due to insufficient water, many farmers shifted from paddy cultivation to coconut plantations. • Few farmers reported a drop in groundwater level. • Farmers shared the general concern that the water supplied from the GA Canal is not adequate to meet their irrigation needs. • Now agriculuture is more mechanized, from land preperation to threshing and winnoving and cleaning the grains. This increases the cost of cultivation. **The major issues faced by the farmers are:** • Farmers complained about non availability of hired labour to do farming activities. • Many shared their concern that they make very little or no profit from the agriculture. • Turn System is being practiced even if the water availability is more, it has to be reconsidered. **The requests from farmers are:** • Farmers requested to properly maintain the structures along the Main Canal Viz. Sluices, Supply Channels etc., and the proposal to increase the carrying capacity of the canals. • To increase the supply level. • Requested to provide Bed Lining throughout the Stretch. • Also, requested to provide common drying yard (*Kalam)* to dry paddy and reduce the moisture content to sell in the DPC.
GAC canal condition and suggestions for improvement	• Main Water Source for this village is from Thiruvapudi Vaikaal (*Kizhakku*), Pudhiya Thai Vaikaal (*Therku*). • Around 170 tanks and lakes were benefitted by the GA Canal in this region and the water is available only during the rainy season. • The farmers requested that water supplied in the Main Canal is less as compared to previous decades, and the Department needs to make effort to increase the quantity of supply.
GAC canal management and farmers participation	Farmers informed that two Water User's Associations (WUA) are functioning in this village, they are (i) Pudukottai Maavatta Kallanai Kalvaai Paasanatharar Sangam (ii) Vettanoor Paasana Sabai (consists of 8 Villages) But the Association members informed that there were no female members in the association.

Officials Attended	**WRD, GA Canal Division** (i) Th. Anbarasan, Assistant Executive Engineer (ii) Tmt. Pushparani, Assistant Engineer (iii) Th. Thennarasu, Assistant Engineer **WAPCOS Limited** (i) Dr. G. Pandiaraj, Social Expert (ii) Th. V. Raghuram, M.S.W (iii) Th. S. Amirtharajan, Engineer (iv) Th. K. Periyasamy, Junior Engineer

FGD at Nagudi Village

FGD Report – 12 (Women's Group)

Village : Kalvirayampettai

Village panchayat : Kalvirayampettai

Taluk : Thanjavur

District : Thanjavur

Main canal/branch canal/tank irrigation : Main Canaland Extension Canal

Number of farmers participated in FGD : 33

Date : 10th September 2020

Communities	The participants are from Old Kalvirayampettai, New Kalvirayampettai and Lakshmipuram hamlets. Majority of the households are from Backward communities and a few schdueled caste community residing in these villages
Livelihoods and resources	Agriculture is the primary occupation, most of the farm families own little land and classified as small and marginal farmers. Land less work as agriculture labour or construction workers for daily wage. Few of the families have back yard dairy.
Farming practices and issues	• The current practice is that farmers cultivate one crop and based on water availability go for double crops. • Padday varieties cultivated by the farmers in these villages are *Ponni*, PO 50, *Ponmani*, IR 20, IR 36, IR 37. • For the current year farmers were happy, that they have already transplanted seedlings in the field, water reached as it used to be in the past. • Few farmers own open wells and use the water from the well to support irrigation in addition to the canal water. • Farmers informed that the paddy crops are being sold to Government Procurement Centres (i.e.,) DPC. • Women farmers informed that they work equal to men, but men are always considered as the head and they only work in the fields and in the domestic sphere not allowed to take any decision. **Women's Role and Self Help Groups:** • Women play multiple roles both in the domestic sphere and their agriculture fields or in the case they are land less they

	also work as wage labourer. • In the field, the two main works women are involved are deweeding and transplanting. • Some of the Self-Help Groups functioning in these villages • An NGO mobilized the women and formed the groups. • Women gathered in the discussion were not owning any agricultural land, • The women from land less households the main source of income is MGNREGA. • All the women attended the discussion informed that they are keen on educating their children. • Few leaders of Self-Help Groups (SHG) were also present in the discussion, the main objective of a SHG is savings and internal lending for low interest rate. • Farmers requested not to plant trees by the Forest Department the Canal or near in the inner slope, as it blocks the water flow. • Few farmers shared that there was a drop in the ground water level. • Women participated in the discussion were highly educated and also secondary schooling and high school drop outs. **Major issues and requests from women are as follows:** • Many women requested to provide alternative livelihood opportunities such as tailoring machines, domestic animals etc. or any other suitable activities., • A few of the older women in the group requested to support to get old age pension, through the Government schemes.
GAC canal condition and suggestions for improvement	**Requests from women are as follows:** • Requested to rehabilitate the steps and ramps in the GA Canal for domestic purpose.
GAC canal management and farmers participation	• Women Farmers informed that they are not aware about Water User's Association (WUA) and there is no female participation in any WUA in Executive Levels in this FGD. • Later, Male farmers conveyed about a Water User's Association under the name "Kalvirayampettai Paasanatharar Sangam" with 15 Executive members.
Officials Attended	**WRD GA Canal Basin** (i) Th. Shanmugavel, Assistant Executive Engineer **WAPCOS Limited**

	(i) Dr. G. Pandiaraj, Social Expert (ii) Th. V. Raghuram, M.S.W (iii) Th. S. Amirtharajan, Engineer (iv) Th. K. Periyasamy, Junior Engineer

FGD at Kalvirayampettai

Annexure 2: Construction and Demolition (C&D), Silt and Labour Camp management Plan

Waste Management Plan

The Waste Management Plan (WMP) for the following wastes generated from the construction activities is one of the important aspects of the ESMP.
It is required that as part of each construction package, the contractor has to prepare and submit a Waste Management Plan within 30 days from the date of the Agreement, to WRD. The Contractor's obligation for proper waste management must be clearly specified in the contract document. The WMP should have specific measures that will be undertaken to segregate, store and appropriately dispose the generated wastes.

A Construction and Demolition (C&D) Waste Management Plan

The construction and demolition activity shall lead to generation of huge quantum of demolition's rubble, which includes sand, gravel, concrete, aggregates, bricks, metal etc., availability of suitable dumping sites, transportation & disposal, pollution & environmental deterioration and their associated costs. Hence, the management of C&D waste will be one of the important concerns of the ERM works of GACS project.

The C&D wastes shall be generated from the following activities of ERM works of proposed project:

- Bed and side lining in Canals
- Renovation / Reconstruction of cross drainage works, canal regulating structures, sluices and bridges
- Remodeling for improvement of works

The quantity of C&D waste to be generated in the project is estimated to be 1,09,408 cu.m. Since there is no desilting, there is no silt envisaged in the project. The package wise detail of C&D waste to be generated is given in Table 1.

Table 1: package wise detail of C&D waste to be generated

S. No	Description	C&D Waste				Silt
		Brick work	PCC	RCC	Total	
1	Package – 01	7149.00	0.00	-	7149.00	Nil
2	Package – 02	16680.00	0.00	-	16680.00	
3	Package – 03	2158.00	411.00	-	2569.00	
4	Package – 04	12986.05	21.00	-	13007.05	
5	Package – 05	112.00	2358.00	24.00	2494.00	

S. No	Description	C&D Waste				Silt
		Brick work	PCC	RCC	Total	
6	Package – 06	273.50	419.00	60.50	753.00	
7	Package – 07	1373.50	261.00	0.00	1634.50	
8	Package – 08	12171.00	6880.00	-	19051.00	
9	Package – 09	1677.00	273.00	36.00	1986.00	
10	Package – 10	1807.50	479.43	70.00	2356.93	
11	Package – 11	3182.46	5151.50	142.50	8476.46	
12	Package – 12	9628.48	6470.00	567.10	16665.58	
13	Package – 13	4167.00	1159.00	0.00	5326.00	
14	Package – 14	3050.54	4125.50	54.00	7230.04	
15	Package – 15	1628.88	2345.75	55.40	4030.03	
				Total	**109408.59**	**Nil**

Source: WRD

The C&D wastes generated shall be stored and managed as follows:

- Storage in the available vacant lands with WRD.
- The reinforcements will be auctioned to authorized recyclers as per WRD rate.
- The concrete material will be used in the restoration of damaged road
- The contractor will be allowed to utilize concrete material for use in backfilling

The contractor shall submit site specific WMP for utilization of generated C&D wastes due to the construction activities proposed as part of ERM works.

Guidelines for preparing C&D Waste Management Plan

- Contractor shall segregate C&D wastes and store at collection centers or handover it to the authorized recyclers.
- Shall ensure that there is no disposal which may lead to obstruction to the traffic, public or canals / drains.
- Contractor, who generates more than 20 tons or more wastes in one day or 300 tons per project in a month shall prepare and submit comprehensive waste management plan for waste generated within their work sites, shall get necessary approvals from the TNPCB before starting construction, demolition, remodeling work.
- Contractor shall segregate the wastes into stacks of concrete, soil, reinforcement and bricks & mortar. WRD shall be kept informed regarding the relevant activities from the planning to the implementation stage on a package-wise basis.
- Contractor shall ensure that other wastes such as solid wastes does not get mixed with this C&D waste and is stored and disposed separately.
- Contractor shall have EMP to address the likely environmental issues from construction, demolition, storage, transportation process and disposal / reuse of C & D waste.
- Contractor shall remove all C&D waste in consultation with the concerned local bodies.

- Contractor shall pay relevant fees for collection, transportation, processing and disposal as notified by the concerned authorities.

Silt collected from silt trap - management

GA Canal head regulator as controlling arrangement is presently existing at the off take point of GA canal to prevent silt and sand from entering the canal. Source of silt and sediment was due to erosion from the existing earthen channel. Instead of existing earthen Canal, it is now proposed to line the bed and sides of the entire GA main canal in this Project. Hence there is no possibility of silt entering into the Canal.

All drainage carriers in the Project area crosses the GA canal through Syphons without confluence with canal water flow. There are no polluting industries in the entire Project area of the GA Canal system. Source of water to the GA canal is only from River Cauvery at Grand Anicut. Hence there is no possibility of silt or sediment being deposited in the canal.

However, Silt traps are proposed in the project in the headreaches of the main canal to trap any silt from the offtake point. After completion of the project and during operation, if silt accumulates, same will be collected in the silt traps. The collected silt collected in the silt trap shall be removed during the closure period of the Canal. The same shall be tested for heavy metals and pesticides before disposal. If pesticides and heavy metals are found to be below the standards it will be disposed off by routine methods i.e., giving it to the required farmers or disposing it in the tree plantation area etc. If pesticides and heavy metals are found to exceed the standards, the silt shall be remediated according to the methods viz. (Physical, Chemical and Bio-remediation). Further, WRD will continue the above process during as well as after completion of the project.

Mitigation Measures:

1. Prepare and submit desilting plan including disposal plan with action timeline and risk management plan prior to carrying out desilting operations from silt traps if desilting needs are envisaged.
2. No stacking of desilted material from the silt traps shall be done on canal bed or agricultural fields during monsoon period. Ensure that the removal of silt from silt traps is done during the canal closure period.
3. The silt needs to be tested for heavy metals and pesticides before disposal.
4. If pesticides and heavy metals are found to be below the standards it will be disposed off by routine methods i.e., giving it to the required farmers or disposing it in the tree plantation area etc.
5. If the silt is found to be contaminated by heavy metals it will be remediated depending on the degree of contamination.
6. Depending on the degree of contamination the silt will be bioremideated by Physical, chemical or biological methods and suitably disposed off.

B Generic Waste Management Plan

The generic waste management plan which may be used as a reference by the contractor to implement the package specific plan. In addition to the details given in Table 2 the plan must provide basic information like inventory of wastes to be generated i.e., types, description & quantities, location & layout of the waste segregation & temporary storage area, test report of sediment / silt samples, etc.

Table 2: Waste Management Plan

Activity	Site Responsibility	Monitoring Responsibility
Project Planning and Design Phase		
• Preparation of guidelines for locating waste disposal sites for hazardous and non-hazardous wastes • Identify existing landfill sites, if available, for disposal of hazardous materials • In case there are no landfill sites in the District, identification of landfill sites located in the nearby District	-	E&S Specialist, WRD
• Site specific plan should be prepared based on guideline provided at section 7.1 to minimise waste generation, its possible reuse, recycling and disposal; • Identify the type as well as sources of wastes during construction and suggest options for possible reuse • Obtaining required site-specific clearances from appropriate authorities • Waste disposal plan should be a part of the bid document as special condition of contract of each package which should be abided by the contractor.	-	E&S Specialist, WRD
Pre-Construction Phase		
• Identify the activities during construction, that have the potential to generate waste and specify measures for the same in the construction schedule to be submitted to the WRD • Identifying the location for disposal of non-hazardous wastes in consultation with the local bodies. Priority should be given to existing waste disposal sites, if available. • Disposal of any hazardous materials shall be in nearby existing landfill sites complying with the Hazardous and other Wastes (Management and Transboundary Movement) Rules, 2016. • Orientation Program of workers, supervisors and other persons associated with construction work on waste	Contractor	Arrangements will be verified by the Sr. Environmental Safeguard Specialist at WRD.

Activity	Site Responsibility	Monitoring Responsibility
management principles, waste disposal mechanism, safety and security measures during waste disposal, management of disposal sites etc.		
Construction Phase		
• The waste generated during construction should either be reused & recycled or dispose depending upon the nature of waste • The reuse of waste shall be carried out by the contractor only after carrying out the specific tests and ascertaining the quality of the waste materials used and getting the same approved by the TNPCB • The contractor shall adopt required safety precautions i.e., provision of PPEs while reusing wastes for construction • In case of filling of low-lying areas with the generated construction wastes, it needs to be ensured that the level of filling site matches with the surrounding areas • In cases where low lying area is used for filling with the generated non-hazardous wastes, care should be taken that these low-lying areas are not part of water bodies. • The contractor shall implement safe and environmentally sound management practice for handling of hazardous and other wastes. • The hazardous and other wastes generated at any of construction site shall be sold to an authorized recycler or shall be disposed off in an authorized disposal facility	Contractor	• The waste management practices adopted by the Contractor, including the management of wastes at construction camps shall be reviewed E&S Safeguard Specialist at WRD. The Contractor should submit periodic report to the WRD on the progress and status of waste management as per the approved plan.
Post Construction Phase		
• Hand over the site after cleaning and clearing the site of all debris / wastes to the designated authority at the WRD and obtaining the handover certificate. • In case of disposal of wastes on private land, certificate of Completion of Reclamation is to be obtained by the Contractor from the landowner that the land is restored to his satisfaction. • Suitable plant species may be planted in the waste disposal site.	Contractor	Handover certificate and completion certificate should be submitted to WRD for settlement of dues.

Labour Camp Management Plan

During construction phase, significant increase in labour population is anticipated in the project area, which shall lead to various environmental and social issues. To mitigate the probable impacts due to labour influx, and establishment of labour camp, a detailed labour camp management plan is prepared to minimise and mitigate the environment and social impacts.

In each contract package, the contractor is required to prepare and submit a "Labour Camp Management Plan" within 30 days of the LoA, to the WRD. This Plan outlines specific measures such as details of living condition and supporting facilities, worker codes of conduct, training programs on HIV/AIDS, COVID-19 etc. that will be undertaken to control degradation of the surrounding environment due to the location and operation of the proposed labour camp, which will minimize the impact on the local community.

Guidelines for Labour Camp / Camp site

The main objectives of the Labour Camp Management Plan shall be identify the key environmental and social aspects to be considered and guidelines for locating the labour campsites. The key environmental aspects to be considered are as follows:

- Sufficient supply of potable water to labour camps and working sites should be ensured. If the same is not available from an intermittent public water supply, then storage tanks must be provided.
- Adequate washing and bathing facilities must be provided with proper drainage.
- Adequate sanitary facilities should be provided within camp with provision of separate facilities for women
- Collection of solid wastes from labour camps and its disposal should be ensured regularly
- The contractor must ensure that there is proper drainage system to avoid creation of stagnant water bodies
- Periodic health check-ups on monthly basis should be conducted at the labour camp in consultation with the local health department / Primary Health Center (PHC)
- First Aid facility may be provided
- Adequate supply of fuel in the form of kerosene or LPG should be provided to labourers to avoid felling of trees for cooking and other household activities.
- The campsites should be secured by temporary fencing which can be dismantled after completion of project activity
- Proper lighting and cross ventilation must be provided
- Labour camps must be located away from forest areas, settlements, cultural heritage & historical sites and water bodies
- It should be ensured by the contractor that area of the labour camp be cleared of the debris and other wastes deposited on completion of construction. The land should be restored back to its original form and condition as it was prior to the

establishment of the construction camps.

- Informing labours about prevailing laws and rules that make sexual harassment and gender-based violence a punishable offence which is prosecuted
- Introducing a Worker Code of Conduct as part of the employment contract including sanctions for non-compliance to child labour engagement, discrimination, harassment of co-workers including women and those belonging to SC / STs and other minority social groups
- Contractors should ensure co-operation with law enforcement agencies in investigating complaints about gender-based violence, child labour engagement etc.
- Training programs on HIV/AIDS, other communicable diseases and COVID-19 for the workers & staff of contractor(s)
- Grievance Redressal Mechanism (GRM) at the camp level to resolve issues, if any arise amongst the workers, and the local community.

The Contractor should implement clear and decisive measures which are critically important. The effectiveness of these measures shall depend on proper supportive actions by the WRD. These are mainly focused on public administration and law enforcement such as:

- Reinforcing local police in a remote setting
- Ensuring that complaints about gender-based violence are taken seriously by local law enforcement, which may be supported by deploying female officers to the project area
- Participation in preventive training with workers to demonstrate the presence of government authority in the project area

The criteria for selection of labour campsites and their management are given in Table 3 and 4 respectively.

Table 3: Criteria for selection of sites for establishment of Labour Camps

Avoidance	Preference
• Lands within 500 m of habitations; • Irrigated agricultural land; • Lands belonging to small farmers; • Lands under forests area; • Lands within 100 m of community tanks and water sources such as canals and Rivers; • Low lying lands, marshy areas; • Lands supporting dense vegetation • Grazing lands and lands with lease rights • Lands where there is no willingness of the landowner to permit its use.	• Waste land; • Lands belonging to owners who look upon the temporary use as a source of income; • Community lands or government land not used for beneficial purposes; • Private non-irrigated lands where the owner is willing; and • Lands with an existing access road

Table 4: Labour Campsite Management Plan

Activity	Responsibility	Monitoring and Supervision
Pre-Construction Phase		
Site Selection: • The contractor shall obtain documents highlighting arrangements made with the WRD for setting up of labour camp, i.e., Extent of land required and duration of the agreement; details and photographs of the site • A detailed layout plan, indicating the various structures to be constructed, access roads, drainage, lighting and other facilities etc. should be prepared and submitted to the WRD. • Site restoration plan should also be prepared detailing the measures for restoration of the campsite after the completion of the project activities. • It should be ensured that there is no use of hazardous construction materials such as Asbestos Containing Materials (ACM) in the construction of the camp. • Provision of free accommodation in the campsite for all the workers employed by contractor for the total contract period.	Contractor	• The suitable sites shall be selected and finalized in consultation with the E&S Safeguard Specialist of WRD. • Verification and approval of finalised site of labour camp by WRD. • The agreement, layout plan and site restoration plan documents shall be submitted to the E&S Safeguard Specialist of WRD
Facilities: • The labour camp should have adequate space for accommodating the labours and their families. • The camp should have all common minimum required facilities like ventilation, electricity supply, water supply, kitchen, separate toilet and bathrooms for ladies and gents, etc. • Identification of sufficient sources of potable water. In case, the same is not available in the vicinity, alternate provision of potable water should be made in the labour camps • The drinking water should be stored in	Contractor	Periodic verification of facilities on monthly basis by the E&S Safeguard Specialist of WRD.

Activity	Responsibility	Monitoring and Supervision
hygienic containers and placed at a distance of more than 15 m from any drains, toilet or other source of pollution.		
Hygiene and Sanitation: • Suitable washing facility for clothes and utensils with proper drainage facilities to be provided. • Sanitary arrangements like latrines and urinals in every work place to be provided which must be culturally appropriate / acceptable. • Separate toilet facility for every 20 male and female labours with proper signages in local language to be provided • The latrines and urinals shall be adequately lighted and hygienic condition shall be maintained	Contractor	Supervision by E&S Safeguard Specialist of WRD on weekly basis
Arrangements for Waste Disposal: • Disposal of sanitary wastes and excreta shall be done into septic tanks. • Wastewater from kitchen wastes shall be disposed into soak pits located at least 15 m away from any waterbody. • Capacity of the soak pit should be at least 1.3 times the maximum volume of wastewater discharged per day. • The bottom of the soak pit should be filled with coarse gravel, sand, carbon and the sides shored up with freeboard to prevent seepage from the soak pit. • Solid wastes generated in the labour camp shall be reused or recycled in landfill sites approved by local bodies.	Contractor	Periodic supervision on weekly basis by E&S Safeguard Specialist of WRD

Activity	Responsibility	Monitoring and Supervision
Health Care Management: • Availability of First Aid Box / Facilities. • An educated person in the camp site should be trained on administering first aid treatment and the box should be placed under his / her command. • In case of any eventuality which demands hospitalization, suitable transport facility should be provided • Periodic visit by a qualified medical doctor of local body to the campsite for health check-up of workers, at least once in 15 days. A register of all health problems must be maintained by the doctor and available at the campsite. • Provision of health insurance of all workers for stipulated period of their engagement.	Contractor	Periodic supervision on fortnightly basis of health care measures like availability of first-aid box, regular site visits by a qualified medical doctor, register of health problems, etc., by the E&S Safeguard Specialist of WRD
Storage Facility: • Storage site within the labour camp should be located at a minimum distance of 30 m from the living area of the workers • Petroleum Products like oil / fuel / lubricants etc. should be stored at a height from the ground level for which a brick-based platform with sand flooring should be constructed to avoid soil and water contamination due to spillage • Cement can be stored at a height from the ground level in a damp-proof area	Contractor	Periodic supervision on weekly basis by E&S Safeguard Specialist of WRD
Other Safety and Security Measures • Provision of fire extinguishers at the camps. Each area shall be earmarked based on fire zone category (Fire zone- 1, 2 & 3). • Display of fire station number in prominent place for easy visibility. • In case the labour campsite has a common kitchen facility, it must be ensured that the common kitchen and any	Contractor	Verification of installation of fire-fighting instruments in the camps and periodic supervision on fortnightly basis by the E&S Safeguard Specialist of WRD.

Activity	Responsibility	Monitoring and Supervision
other kitchens in the campsite is located at least 20 m away from the living area. Only LPG stoves are to be used. Use of fuelwood stoves shall not be permitted for use in camp site. • Provision of identity cards to labourers and residents of construction camps.		
Construction Phase		
• Construction camps shall be maintained free from litter, in hygienic condition and should be kept free from spillage of oil, grease or bitumen. • Any spillage should be cleaned immediately to avoid water and soil pollution • The following precaution needs to be taken in construction camps such as: - No leaching of oil & grease into water bodies - Non-disposal of wastewater into water bodies; collection and appropriate disposal of solid wastes on daily basis - Hygienic condition of the toilet and its regular maintenance - Availability of first-aid care provision in the camp - Display of emergency numbers (fire, police, ambulance, medical hospital etc,) in a common place visible to others.	Contractor	Periodic verification of facilities on monthly basis by the E&S Safeguard Specialist of WRD.
Post-Construction Phase		
• Upon completion of construction, all labour camp facilities shall be dismantled and removed from the site. • The site shall be restored to the maximum possible condition which is prior to commencement of the works. • Various activities to be carried out for site restoration such as - Cleaning / removal of oil and fuel	Contractor	The restored site shall be inspected by the E&S Safeguard Specialist of WRD and verified as per the approved restoration plan. WRD should issue a clearance certificate before final settlement of claims.

Activity	Responsibility	Monitoring and Supervision
contaminated soil and its disposal in approved waste disposal areas. - Labour campsite shall be landscaped and planted with trees as per the restoration plan - Sealing / filling up of soak pits and septic tanks; disconnection of electricity supply; - Disposal of all garbage in the disposal sites approved by local body		

Gender based violence

To minimize the gender-based discrepancies / violence, contractor shall take following measures at labour campsite as well as worksite:

- Establishment of labour campsite at least 500 m away from local habitation to reduce chances of harassment of local women and establishing 24x7 security at each labour campsite to restrict entry of outsider within labour camp boundary
- Provision of separate toilet for women labours
- Mandatory training and awareness raising campaigns at regular intervals for the workforce about refraining from unacceptable conduct toward local community members, especially women
- Proper lighting and cross ventilation must be provided
- Informing labours about prevailing laws that make sexual harassment and gender-based violence a punishable offence which is prosecuted
- Introducing a Worker Code of Conduct as part of the employment contract including sanctions for non-compliance to child labour engagement, discrimination, harassment of co-workers including women and those belonging to SC / STs and other minority social groups.
- Contractors should ensure co-operation with law enforcement agencies in investigating complaints about gender-based violence, child labour engagement etc.
- Training programs on HIV/AIDS, other communicable diseases and COVID-19 for the workers & staff of contractor(s), especially women.

Table 5: Debris Disposal Locations

Package number	Debris Disposal Locations
1	**2 Nos at** LS 12.013 km and LS 12.42 km
2	**1 No at** LS 28.830 km
3	**1 No at Vannarapettai Village** LS 33.600 km
4	**1 No at** LS 52.060km
5	**2 Nos at KB Canal** at LS 20.956 km and LS 28.640 km
6	**3 Nos at KB Canal** at LS 29.187 km, LS33.712 km and LS44.669 km
7	**6 Nos at** VB Canal at LS 0.450 km, LS 6.240 km, LS 17.344 km, LS 18.779 km, LS 20.563 km and LS 30.241km
8	**5 Nos at** LS 62.542 km, LS 71.857 km, LS 74.585 km, LS 82.987 km and LS 92.200 km
9	**2 Nos at** LS 18.764 km and LS 35.00 km
10	**2 Nos at Kayanur** LS 0.030 km and Olavayal LS 5.453 km
11	**4 Nos**. **at** LS 92.225 km, LS 96.660 km, LS 101.820 km and LS104.820 km.
12	**8 Nos at GA Extention** at LS 2.750 km, LS 5.263 km, LS10.370km, Ammachathiram main at LS 5.631 km, Ammachathiram No1 at LS0.750km, Anavayal at LS5.782km, LS6.263 km,LS9.383km.
13	**5 Nos GA New Main Canal at** LS 1.787 km, Mahaganpathipuram LS 7.2 29km, Mumbalai distributory LS13.57km and at Thiruvapady at LS 1.184 km, LS 5.481 km.
14	**9 Nos at** Pudupattinam LS 0.50 km, LS 6.50 km, LS 7.50 km, LS 12.55 km, Sethubavachathiram LS 0.17 km, LS2.576km, LS 6.18 km, LS 10.5 km and LS 13.57 km.
15	**4 Nos** at LS 16.000 km, LS 17.600 km, RS 17.600 km and LS 23.035 km

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Annexure 3: List of Registered Recyclers of Used Oil and Waste Oil

Sl.No	District	Name & Address of the Industry	Authorized Reprocessing Capacity		Contact details
1.	Coimbatore	M/s Sri Balaaji Industries, Unit-II, SF No.16/4 Part, Mettupalayam Village, Kinathukadavu Taluk, Coimbatore Ditrict.	Used oil 2400 T/Annum	Waste oil 1200 T/Annum	Thiru C.Guru Sankar Proprietor 9880068581 guru.balaajiindustries@gmail.com
2.	Coimbatore	M/s Steve Industries, (previously M/s Jaya Traders) SF No. 36, Seerapalayam Village, Coimbatore South Taluk, Coimbatore District.	Used oil 5000 KL/Annum	Waste oil 4000 KL/Annum	Thiru Nirmal Stephen Partner 9443383873 steveindustries@rediffmail.com
3.	Coimbatore	M/s Nagalakshmi Agencies SF No. 540/1, Vellaikinar Village, Coimbatore North Taluk, Coimbatore District.	Used oil 3600 KL/Annum	-	Tmt B.Rajamani Proprietrix 9843141140 nagalakshmi_agencies@yahoo.co.in
4.	Coimbatore	M/s Nagalakshmi Agencies, Unit-II SF No. 540/1B2B, Vellaikinar Village, Coimbatore North Taluk, Coimbatore District.	-	Waste oil 4320 KL/Annum	Tmt B.Rajamani Proprietrix 9843141140 nagalakshmi_agencies@yahoo.co.in
5.	Coimbatore	M/s ARPE Lubricants, Plot No. 94, SIDCO Industrial Estate, Malumichampatti Village, Coimbatore South Taluk, Coimbatore District.	Used oil 9000 KL/Annum	Waste oil 3000 KL/Annum	Thiru R.Parivallal Proprietor 9945100166 bharathlub@gmail.com
6.	Coimbatore	M/s Shri Sathya Sai Lubricants SF No. 86/1F, Kunnathur Village,	Used oil 1500 T/Annum	-	Tmt R.Anitha Proprietrix 9698234566 dinetam@gmail.com

Sl.No	District	Name & Address of the Industry	Authorized Reprocessing Capacity		Contact details
		Annur Taluk, Coimbatore District.			
7.	Dindigul	M/s Sasi Industries, Plot No. 12, SIDCO Industrial Estate, Dindigul,Dindigul District.	Used oil 1350 T/Annum	Waste oil 3600 T/Annum	Thiru Dhabapal Managing partner 9443020613 sasiindustriesdgl@gmail.com
8.	Erode	M/s Saizrol Industries, No. 64, Thannerpanthal Palayam Road, SF No. 536/8, Suriyampalayam Village, Erode Taluk, Erode District.	Used oil 2400 T/Annum	Waste oil 288 T/Annum	Thiru N.Selvam Proprietor 9443169983 saizrolindustries@rediffmail.com
9.	Erode	M/s Jayam Refineries, Plot No F – 13, SIPCOT Industrial Growth Centre, Perundurai, Erode District.	Used oil 5400 T/Annum	-	Thiru S.Saravanan Managing Partner 9443374484 visahamentechs@gmail.com
10.	Erode	M/s Sai Ram Industries, Plot No F 10, SIPCOT Industrial Growth Centre, Perundurai, Erode District.	Used oil 1250 KL/Annum	Waste oil 3000 KL/Annum	Thiru Natarajan Partner 9698234566 dinetam@gmail.com
11.	Karur	M/s Vinayaga Lubricants, Plot No. 67, SIDCO Industrial Estate, Athur Village, Manmangalam Taluk, Karur District.	Used oil 4180 T/Annum	Waste oil 4500 T/Annum	Thiru S. Ramesh Proprietor 9367142709 vinayagalubricants@gmail.com
12.	Karur	M/s Thirumala Industries, Plot No. 78, SIDCO Industrial Estate, SF No. 562pt, Athur	Used oil 1800 KL/Annum	Waste oil 1200 KL/Annum	Tmt R Santhi Managing Partner 7708005322 thirumalaindustriesti@gmail.com

Sl.No	District	Name & Address of the Industry	Authorized Reprocessing Capacity		Contact details
		Village, Manmangalam Taluk, Karur District.			
13.	Karur	M/s Sri Lakshmi Oil Refineries, SF.No. 478/B2pt, K.Pitchampatti Village, Karur Taluk, Karur District	Used oil 2500 KL/Annum	-	Tmt P Gomathi Proprietrix, 9442635962 gomathiba4@gmail.com
14.	Madurai	M/s Sri Meenakshi Petro Products, No.141 Virudunagar Road, Thirumangalam, Madurai District	Used oil 2880 T/Annum	Waste oil 2880 T/Annum	Thiru Ganesh Manager 9362280382 ganeshvelayutham.m@gmail.com
15.	Madurai	M/s Sun Reclaimery, SF No. 25, Uchappatti Village, Thirumangalam Taluk, Madurai District.	Used oil 4140 T/Annum	-	Thiru Ramasamy Partner 9842182344 info@sunreclaimery.com
16.	Madurai	M/s King Industry, Shed No. 43, Mahia Industrial Estate, SF No.9/7, Vitankulam Village, Madurai East Taluk, Madurai District.	Used oil 3600 KL/Annum	Waste oil 2750 KL/Annum	Thiru Kannan Partner 9842133544 kingindustry43@gmail.com
17.	Madurai	M/s Southern Petrocoal, SF No. 103/9B, T. Pudupatti Village, Thirumangalam Taluk, Madurai District	-	Waste oil 2600 KL/Annum	Thiru G.Kannan Partner 9894636747 southernpetrocoal@gmail.com
18.	Ranipet	M/s Lakshmi & Co, (Used Oil RR) Plot No.99, SIDCO Industrial Estate, Ammanur Village, Arakkonam Taluk, Ranipet District	Used oil 3400 KL/Annum	Used oil 3400 KL/Annum	Thiru M.Raghavan Proprietor 9445076557 lakshmiandco2013@yahoo.in
19.	Ranipet	M/s M.R. Industries	Used oil 3240	-	Thiru R.Mani Proprietor

Sl.No	District	Name & Address of the Industry	Authorized Reprocessing Capacity		Contact details
		Plot No.73,SIDCO Industrial Estate, Ammanur Village, Arakkonam Taluk, Ranipet District	T/Annum		9444009266 maheshdevarayan1@gmail.com
20.	Ranipet	M/s Asia Regenerators, SF No. 507/1a & 31/6A, Agavalam Village, Arakkonam Taluk, Ranipet District.	Used oil 3600 KL/Annum	-	Thiru G. Srinivasan Partner 9444041102 asiaregen@gmail.com
21.	Theni	M/s Avatar Petro Chemicals P Ltd, S.F.No. 2321/3, Thimmarasanaickanur Bit I Village, Andipatti Taluk, Theni District	-	Waste oil 5820 T/Annum	Thiru Vijayakumar Karuppiah Managing Director 9894047412 avatarpetro@gmail.com
22.	Tiruvallur	M/s Mega Petro Products Plot No. 60, SIDCO Industrial Estate, Kakkalur, Tiruvallur Taluk, Tiruvallur District.	Used oil 3915 T/Annum	Waste oil 3420 T/Annum	Thiru K.A Gunasekaran Managing Partner 9444068211 megapetro2013@yahoo.com
23.	Tiruvallur	M/s Quality Lube Product Pvt Ltd, Plot No.35C & 36A,SIDCO Industrial Estate, Vichoor, Ponneri Taluk, Tiruvallur District.	Used oil 3600 KL/Annum	-	Thiru J. Prabakaran Managing Director 9941921888 lube_products@yahoo.co.in
24.	Tiruvallur	M/s Quality Lube Product Pvt Ltd, Plot No.35A, 35B, 35C &36A, SIDCO Industrial Estate, Vichoor, Ponneri Taluk, Tiruvallur District	-	Waste oil 4800 KL/Annum	Thiru J.Prabakaran Managing Director 9941921888 lube_products@yahoo.co.in
25.	Tiruvallur	M/s Priya Petro	Used oil	-	Thiru G.Ravi

Sl.No	District	Name & Address of the Industry	Authorized Reprocessing Capacity		Contact details
		Products, (Used Oil Reclamation Unit), Plot No. 123, SIDCO industrial Estate, Vichoor, Ponneri Taluk, Tiruvallur District.	2592 T/Annum		Proprietor 9884083299 priyapetro@yahoo.com
26.	Tiruvallur	M/s Priya Petro Products, SF No. 259pt, Vichoor Village, Ponneri Taluk, Tiruvallur District.	-	Waste oil 3300 T/Annum	Thiru G. Ravi Proprietor 9884083299 priyapetro@yahoo.com
27.	Tiruvallur	M/s Supreme Petro Products, (Used Oil) SF No. 225/1A2J, 225/1A2K, Eguvarpalayam Village, Gummidipoondi Taluk Tiruvallur District.	Used oil 6200 KL/Annum	-	Thiru Manavalan Partner 9444431111 supremepetroproducts@gmail.com
28.	Tiruvallur	M/s Supreme Petro Products, (Waste Oil), SF No. 225/1A2J, 225/1A2K, Eguvarpalayam Village, Gummidipoondi Taluk Tiruvallur District.	-	Waste oil 10800 T/Annum	Thiru Manavalan Partner 9444431111 supremepetroproducts@gmail.com
29.	Tiruvallur	M/s Sun Lube Industries, Plot No. R-22, Phase - II, SIPCOT Industrial Complex, Gummidipoondi, Tiruvallur District.	Used oil 5616 KL/Annum	-	Thiru V.Kumar Partner 9444411234 sunlube2014@gmail.com
30.	Tiruvallur	M/s Trigel Petro Chem (P) Ltd Kakkalur Village, Tiruvallur Taluk, Tiruvallur District.	-	Waste oil 3134 T/Annum	Thiru K.Sivasubramanian Managing Director 9444068211 trigelpvtltd@yahoo.com

Sl.No	District	Name & Address of the Industry	Authorized Reprocessing Capacity		Contact details
31.	Tiruppur	M/s ATLAS Corporation, Rasthavalasu Village Kankeyam Taluk, Tiruppur District.	Used oil 4032 KL/Annum	Waste oil 1400 KL/Annum	Thiru S.Arun Kumar Proprietor 9994200001 atlascorpkarur@gmail.com
32.	Tiruppur	M/s Sri Maruthi Industries, SF No. 202/A1/B, Rasatha Valasu Village, Kankeyam Taluk, Tiruppur District	Used oil 1500 KL/Annum	Waste oil 5400 KL/Annum	Thiru L.Thirumal Proprietor 9790274567 srimaruthiindustries@gmail.com
33.	Tiruchirappali	M/s Spaze International, SF No. 247/3A, 247/3B, Omandur Village, Manachanallur Taluk, Tiruchirappali District.	Used oil 4500 KL/Annum	-	Tmt V.Nithya Proprietrix 9943361103 spazeinternational@gmail.com
34.	Tirunelveli	M/s PMB & Co, SF No. 95/4, Thirupanikarisalkulam Village, TirunelveliTaluk, Tirunelveli District	-	Waste oil 2880 KL/Annum	Thiru P.M.SahulHameed Partner 9443358097 tnv0138@gmail.com
35.	Villupuram	M/s DVR Refiners, SF No. 8/6, Eraiyur Village, Vanur Taluk, Villupuram District.	Used oil 11760 KL/Annum	Waste oil 5760 KL/Annum	Thiru Dilipkrishnan Managing Partner 9444916912 dvrrefiners@gmail.com
36.	Villupuram	M/s Sri Gowri Industries, SF No. 77/2C, Kondalankuppam Village,	Used oil 3000 T/Annum	Waste oil 12500 T/Annum	Tmt J Nathiya Proprietrix 9345679596 srigowri2019@gmail.com

Sl.No	District	Name & Address of the Industry	Authorized Reprocessing Capacity		Contact details
		Vanur Taluk, Villupuram District			
37.	Villupuram	M/s Thirupathi Oil Company, Unit-1, SF No. 129/2, Venmaniyatoor Village, Tindivanam Taluk, Villupuram District	-	Waste oil 4500 KL/Annum	Thiru T.Muthuraja Proprietor 7810012233 thirupathimuthuraja@yahoo.com

Annexure 4: Compensatory Tree Plantation Plan

INTRODUCTION

PROJECT OVERVIEW

A forest is a complex, self-regenerating system, encompassing soil, water, microclimate, energy, and a wide variety of plants and animals in mutual relation. A commercial plantation, on the other hand, is a cultivated area whose species and structure have been simplified dramatically to produce only a few goods, whether lumber, fuel, resin, oil, or fruit.

Trees alter our environment by using their leaves to filter the air we breathe by removing dust and other particles. Reforestation is among the best ways to support damaged or destroyed forests. It is a process that occurs when our woodlands are deforested due to natural disasters or human abuse. As environmental awareness has increased, a global movement has been taken to restore destroyed forests. Here are some of the numerous benefits of reforestation.

Enhancing biodiversity

Due to various developmental activities and climate change, we are on the verge of a major crisis resulting from rapid climate change, global warming, and the greenhouse effect. As more animals are driven out of their native habitats, the earth's biodiversity is shrinking. Reforestation is the only solution to overcome these negative consequences.

Absorbing carbon dioxide and combating global warming

Environmental disasters and pollution from industry and transport vehicles are not only wreaking havoc on human life but also have contaminated the environment in cities and far off places. Plants absorb carbon dioxide from the atmosphere, which aids precipitation and lowers surface temperatures. Trees enable the reduction of carbon dioxide in the atmosphere and the presence of harmful gases such as methane. Therefore, planting trees throughout the world is among the most efficient and cost-effective ways to mitigate carbon emissions and tackle global warming.

Improving water quality

Watersheds are significant elements of environmental well-being, can also be revived through reforestation. By reducing soil compaction, the ground enables more water to penetrate and store, decreasing surface runoff and sediment migration. Trees can also absorb and block precipitation, lowering inputs to streams even more, and the trees can collect metals and minerals that are harmful to water quality.

Mitigating soil erosion

Erosion is another environmental risk from deforestation. Trees reduce as well as prevent soil erosion and water pollution. Tree roots act as natural nets, penetrating deep into the ground and holding the dirt in place. As a result of the prevention of soil runoff, vital nutrients are preserved, and the soil remains productive. Falling leaves and dead branches provide fertilizers to the soil.

Preserving habitats

Deforestation and industrialization have always posed a serious danger to any region of the ecosystem. Many valuable plant species have been endangered, and many animals are on the verge of extinction. Reforestation can not only control environmental pollution but also help protect wildlife. Restoring forests helps overcome habitat loss as well as dangers to species' survival.

The proposed project envisages to plant the new plant saplings in a ration f 1:10 for every tree felled.

Grand Anicut Canal system

Grand Anicut Canal, also called as 'Kallanai' is said to be the oldest water regulating structure in the world, constructed in the 2nd century A.D by the Chola King Karikal Cholan. Grand Anicut canal system was one of the most successful canal system in Tamil Nadu and was formed as part of Cauvery Mettur Project during the project period of 1925-1934. It takes off from right flank of Grand Anicut (Kallanai) and traverse about 102 km in Thanjavur District and 46 km in Pudukottai District and finally falls into a tank called Mumbalai tank located near the South Vellar River in Pudukottai District. There are 327 numbers of branch channels to a total length of 1,232 km. The canal is feeding 694 system tanks in Thanjavur (526) and Pudukottai (168) Districts.

Modernization of the Grand Anicut canal system involves Extension, Renovation and Modernization (ERM) components to optimize the benefits in view of the technical advancement and to rectify the deficiencies experienced in operation and maintenance of the project over the past years.

The Grand Anicut Canal System (GACS) comprises of the GA Main Canal, which traverses a length of 148.65 kms and branch channels totalling to about 1232 kms which includes laterals also. The Main Canal is divided into 28 reaches according to hydraulic features like Bed Width, FSD etc. The Grand Anicut (Dam) is 328 metres long; 12.20 to 18.30 metres in width and 4.57 to 5.49 metres in height. The Main Canal passes through three administrative Districts namely Tiruchirappalli (05 kms), Thanjavur (104 kms) and Pudukkotai (39.65 kms) in the State of Tamil Nadu, India.

The Public Works Department / Water Resources Organisation (PWD/WRO), Government of Tamil Nadu (GoTN), have identified components of GACS, which need reconstruction, rehabilitation, repair and new components, which are necessary for equitable distribution, maintaining hydraulic profile and for discharge control in GACS, through preparation of Detailed Project Report by WAPCOS Limited, A Government of India (GoI) Enterprise under the aegis of the Union Ministry of Jal Shakti.

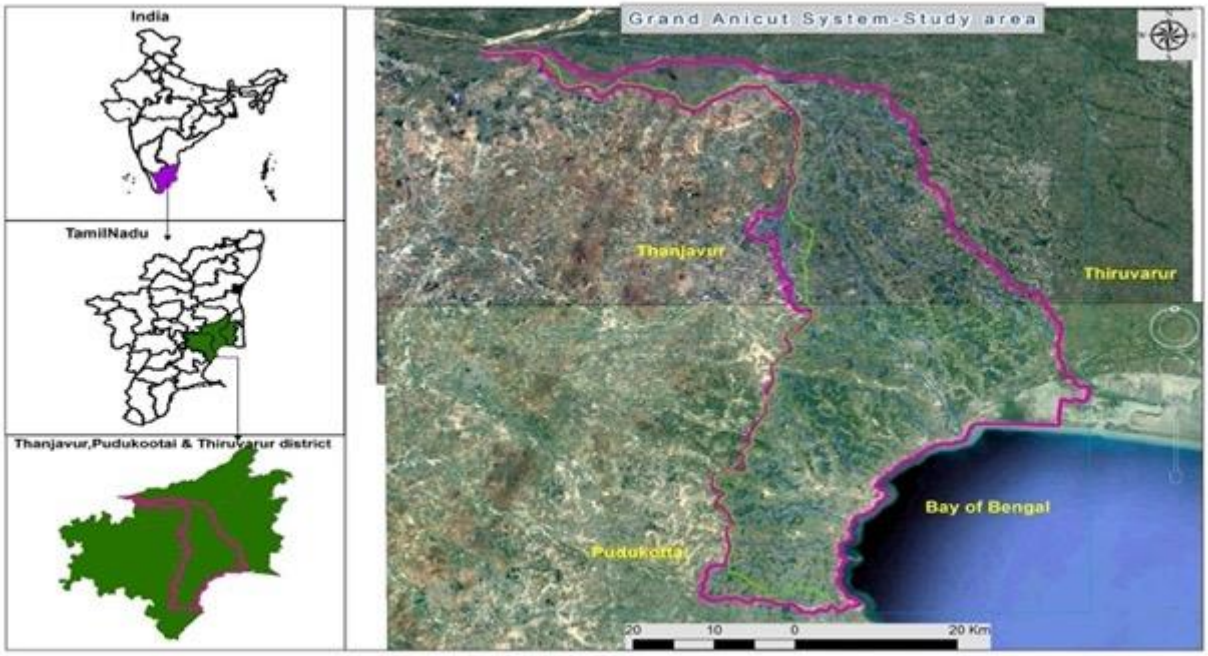


Figure –1: Project Area Map of GACS

Criteria for sapling/ tree Selection

2.1 Meteorological information

The mean maximum temperature is 37ºC during May – July and the mean minimum temperature is 20ºC during November-January. The north-east monsoon provides much rainfall with 545.7mm and 953.2mm as normal and actual rainfall respectively, while southwest monsoon provides 342mm and 303.1mm as normal and actual rainfall respectively.

During May, dust storms, whirlwinds and dusty winds flow from various directions. The south west winds that set in during April, become strong in June and continue till September Cyclonic storms of high velocity affect the District once in 3 to 4 years during November - December.

Based on the geographical and climatological setting and other factors the following matrix was developed to select the species for the proposed compensatory tree plan.

Table 1 Matrix used for developing trees for compensatory plantation

Site factors	**Characteristics to consider**
Social factors	**Purpose of the trees**: Landscaping, foodder for birds, bats, small animals and butterflies, shade, serving as windbreaks, a filter of pollutants/dust. **Functional utility:** Medicinal, nutritional, economic values.
Economic factors	Establishment costs, Maintenance and management costs

Site factors	Characteristics to consider
Institutional factors	Landscape policies, framework, and plan
Tree characteristic factors/ Resistance to environments/ dry weather	Flowering, adaptability, diversity, tolerance, structure, wind tolerance; resistance to termites, drought, poor soil, high temperatures, diseases and pests, and mechanical damage; **Crown, height, and canopy density**: Selected trees should have a good canopy, providing shade to cool the area along the road, making it more comfortable for the pedestrians.
Environmental Constraints	**Climatic conditions** Heat, drought, and waterlogging tolerance and soil conditions,
Cultural constraints	Utilities such as structures (buildings) and power lines : The selected trees should not grow tall enough to disrupt power lines, but if that is the case there must be a pollarding strategy.
Limitation constraints	**Space and planting location:** Plantation strategy for planting along a Rear slope of the canal, at Bunds of Tanks, or foreshore area of tanks, etc.

Table 2 List of common tree species recommended for plantation and their Criteria for selection

No.	Botanical name	Common Name	Criteria for selection
Fruit Trees			
1	*Mangifera indica*	Mango	It is a large fruit tree, capable of growing to a height of 30 metres (100 feet). This species has adapted to a wide variety of climates where it has become naturalized. The fruits are eaten and dispersed by bats, hornbills, monkeys, elephants, raccoons, porcupines and humans,
2	*Syzygium cumini*	Naval tree	The naval tree is one of the fast-growing tropical and sub-tropical trees preferring moist, Riverine habitats, that is valued for its fruit and timber. The sweet fruit is readily consumed by a variety of animals and birds which, along with water, spread seeds widely. It grows rapidly.
3	*Tamarindus indica*	Tamarind	As a multipurpose tree with nutritional, medicinal and cultural importance for rural communities tamarinds provide many ecosystem services. For cropland areas, a positive effect of tamarinds on soil organic matter and on soil biological properties has recently been demonstrated
4	*Phyllanthus*	Gooseberry	The tree is small to medium sized, reaching 8 to

No.	Botanical name	Common Name	Criteria for selection
	emblica		18 m in height, with crooked trunk and spreading branches. The leaves simple, sub-sessile and closely set along branchlets, light green, resembling pinnate leaves. The fruits provide nutrition to birds small mammals like squirrels etc.
5	*Psidium guajava*	Guava	P. guajava is a fast growing tropical and subtropical species adapted to a wide range of environmental conditions. It is tolerant of shade, a precocious and prolific reproducer with seed dispersal aided by avian and mammalian vectors. It can form dense thickets.
6	*Manilkara zapota*	Sapota	Sapota can grow to more than 30 m (98 ft) tall with a trunk diameter of up to 1.5 m (5 ft). The trees can survive in warm, typically tropical environments. From germination, the tree will usually take anywhere from five to eight years to bear fruit. They yield fruit twice a year, though flowering may continue year-round.
7	*Artocarpus heterophyllus*	Jack fruit	The tree grows as an evergreen tree that has a relatively short trunk with a dense treetop. It easily reaches heights of 10 to 20 m (33 to 66 feet) and trunk diameters of 30 to 80 cm (12 to 31 inches). It sometimes forms buttress roots.
8	*Terminalia catappa*	Indian Badam	Evergreen, tall tree which naturalizes readily in littoral habitats. It is a fast-growing tree at juvenile stages, moderating the speed of growth as it ages. Usually, they start flowering and fruiting within 2 to 3 years after planting.
9	*Moringa oleifera*		Moringa oleifera is a fast-growing, drought-resistant tree of the family Moringaceae, native to the Indian subcontinent. It can propagate through tree cuttings and seeds. Provides habitat for a variety of moths and butterflies.
Berry trees			
10	*Ficus religiosa*	Peepal tree	Semi-evergreen tree with shiny leaves. Provides space for nesting and roosting for birds and mammals.
11	*Ficus benghalensis*	Banyan tree	Semi-evergreen tree with spreading canopy and compact leaves. The berries are readily eaten by birds and small animals.
12	*Azadirachta indica*	Neem	Neem adapts to a broad range of climate and soil conditions. Fast-growing, evergreen, drought and pest resistant
13	*Pithecellobium dulce*	Kodukka puli	It is a Nitrogen fixing tree which is a hardy, tenacious, seedy, and able to provide their own nitrogen, that can colonize soils and sites that are difficult or impossible for other trees. It

No.	Botanical name	Common Name	Criteria for selection
			often establishes in grass ecosystems without the benefit of weed and grass.
Timber trees			
14	*Monoon longifolium*	Netlingam tree	Narrow tree with distinctive weeping, columnar crown. Neat and formal appearance makes it suitable for lining of fences and marking of boundaries.
15	*Tectona grandis*	Teak wood	Teak is a tropical hardwood tree species in the family Lamiaceae. It is a large, deciduous tree that occurs in mixed hardwood forests. Hardy species that is resistant to drought and arid climate.
16	*Bambusa tulda*	Bamboo	The bambusoid taxa have long been considered the most "primitive" grasses. Bamboo forests are very friendly to the environment. They reduce pollution by producing oxygen, more than 35 percent more than trees do. It also provides shelter to a variety of reptiles and nesting for birds.
17	*Pongamia pinnata*	Pungam	Evergreen, medium-sized tree with dense foliage. It is a fast-growing deciduous tree that can grow upto about 15-25 meters in height with a large canopy that spreads equally wide. The leaves are a soft, shiny burgundy in early summer and mature to a glossy, deep green as the season progresses
18	*Thespisia populnea*	Indian Tunlip	A multipurpose tree, providing food, medicines and many other commodities for local use. The Indian tulip tree is an evergreen bushy tree that can grow upto 40 ft or more with a spread of 10 to 20 ft. It has heart-shaped leaves and cup-shaped yellow flowers that are produced intermittently throughout the year in warm climates
19	*Spathodea campanulata*	Nandi flame	Grows to be a large tree, up to 25 m, with a broad crown; ornamental, drought-resistant, termite resistant. The Nandi flame tree is an evergreen or semi-deciduous tree with a dense, bushy, oval crown; it can grow from 10 - 35 metres tall. The stem tends to become hollow, dropping large branches as the tree ages. The tree is planted for soil improvement, reforestation, erosion control and land rehabilitation, and also as a live fence. It is able to colonize even heavily eroded sites, though form and growth rate suffer considerably on difficult sites
20	*Cassia fistula*	Sarakondrai	The species is native to the Indian subcontinent

No.	Botanical name	Common Name	Criteria for selection
			and adjacent regions of Southeast Asia. The tree has strong and very durable wood. *Cassia fistula* produces large amounts of seeds that remain viable for more than a year, and is also able to propagate through cuttings and layering, and is tolerant of a wide range of soils and climate. *Cassia fistula* is a medium sized deciduous or semi-deciduous tree, 10 to 15 m tall with a straight trunk to 5 m in height and 1 m in diameter. It has spreading branches that form an open crown.

List of shrubs suitable for planting between trees

No.	Scientific name	Common Name	Criteria for selection
1	*Bougainvillea spectabilis*	Bougainvillea	Evergreen, climbing shrub producing stems up to 10 m long, ornamental
2	*Lantana camara*	Wild Sage	Evergreen, can grow up to 2 m tall, erosion control
3	*Thevetia Peruviana*	Yellow Oleander	Drought tolerant, ornamental, stalks are 2-3 ft tall
4	*Lawsonia inermis*	Maruthani/ Henna	Henna is a tall shrub or small tree, standing 1.8 to 7.6 m tall (6 to 25 ft). It is glabrous and multi-branched, with spine-tipped branchlets.

Setting up and managing a tree nursery

Based on a reconnaissance survey carried out in and around the project area it was observed that there are is a scarcity of nursery that can cater to the required quantum of tree saplings for the present project. Hence it is put forth that a dedicated nursery may be established and plants be maintained at the nursery. It is also suggested that instead of pooling the saplings in a single point it may be spread out throughout the project area for the ease of replacement.

In setting up a nursery, several factors are to be taken into consideration: the nursery site selection, design, and construction; pest and disease management; and planning and record keeping.

There are two types of tree nurseries;

Temporary Nursery – This is established in or near the planting site and can be used for a year or two (one or two seasons).

Permanent Nursery – This nursery is meant to serve a longer period, hence seedlings can be raised from year to year. The size of the nursery is dependent on the number of seedlings to be raised.

Nursery site selection

The selection of the area for a nursery is very important and should be sited as centrally as possible to the sites to be planted. Critical points to consider in the selection of a nursery area are:

- The area should be well drained and free from waterlogging.
- The plants should be exposed to direct sunlight.
- The nursery should be close to a water source for ease of irrigation. Canal/River water can be occasionally used for tree saplings.
- The area should be well protected from pets and wild animals.
- The area should be flat or gently sloping, with a slope ranging from 0 to 30 degrees.
- The number of seedlings depends on the planting pattern used, which can either be square or rectangular.
- The recommended spacing between two lines is either 10 cm or the width of the palm, and spacing between the plants is 10 cm.
- Further, the recommended height for transplanting trees is between 1.5 m and 1.75 m.
- A parallel stock of seedlings, sapling and Stacking need to be maintained for replacement in site.
- Unnecessary use of pesticides, Weedicides and chemical fertilizers should be avoided. Only if the use of pesticides is inevitable then it can be used under strict supervision of the Nursery horticulture specialist.

Designing Plantations

Pre-Planting Management

Site preparation

Appropriate planning of the planting location is very important for good root development of trees. The main aim of plan is to determine the favourable growing spots for seedlings and tree saplings. In addition to site preparation there is a vital need to identify the areas for the plantation. Based on the land and water availability the an elaborate plan has been prepared for the compensatory tree plantation in the locations as shown in the Table 4.1.

Planting Procedure

Preparation of the site for plantation

- Before the onset of monsoon all the weeds of the plantation area should be mechanically removed.
- Pits may thereafter be dug along the contour up to the size of 0.45 cm deep, 0.45 cm wide as shown in the table (no) against each species and allowed for a couple of days.
- The dug pits should thereafter be filled up to ¾th depth with horrified down dung/compost at the about 5-6 kg. and phosphate at about 100 gram per pit.
- The fruit trees should be planted in open and flat top region while the rest of the land should be planted with fuel/ fodder/timber species lifted in the table.
- In case of open plantation and in the absence of tree guard, a deep trench should be excavated around the outer boundary of the plantation area (0.05(cm) wide x 0.5(cm) deep) the inner rim of which can be covered by sowing three lines of Babul (*Acacia*

nilotica) seeds. This would provide a life fencing to the plantations against cattle trespass in one hand and increasing the biomass content along with enrichment of the soil on the other. This will help in conserving the moisture and fixing nitrogen in the soil and thereby increasing the biomass on the other.

- The fuel, fodder and timber species should be planted in the rest of the area, which will not only fix nitrogen and conserve moisture but also provide shade to the growing plants besides enriching the biomass.
- The planted seedlings as well as the leguminous cover crop in the interspace will need watering, particularly during the dry months.
- Arrangement for minimal irrigation must be made.
- During the periods of summer and dry season drip irrigation maybe used to conserve water and prevent the saplings from drying off.

Problem areas are characterised by constraints that call for additional resources for treatment and may include dry and arid areas, rain shadow areas, areas subjected to heavy browsing or grazing pressure, sheet rock areas, highly refractory, alkali or acidic lands, areas requiring change of soil, critical (survival) irrigation supplements, etc. In urban setups, site preparation may require some planning, unlike in rural settings. In preparing the site for tree planting, the size of the planting area should be well determined, the competing vegetation should be removed, and the soil should be prepared.

The three steps for site preparation are:

- Determine the size of the planting area
- Remove the competing vegetation
- Prepare the soil

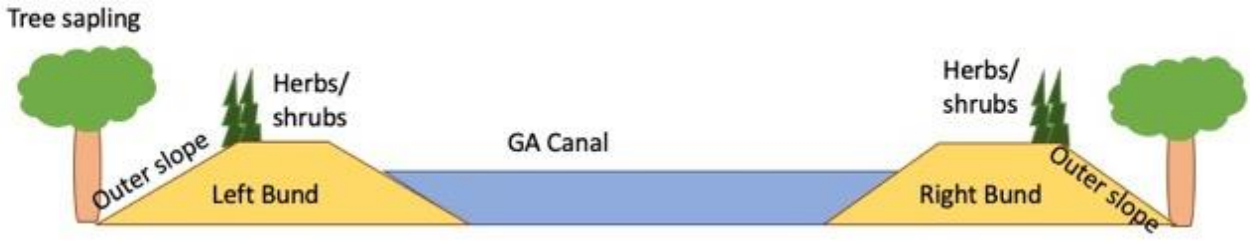


Fig 2. Model Plantation along the slopes of the canal

The outer slopes of the reaches as described in the table 4.1, is chosen for the plantation. The top layer of the outer slopes in the right and left bank are to be planted with Herbs/Shrubs and grasses including bamboo variety at a spacing of 2 to 3m. The outer slopes and the adjacent area of the bank are to be planted with woody saplings that can attain a height of approximately 10m. Hence it is advisable to plant the saplings at an interval of 5m grid spacing. The CS for the plantation along with the canal is shown in Fig 2.

The LS of the canal along with the plantation of is shown in Fig 3. The spacing for tree sapling is 5m along the canal and herbs/shrubs can be planted in the space between the trees. This will help in preserving the prepared topsoil to time till the tree saplings takeover. In addition to this,

the shrubs will also help to preserve the micro-faunal assemblages and in turn provide a feeding ground for the birds and small mammals.

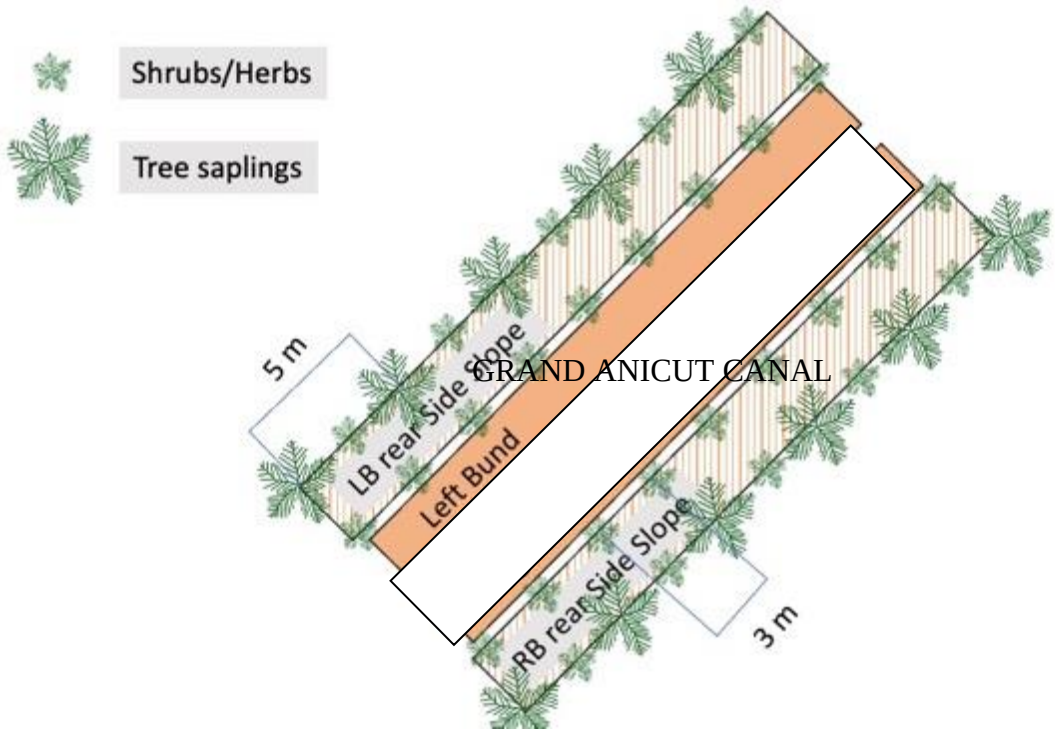


Fig 3. Model Plantation LS along the slopes of the canal.

In addition to the rear slopes of the canal and adjacent areas, certain areas that belong to the WRD has also been chosen for the plantation. The proposed plantation in this area is to be made in 5m grid. These plains are more suitable for the trees with more than 10 m crown height. In these plantation areas the space between the trees are to be planted with herbs and shrubs. These shrubs not only helps to preserve soil moisture in the dry seasons, but also aid in control of pests and prevent the overgrazing of the areas. The thorny shrubs and herbs also act as habitat for the insects. The pictorial representation is shown in the Figure 4.

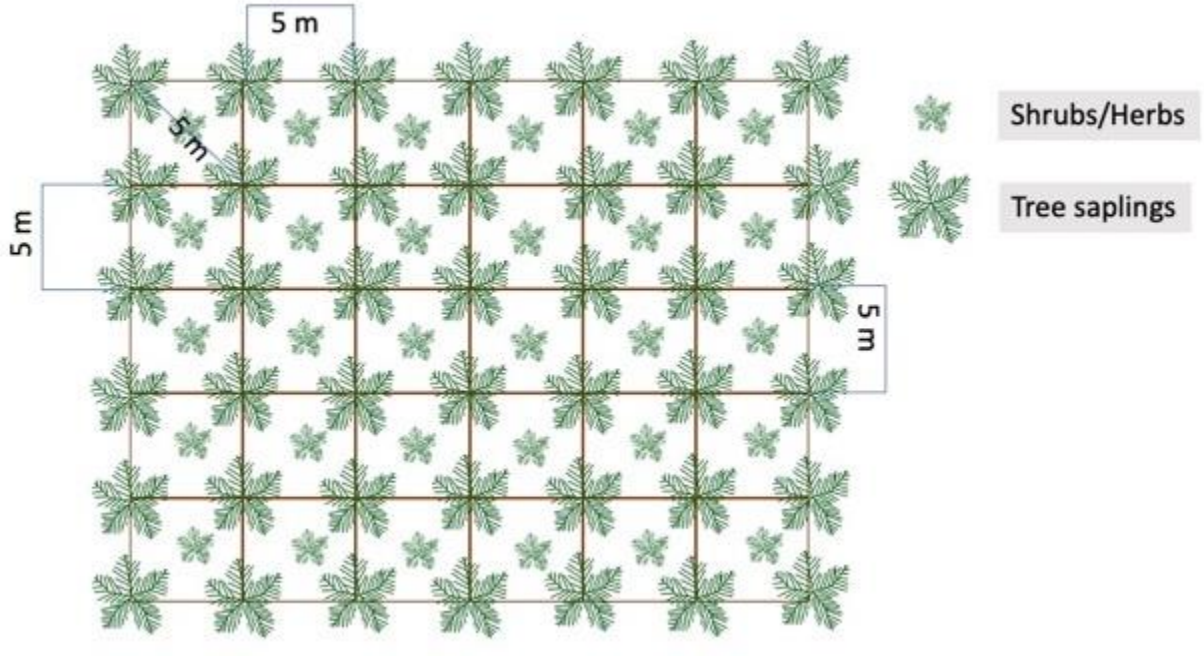


Fig 4. Model Plantation in WRD land

The area earmarked as per package for the plantation is described elaborately in the table 3. This table also shows the details in length and area along with the village details are described in the table 4.1. the total number of trees to be removed for the expansion, renovation and modernisation is **23,183** trees. However this is a tentative number that will be revised as on when during the expansion, renovation and modernisation of the project. The plan is for **2,31,830** tree saplings.

Table 3 Details of tree plantation to be carried out package wise

Package no	Name of Tanks/ Canal/ Drain/ WRO Land	Village	Tank Bund Canal/ Channel Length in meter or WRD Land area in sq.mts	No of trees to be Planted
1	GA Main LS 000 to 12.624 km (RB and LB rear Side slope)		12624 X 2	3270
2	GA Main LS 12680 to 30.430 km (RB and LB rear Side slope)		4850 X 2	2000
3	GA Main LS 30.433 to 45.280 km (RB and LB rear Side slope)		10770 X 2	4300
	Neivasal Thenpathi Channel 0.00 to18.10 km (RB & LB Side)		17925 X 2	1630
	Total			**5930**
4	GA Main LS 45.290 to 58.650 km (RB and LB rear Side slope)		15200	4520
	KB canal 0.00 to 13.00 km (RB & LB Side Slope)		7500	1500
	Tank (3 Nos)			430

Package no	Name of Tanks/ Canal/ Drain/ WRO Land	Village	Tank Bund Canal/ Channel Length in meter or WRD Land area in sq.mts	No of trees to be Planted
	WRD Land Area	Kandithambattu	6070	275
	WRD Land Area	Pudur	6070	275
	WRD Land Area	Kasanpallam	4047	200
	WRD Land Area	Thuraiyur	16188	800
	Total			**8000**
5	KB canal 13.00 to (RB & LB Rear Side Slope)		5311	2000
	K.B. 8/10 Channel 18.531 km RB and LB Side Slope			600
	Tank 2 Nos		2012	400
	Total			**3000**
6	KB Main Channel 18.531 to 35.00 km (RB and LB Rear Side Slope)		16379 x 2	5990
7	VB main Canal and Channel		35280 X 2	11090
	Tanks			8510
	Total			**19600**
8	GA Main LS 58.650 to 92.650 km (RB & LB Rear Side Slope)		3400 x 2	13600
	Naryar Drain		5000 X 2	2330
	Agniyar Drain		35000 X 2	14000
	MS River		40000 X 2	16000
	WRD Land Area	MS Aqueduct	30000	1200
	WRD Land Area	Thachinamoorthipuram	20000	800
	Total			**47930**
9	RB Main Canal LS 0.0000 to 42.846 km (RB & LB Rear Side Slope)		42846 X 2	5940
	RB no 3		1500 X 2	600
	RB no 4		2000 X 2	800
	Narsingapuram main drain		9600 x 2	3840
	Veerakuruchi		2345 x 2	938
	Right side supply		5465 x 2	2185
	RB no 9		4000 x 2	600
	RB no 10		1500 x 2	1600
	RB no 19		1117 x 2	446
	RB no 20		3612 x 2	1444
	RB no 21		3725 x 2	1490
	Rear Channel		1786 x 2	715
	RB no 17		1493 x 2	597
	RB no 16		1281 x 2	512
	RB no 11		967 x 2	293
	Total			**22000**
10	Olavayal Channel LS 0.00 to 27. 740 km (RB & LB Rear Side Slope)		27740 X 2	11050
	Kayavor Channel LS 0.00 to 6.630		6630 X 2	2650

Package no	Name of Tanks/ Canal/ Drain/ WRO Land	Village	Tank Bund Canal/ Channel Length in meter or WRD Land area in sq.mts	No of trees to be Planted
	(RB & LB Rear Side Slope)			
	Total			**12140**
11	GA Main LS 92.650 to 101.60 km (RB and LB rear Side slope)		16960 X 2	4841
	Tank (33 Nos)		36498 X 2	7299
	Total			**12140**
12	GA Extension LS 101.60 to 118.60 km (RB and LB rear Side slope)		17000 X 2	6800
	Aamanichatram Channel 0 to 16.00m (RB and LB rear Side slope)		16000 X 2	6400
	Annavayal Channel 0.00 to 4.50 km (RB and LB rear Side slope)		4500 X 2	1775
	WRD Land Area	Neivathali		14815
	Total			**29790**
13	GA new main Channel		22000 X 2	9600
	Thiruvapadi Channel		13000 X 2	5200
	Narasinga Cauvery Drain		16000 X 2	6400
	Mudiyanar Drain		11500 X 2	4380
	Kalakkamangalam		8000 X 2	3200
	Total			**28780**
14	Padupatinam Main Canal (RB and LB rear Side slope)		14530	7265
	Sethubavachatram Main Ch (RB and LB rear Side slope)		15840	7040
	Tank (29 Nos)		18223	3645
	Total			**17950**
15	Padupatinam Main Canal (RB and LB rear Side slope)		9560	3823
	Karisavayal Channel (RB and LB rear Side slope)		5550	2220
	Tank (29 Nos)		31425	5707
	Total			**11750**
	GRAND TOTAL			**231830**

CONCEPTUAL PLAN FOR PLANTATION IN DRY AREAS.

The Main Canal of GACS traverses a total length of 148.65 kms through the three Districts i.e.,, Tiruchirappalli (05 kms), Thanjavur (104 kms) and Pudukkotai (39.65 kms) in the state of Tamil Nadu, India. The area in Pudukkotai and part of Thanjavur are falling under dry climate. In these areas it becomes practically challenging for water intensive trees to be planted and maintained. In some areas the soil suitability for growing deciduous trees needs to be assessed based on point to point basis. These areas can be utilised by growing trees like casuarina and bamboo and deciduous trees. In addition to soil improvement such plantations help in reducing the felling of

trees for socio economic and cultural reasons. Hence a separate plan has been formulated and is described below.

Casuarina Plantation

Casuarina is a multipurpose tree cultivated in a wide range of agro-climatic conditions for more than a century. Nitrogen- fixing ability, good pulping traits for manufacture of paper, high calorific value of wood and short gestation period. has made it a preferred crop for farmers in South India.

During the first half a century after its introduction in India, Casuarina was predominantly planted by the Government agencies adopting long rotations of 15 to 30 years with one or two thinnings (Kaikini, 1937). When farmers started cultivating the tree, they found that it was amenable for high density planting with irrigation and fertilizer applications. Gradually the rotation period was reduced to a maximum of 5 years with high stocking (up to 10,000 stems per ha). It also has a simple and cost- effective nursery, field planting, tending, pruning and harvesting practices making the overall cost of cultivation low. Intercropping with other tree saplings also helps in weed management and improving soil fertility. With the availability of genetically improved planting material like seeds from seed orchards and clones from fast-growing provenances, farmers tend to adopt wider spacing and intensive cultural practices to optimize productivity.

WATER HARVESTING AND PLANTING TECHNIQUES

In the areas of water scarcity and the places where total availability of water and the per capita availability of water are very low water harvesting techniques maybe used for the plantations.

Option 1

The green belt development also aims at harnessing rainwater through micro water harvesting. In the conventional planting, for the fast growing species like *Eucalyptus* and *Casuarina* an espacement of 2m x 2m is being followed by Forest Department. The farmers are practicing *Casuarina* cultivation under 1m x 1m espacement in other dry areas of Tamil Nadu. Keeping the same density of population of 2500 per ha. for 2m x 2m conventional planting design, the saucer planting technique was developed which harnesses about 1 lakh litres of water per acre for every rain that fills it up to the brim (Figures 1-3).

An experiment conducted at SFRI, Kolapakkam with this saucer design has indicated that 20 months after planting compared to the conventional planting, saucer planting yielded 50% more stem volume in the case of *Eucalyptus tereticornis* clones (ITC 3). At 6m x 6m interval, about 277 no. of saucers of 3m dia. and 30 cm. Depth could be dug up per ha. The perimeter of the saucer is 9m. Hence, at an espacement of 1m x 1m per saucer, 9 seedlings of *Casuarina* or *Eucalyptus* or any other fast growing, straight boled, thin crowned tree species could be planted. Each saucer of these dimensions could hold 1000 litres of water. Therefore, 2,77,000 litres of water per ha. per heavy rain could be harnessed. Assuming that 10 such rainy days occur in a year about 27 lakh litres of water would be made available for these plants per year per ha.

Similar methods can be used for other plantations too on an experimental basis and required improvement can be made in order to achieve a similar stem volume.

Option 2

The size of pits recommended is 30 cm^3. Each pit filing should be mixed with 200 g of Vermicasting, 20 grams of VAM, 10 grams of *Phosphobacteria* and *Azospirillum*. For legumes alone, additionally 10 grams of *Rhizobium* is recommended. Trees needling more canopy area like *Tamarind* graft, *Simaruba glauca* and Timber species can be planted per pit. A pit size of 60 cm^3 should be dug up at the center of the saucer. For this pits also, Vermicasting, VAM, *Phosphobacteria and Azospirillum, Rhizobium* should be applied without omission. The quantity of these bio-nutrients and bio-fertilizers could be 1kg of Vermicasting, 30 grams of VAM, 10 grams of *phosphobacteria, Azospirillum* and *Rhizobium* for legumes only, per pit.

Option 3

The ***third*** alternative will be planting up the tree saplings in 1cu.m. pit with an espacement of 3 to 4 m. Each cu.m of pit should be applied with 2 kg of vermicasting, 50 grams of VAM, 15 grams of *phosphobacteria*, 15 grams of *Azospirillum*. 15 grams of *Rhizobium* should be added for legume species only (Figure 4). If pro rata is a limiting factory, the quantity of Vermicasting and VAM could be proportionally reduced to fit in the pro-rata.

Option 4

The ***fourth model*** is trench mound, which could be dug up with a help of tractor. The diagrams appended are self/explanatory. In the trenches, according to the species and according to the site, differing espacement could be decided by the CFs and DFOs.

Option 5

The ***fifth model*** will be that of staggered trenches, which could be dug up with the help of bulldozers. About 67 trenches per acre could be dug up. Each pit could hold about 4000 litres of water. Therefore, 2,80,000 litres of rainwater could be harnessed per acre (Figures 6 & 7).

In this trench method around each trench, about 16 plants could be planted with an espacement of 1.08 m x 1.08 m and with 0.80m x 0.80m in the other 2 sides. If trees have to be planted at 3m x 3m, 4m x 4m or 5m x 5m espacement, they are planted either in 60 cm^3 sized pits or more ideally in 1m3 pits, depending on the fund available, in between the staggered trenches.

The approximate cost would be around Rs.10, 000/- per ha. 7 lakh litres of water could be harnessed per ha. Per rain. Assuming 10 such heavy rain days in a year, 70 lakh litres of water could be harnessed. For the planting density of 2500 per ha. In these staggered trench methods, each seedling will be assured of at an average of 8 litres of water per day which is only an arithmetical average.

The interspace between the saucers or trenches could be sown with rainfed fodder species like *Stylo scabra* or Vigna sinensis which are high yielding. Depending on the market demand and site conditions, medicinal plant cultivation could be thought off. Either one model or combination of models could be made use of in the 20 ha. Plot depending on the species and soil type.

Table 4: Conventional Planting

S. No	Espacement in mt.	No. of Plants / ha
1.	1mt * 1mt	10,000
2.	1mt * 1.5mt	6,666
3.	1.5mt * 1.5mt	4,444
4.	2mt * 2mt	2,500
5.	2mt * 2.5mt	2,000
6.	2.5mt * 2.5mt	1,600
7.	3mt * 3mt	1,111
8.	3mt * 3.5mt	952
9.	3.5mt * 3.5mt	816
10.	4mt * 4mt	625
11.	4mt * 4.5mt	555
12.	4.5mt * 4.5mt	493
13.	5mt * 5mt	400
14.	5mt * 5.5mt	363
15.	5.5mt * 5.5mt	330
16.	6mt * 6mt	277
17.	6mt * 6.5mt	256
18.	6.5mt * 6.5mt	236
19.	7mt * 7mt	204

Table 5: No. of plants in 3 mt Saucer Planting

S. No	Distance between the saucer pits centers	No. of Center Points/ha.	No. Of plants along the periphery of the 3mt dia saucer at 1mt espacement	Total No. of plants/ha.
1	3mt	1111 *	8	8888
2	3.5mt	816 *	8	6528
3	4mt	625 *	9	5625
4	4.5mt	493 *	9	4437
5	5mt	400 *	9	3600
6	5.5mt	330 *	9	2970
7	6mt	277 *	9	2493
8	6.5mt	236 *	9	2124
9	7mt	204 *	9	1836

Table 6: *Casuarina equisetifolia* (Selected Variety)

S. No	Mode of planting	No. of Trees/ha.	Escapement	Volume in m^3
1	Saucer	2493	6mt * 6mt	10.17
2	Control	2500	2mt * 2mt	3.46

Table 7: ITC3-*Eucalyptus* Clone

S. No	Mode of planting	No. of Trees/ha.	Escapement	Volume in m^3
1	Saucer	2493	6mt * 6mt	14.2101
2	Control	2500	2mt * 2mt	9.5

(20 Months after planting)

Saucer at 6m * 6m.

277 Nos.of saucer pits/Ha. 2493 Plants @ 9 per saucer/Ha.

Volume of water in one saucer -1,000 lit (approx) therefore per acre

-1,00,000 lit/per rain (approx) Assuming 10 heavy rainy days/year

Total volume of rain water harvest/year/acre -10 lakh (approx) Planting Along the Periphery

Planting Along thePeriphery

Saucer Pits-I

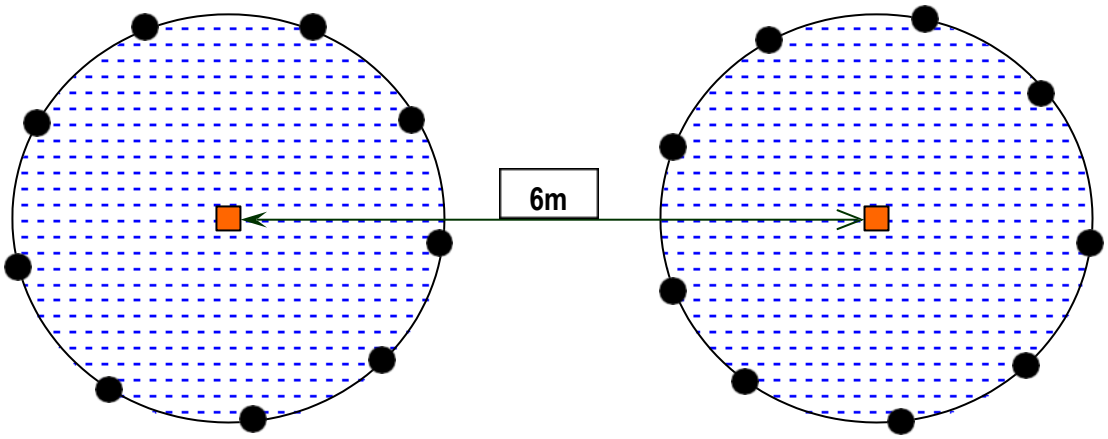


Figure 4: Cross Section Of a Saucer Pits-I

SAUCER PIT-II

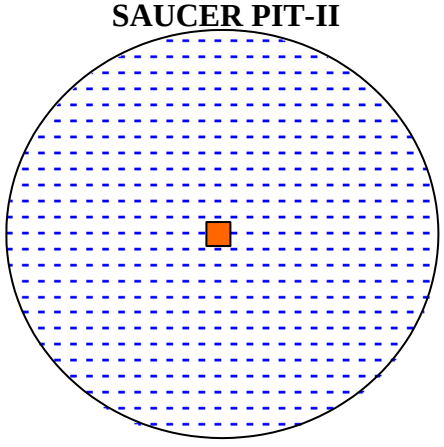


Figure 5: Cross Section of a Saucer Pit Central Planting $1m^3$ Pit

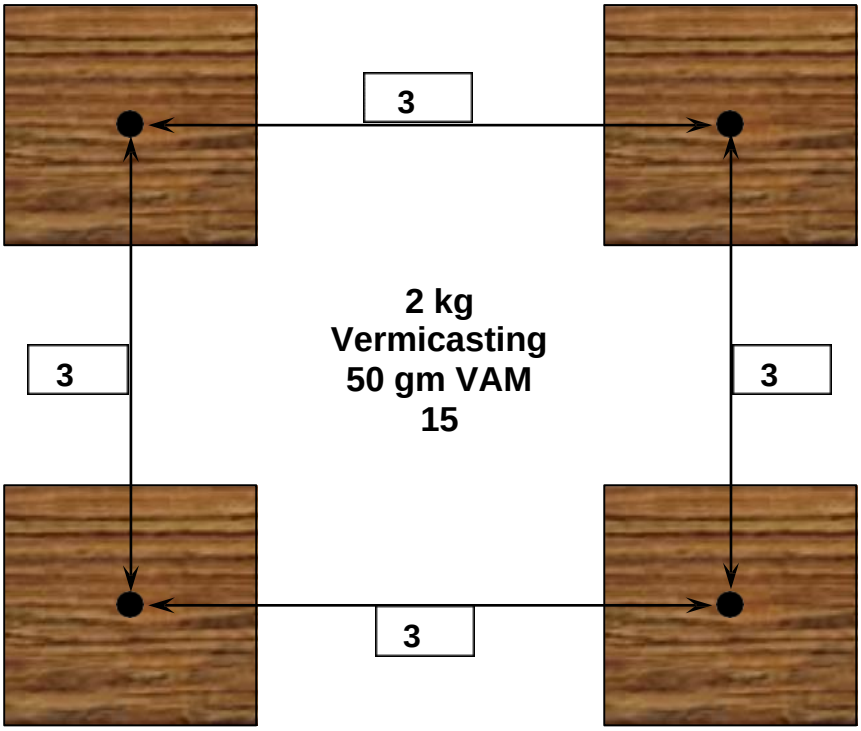


Figure 6: Filling the pits

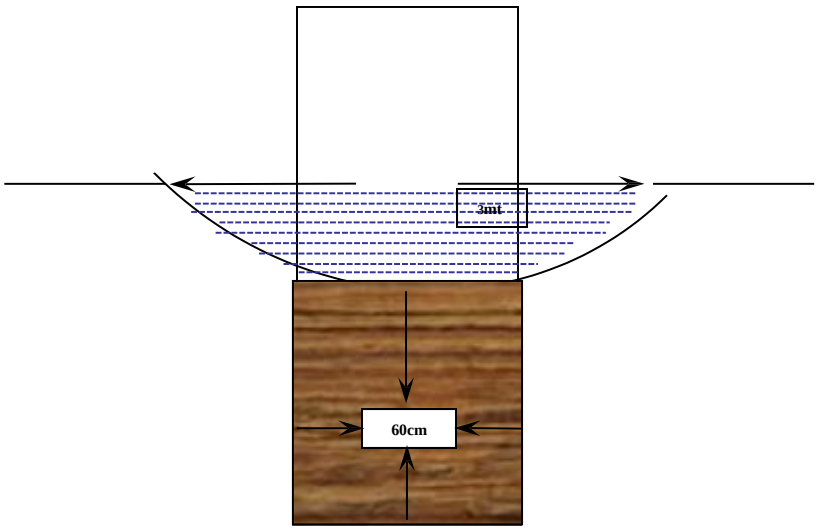


Figure 7: Planting in the Center

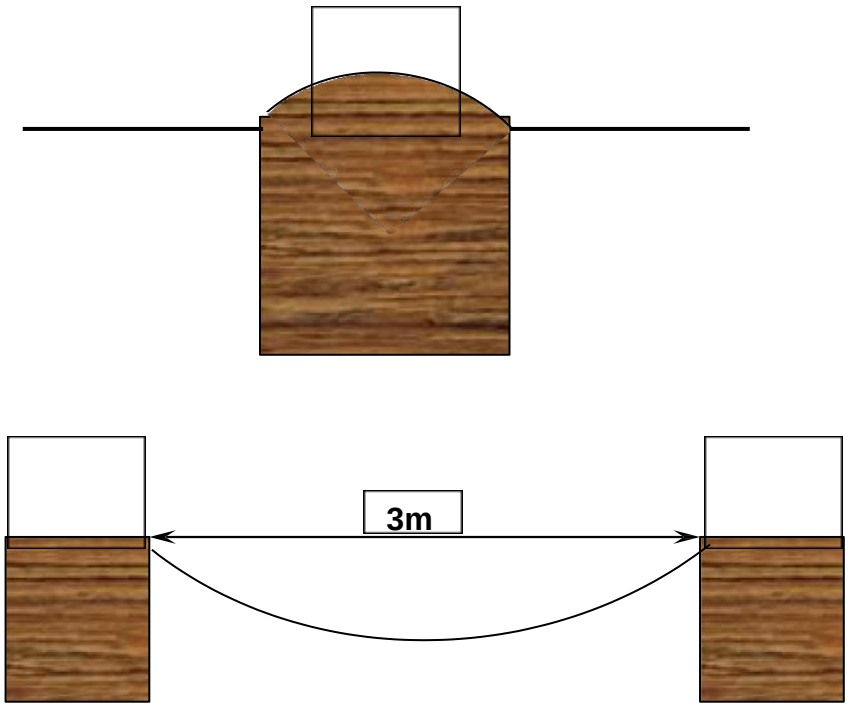


Figure 8: **Cross Section of a 1m^3 Pit**

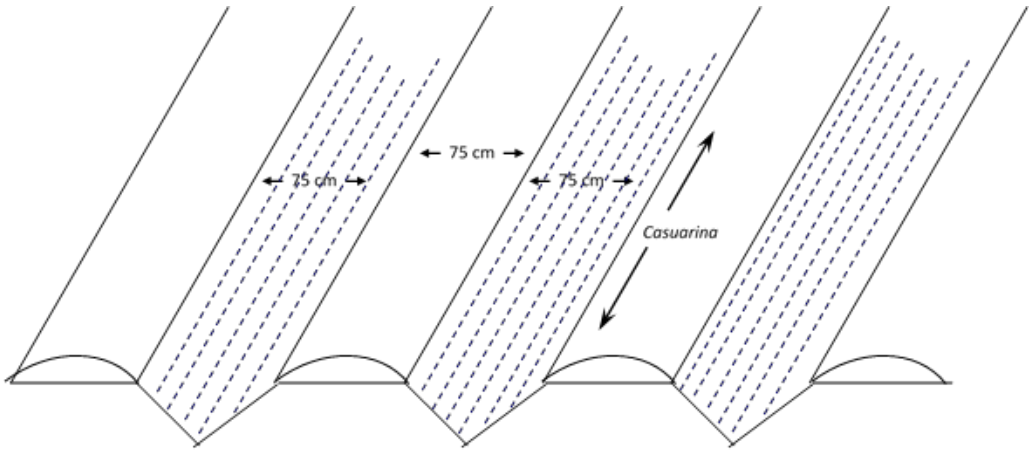


Figure 9: Trench And Mound

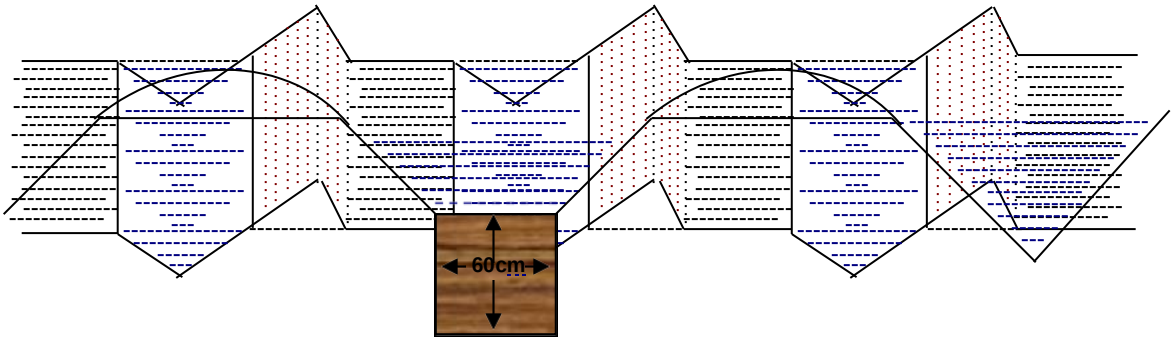
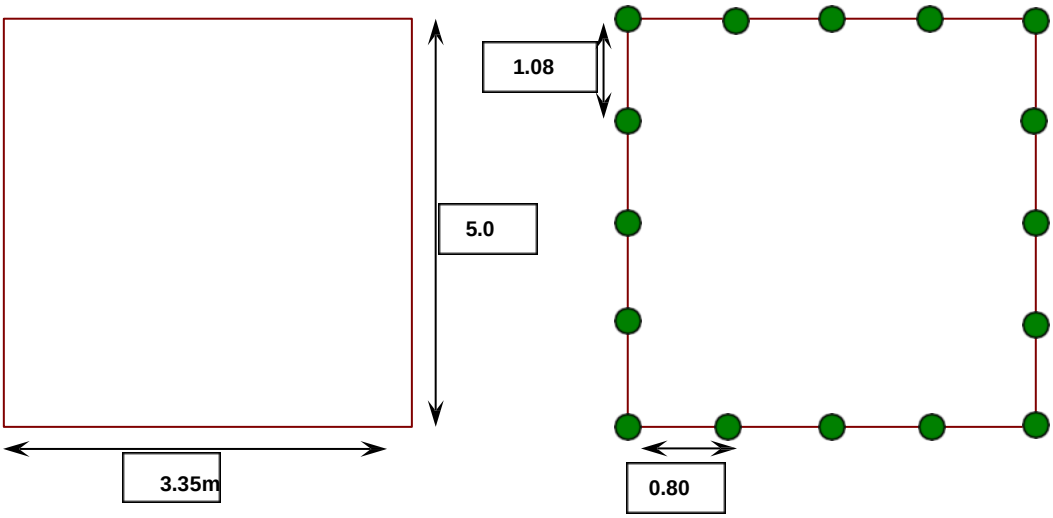
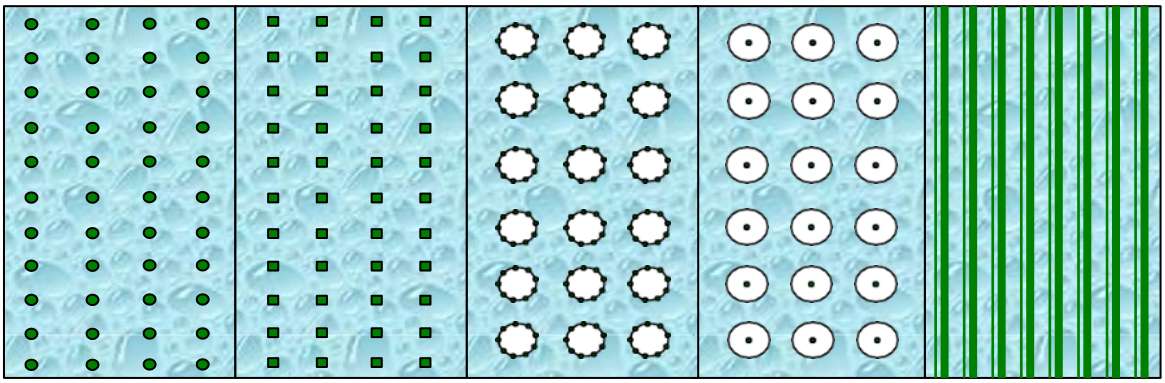


Figure 10:Staggered Trenches

(Using Bulldozers)





T1- Conventional	T2- lm^3 Pit	T3 Saucer	T4 Saucer	T5 Ridge &Furrow

4ha. for each treatment

Individual treatment of 4 ha. could be divided into convenient plot sizes depending on the species chosen for the site.

Figure 10: Periphery planting

Maintenance and Post-Planting Management:

Maintenance is one of the factors to consider before embarking on tree planting. Trees should not be planted until the necessary resources for maintenance have been arranged. According to Steenbergen (2015), some of the key maintenance strategies are preventing physical contact of the seedlings with livestock as well as watering during the dry season. Managing a roadside tree properly enhances public safety, making the city more livable and improving the environment (Hasan et al., 2016). Maintenance shall include, but is not limited to:

Mulching

All tree pits and individual shrub pits are mulched with appropriate material to reduce the rate of soil moisture water. Organic mulch, such as shredded bark or pine straw, helps conserve moisture and keeps weeds at bay (DeJohn, 2019). To prevent rot, do not pile mulch against the trunk (Pomery, 1987). Having grass grow under trees is beneficial, as it acts as a cover crop or natural mulch; hence, more water will be retained in the soil.

Staking

Staking provides extra support, protection, or help to the tree to stay anchored. In the case of roadside tree planting, staking protects trees from destruction from animals (since they are young and palatable) and passersby. Staking can be done with the use of sticks. However, staking is not to be done on all newly planted trees; only stake the following:

Bare-root trees or trees with a small root ball

Trees planted in areas with lots of foot traffic

New trees that cannot stand on their own or that begin to lean

Tall, top-heavy trees with no lower branches Young trees, if you live in a very windy area or if the soil is too wet or loose. (Davey, 2017)

Lopping

Lopping is a form of harvesting in which only the lower branches are cut and

new branches re-sprout along the lower portion of the stem. This harvesting method can be used to reduce branches that may interfere with traffic.

Pollarding

This is a tree harvesting system whereby all branches are removed but the main trunk is left standing. After the branches are cut off, new shoots are allowed to sprout from the main stem and form a new crown. When the tree loses its sprouting vigor, the main stem can also be cut for use as large diameter poles. An advantage of this method is that the new shoots are high enough off the ground that they are out of reach of most grazing animals.

Coppicing

This is a particularly suitable method for the production of firewood and small poles (withies). It is one of the most widely practiced harvesting methods for dryland species. When the main stem has reached the desired dimensions, it is cut at the base of the trunk. New shoots develop from the stump or roots. Only three to four vigorous shoots should be allowed to grow to full size. The others should be cut back to prevent competition for growing space

Several rotations of coppicing are usually possible with most species. The length of the rotation depends on the size of the specific or desired wood products. After several harvests, the sprouting vigor will diminish, but this will vary from species to species.

Pruning

Pruning usually involves the removal of smaller and lower branches of trees. Pruning can be a major source of firewood and wood for other purposes. Branches should be cut clearly and as close as possible to the main stem. Branches are also used as mulch between tree rows in alley cropping systems.

The main objective of pruning is to add value to the trees, and it is mostly undertaken at the end of the dry season to serve the following purposes: (Federation, 2011)

The most common types of tree pruning are:

- To increase light reaching crops
- To check on the spread of pests and diseases
- To promote straight stem growth
- To give room for mechanized farm operations; and
- To improve growth rate of trees and the quality of poles or timber while providing immediate products.
- To reduce competition between trees and adjacent cropland (the best pruning is two-thirds of the maximum tree height) (Makee, 2016).
- To controls plant size and shape
- To keep shrubby evergreens well-proportioned and dense
- To remove unwanted branches, waterspouts, suckers, and undesirable fruiting structures that detract from plant appearance
- To improve the quality of the trunk for timber production To minimize shading

The most common types of tree pruning are:

- Crown thinning, which involves selectively removing some secondary branches (particularly weak branches) to bring out the crown structure, without altering the overall size or shape of the tree. This method increases light and air penetration, which in turn promotes better form and health of the tree (Hibberd, n.d). (Do not overdo crown thinning on mature trees.)
- Crown raising/lift, which is the removal of the lowest branches and the preparation of lower branches for future removal. This method shortens low branches to regularly suppress their growth and, in turn, force more growth in the upper branches. For roadside tree planting, removing lower branches allows more clearance.
- Crown reduction which involves removing larger branches at the rop of the Proper the tree to reduce its height. When done properly, crown reduction pruning is different from topping, because branches are removed immediately above lateral branches, leaving no stubs. Crown reduction is the least desirable pruning practice. It should be done only when necessary.
- Crown cleaning, which is the selective removal of dead, dying, and diseased wood from the crown.

Proper branch pruning

- Cut a small branch or twig about 1/4 inch above the bud.
- To shorten a branch or twig, cut it back to a side branch or cut about 1/4 inch above the bud.
- Always prune above a bud facing the outside of a plant to force the new branch to grow in that direction (University of Minnesota Extension, 2020).
- Use the right, sharp tools such as a pruning saw to minimize damage to the tree.
- Cuts should be slanted to prevent water entry and rotting (Makee, 2016).

Micro Planning

After the completion of plantation an awareness campaign should be arranged by the agency in order to focus on the need for conservation of the plantation done. The benefit- sharing and roles and responsibilities of agency, WRD and the community, and benefits and procedure of

participatory microplanning and monitoring shall be carried out. The micro- planning will start with preparing base line information about the condition of the plantation carried out.

The microplan would be an integrated plan for both village and WRD. Thus, it will have two parts: (a) Plantation development, and (b) village development.

Training and Capacity Building

This component will aim at providing training to the villagers and also to build their capacity through organizing linkages with the programmes/ schemes of other departments/ organizations in the public and private sector for the furtherance of the objectives of the scheme. Special focus will be given on the needs of the marginalized groups of the village community, the women self-help groups and traditional forest-based artisans.

Monitoring and Evaluation:

Monitoring

Each plantation area will be monitored by the PIU, PMU and PMC Officials through field inspections and otherwise. The officials/experts/specialists will undertake field checks of the works undertaken by the agency and submit reports to the Executive Engineer. The norms set out shall include the criteria for field inspection of departmental works by its officers will also apply to monitoring Agencies (PMU and PMC).

The PIU will maintain a record of the geographical coordinates of each plantation plot so that sampling of the areas for the monitoring of young plantations could be done in a more scientific manner. Such a record would be compatible to GIS analysis and obviate the occurrence of overlap or duplication of efforts of plantation.

Evaluation

The PMU/PMC will conduct independent evaluation of individual plantation quarterly during the period of 2 year cycle and a final evaluation shall be conducted througha joint inspection with PIU, PMU, PMC and the Plantation agency to record the actual growth of the plantation and the requirement criteria.

A Concurrent Evaluation and Final Evaluation will be undertaken by reputed independent organizations. Independent organisation will also include reputed academic institutions, NGOs, professional consultants, and experts who have qualification and experience in forestry, natural resource economics or business or sociology of natural resource management.

Awareness Generation, Extension and Training

Creating awareness through printing and circulation of Pamphlets on nursery/planting technique, economics and marketing of important tree species Guides on establishment of Hi-tech/Satellite nurseries, assessment of species (type and quantum), and land availability

SUMMARY:

Among the other outcomes particular to a given landscape, FLR afforestation/reforestation projects should do the following:

Focus on restoring forest functions and improving ecological processes at a landscape level (in line with biodiversity and environmental goals);

- Address socio-economic and environmental dimensions (in line with livelihood goals and to help ensure carbon permanence);
- Address root causes of degradation such as land tenure (in line with livelihood goals and to help ensure carbon permanence);
- Increase forest resilience through enhanced connectivity and species diversity (to contribute to adaptation and biodiversity goals); and
- Encompass a mixture of locally appropriate approaches.

Annexure 5: Conservation and Management Plan for *Macaca Radiata*

Introduction

Many species of animals that are geographically widespread, largely commensal to humans, and found in relatively large numbers. However, many such common species have undergone a drastic decline in their populations in the past few decades. Several factors contribute to the decline of the commensal species. Most of these species compete with humans for resources, often resulting in human-animal conflict, which in turn, lead to killing of animals by people. The Bonnet macaques are largely found at temples in the southern part of India. In India, primates are often harassed, trapped and relocated elsewhere even from the places of Hindu worship (M Singh–personal observations). A drastic decline of a commensal species may also occur due to habitat fragmentation following land use modification, urbanization, increased predation pressure, elevated parasite loads and interspecific competition. Land use modifications caused by human activities have led to the extinction of several animal species. Land use modifications lead to habitat loss by destruction of the vegetated areas, habitat degradation by reduction in quality of vegetated areas, habitat isolation by reduced land use connectivity, and changes in biology, behaviour and interactions of a species.

One of the main drivers of land-use modification is infrastructure development, a process of urbanisation, which is a consequence of expanding human population. Populations of several species have been shown to utilize remaining patches of intact vegetation on roadsides or places near Rivers, canals and lakes as marginal habitats e.g. Bonnet macaques, (*Macaca radiata)* etc. Interspecific interaction with predators and competitors resulting in reduction of distributional range has also been shown to be a major reason for the decline and extinction of several species. Mammals are found to be extremely vulnerable to these conditions and their responses to changing land use can serve as a good indicator of adaptability or local extinction for other vertebrates and invertebrates inhabiting the same area.

The environmental impacts can be divided into two categories named as primary impacts which can be attributed directly to the project. Secondary impacts are those that are indirectly induce threats due to the proposed actions. ERM of GAC is a site-specific activity and has to be carried out in a systematic manner. The existing flora and faunal diversity in the project area has to be recorded as baseline data to compare its future status due to implementation of ERM project and action is initiated to ensure all kinds of adverse impacts are resolved. Since

there is no major land use change due to the ERM of GA canal there will not be any additional stress on the biota or the ecosystem of the project influence area. However during the construction of the canal there may be disturbances to the biota.

Based on the baseline study it was observed that the area of influence has several species of faunal assemblages. Of them, the bonnet macaque ie. *Macaca radiata* is listed as "Vulnerable" under criteria A2acd+3cd. In order to conserve *M. radiata* a conservation plan has been developed as a part of the ESIA study. The broad classification, description, distribution, behaviour and threats were studied to develop this plan.

Taxonomy

Kingdom	Phylum	Class	Order	Family
Animalia	Chordata	Mammalia	Primates	Cercopithecidae

Taxonomic Notes:

Two subspecies are recognized, distinguished on the grounds of both morphological (*Macaca radiata radiata* is dark bellied and M. r. diluta is pale bellied), and behavioural differences (females largely disperse between groups only in M. r. diluta, while males disperse in both the subspecies; M. Singh pers. comm.).

Bonnet macaque, *Macaca radiata*

Scientific name	Family name	Common name	Local name	IUCN status
Macaca radiata	Cercopithecidae	Bonnet macaque	Kulla Kurungu	Schedule II

Assessment Information

Red List Category & Criteria:	Vulnerable A2acd+3cd (ver 3.1)
Year Published:	2020
Date Assessed:	November 21, 2015

Geography, Distribution and Habitat

Overall, *M. radiata* is highly visible throughout India's southern peninsula's evergreen, deciduous forests, dry prairies, urban spaces, such as tourist-drenched temples and outskirts of villages and towns and grasslands. The scrappy bonnet macaque's ability to live commensal with humans presents perhaps its greatest vulnerability: although the species appears abundant and at ease among humans.

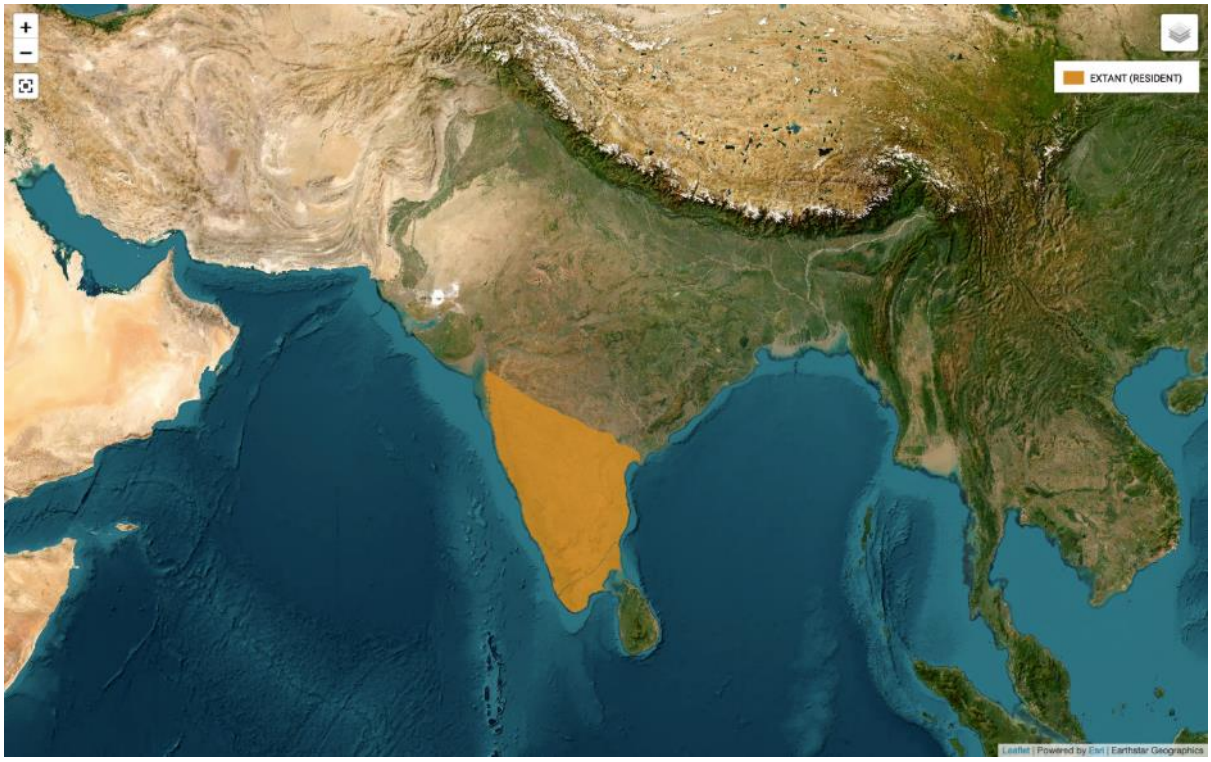
RANGE DESCRIPTION

This species occurs in peninsular India (Telangana, Andhra Pradesh, Goa, Gujarat, Karnataka Kerala, Maharashtra and Tamil Nadu). It is found from the southern tip of India up to the southern banks of Tapti River in the north, and to the Krishna River in the northeast.

The two recognized subspecies are *M.r. diluta* and *M.r. radiata*:

- *Macaca radiata diluta*: Occurs in Kerala and Tamil Nadu, north to Cumbam in the Western Ghats at the southwestern foot of Palani Hills in the centre and Pondicherry in the east.
- *Macaca radiata radiata*: Occurs in peninsular India (Telangana, Andhra Pradesh, Goa, Gujarat, Karnataka, Kerala, Maharashtra and Tamil Nadu), south to the Palani Hills and southeast as far as Timbale, inland of Pondicherry.

In the study area the *M. radiata* is found in the areas nearer to GA canal at NT channel offtake to Vallamvari at Kandithambattu. and in the lower parts of the GA canal. It is sometimes found in the outskirts of Thanjavur town. They are also found in parts of the Point Calimere Wildlife and Bird Sanctuary (PCWBS). These areas are abundant in large trees and they provide a perfect place for the survival of *M. radiata*.



Distribution Map of *Macaca radiata* (Source IUCN 2020)

Physical description of the Bonnet macaque

Bonnet macaques (*Macaca radiata radiata)* earn their common name from a singular feature: a cap-like tuft of hair fanning out from the top of the head, so much like a tussock of dry grass and which have pale bellies gray- or golden-brown coats. Framed by large ears, the wrinkled, hairless face of a bonnet macaque begs attention. In females, the face is pink. Her marble-round eyes stare out at the world from a highly expressive brow. Large teeth may be displayed in aggression or fear. Moreover, it has cheek pouches for storing food and narrow, down-facing nostrils. While her sense of smell appears to be less developed due to her narrow nostrils, a bonnet macaque can rely on her sense of taste to confirm when fruit is ripe and ready for consumption. With eyes that see in colour and nimble, sensitive hands, she deftly navigates her world. Scientists have observed juveniles using their tails for support while climbing, even though the tail itself is not prehensile that is, capable of grasping objects like branches.

Size, weight, and lifespan

A bonnet macaque is smaller than many other macaque cousins, weighing, on average, about 8.5lbs (3.9kg) for females and 14lbs (6.7kg) for males, with average lengths of 14in (35cm) to 24in (60cm), for females and males respectively. The tail measures two-thirds the length of the body. In captivity, bonnet macaques may live up to 35 years, but not so in the wild.

Disease, encounters with predators, and conflicts with humans typically cut a bonnet macaque's lifespan to 20-25 years.

Behaviour

Humans and bonnet macaques alike have become accustomed to interacting with each other. The bonnet macaque commonly loiters in and around human spaces, including temples and villages, and has been seen resting in ficus trees near to where humans live. Villagers sometimes sell fruit or rice to tourists for the sole purpose of feeding the monkeys.

Daily life and group dynamics

Primatologists classify bonnet macaques as both arboreal and terrestrial meaning they live in trees and on the ground. As quadrupeds, they walk on all fours and spend a great deal of their daily life on the ground, where they have access to food, whether that be foraged or hand-fed by humans. They navigate the canopy with aplomb, stabilized by their ability to keep three or more limbs in contact with branches at all times. Bonnet macaques live in multi-male, multi-female troops of about 30 individuals, organized in a linear, age-ranked order. It's interesting to note, however, that this social hierarchy appears to bear less influence over some of the bonnet macaques' most common behaviors, such as social grooming. All troop members participate in this calming and bonding activity. While a male will move between troops to gain rank, a female will generally stay with the troop into which she was born. As a diurnal species, bonnet macaques are most active during the day. At night or when resting, same-sex bonnet macaques will huddle together, while dominant males will clasp juvenile males close to them.

Predation, communication and perception

The alarm call is one of the most important forms of communication for the bonnet macaque. When predators come close, bonnet macaques will emit a high-pitched call that drives the troop into the safety of the canopy. Some studies note that bonnet macaques can also recognize the alarm calls of other primate species. For affection and tension relief, bonnet macaques will grin, smack lips, and click tongues. A grimace is a sign of submission or fear. Large males greet each other by embracing, grinning, and gripping each other's genitals.

Food and feeding habit

The bonnet macaque spends much of his time inhabiting temples and other urban places where they can readily consume human food. Although they prefer fruits and plant materials,

they are omnivore and will resourcefully rummage for nourishment in nearby houses, food stalls, gardens, and trash piles. Bonnet macaques are not specialised in their diet. Sometimes, tourists will find entertainment in feeding the monkeys, making the foraging work all the easier. In general, bonnet macaques eat fruits, soil, insects, and sometimes small invertebrates and reptiles.

Some of the plant species that bonnet macaque feed on is Banyan (Ficus benghalensis), Neem (Azadirachta indica), Pongamia (Pongamia pinnata), Tamarind (Tamarindus indica), Mango (Mangifera indica), Gulmohar (Delonix regia), Copperpod (Peltophorum ferrugenium) and Cashew (Anacardium occidentale). Bonnet macaques are also seen eating grasshoppers, crickets, termites, spiders and birds eggs.

Consuming high concentrations of fruits, plant materials, and certainly human foods can upset even the most robust of digestive systems, but the bonnet macaque appears to have a way to alleviate indigestion, nausea, and diarrhea. This has led to them congregating in large numbers near temples and tourist sites that are close to small forest patches, where people feed them. They are also found on tree-lined roads and plantations near villages and GA canal.

Reproductive behaviours and social organization

The philopatric female bonnet macaque brings a level of hierarchical stability to her troops; when females remain with their natal group, hierarchy remains relatively unchanged. Males, however, disperse to other troops as they mature, and must compete heavily for status and reproduction. Competitive fighting among males intensifies during the tense few months during which females are receptive to mating (which peaks in September and October). Females typically bear one offspring each year. A mother keeps her infant very close often on her back or in her arms for the first six months to 12 months of life, nursing for a majority of that time. After weaning, the infant remains under the watchful eye of his mother, but the workload is shared, with the whole community taking part in protecting the young. At one-year old, a bonnet macaque is able to fend for himself. Males also play an important role in the protection and rearing of juveniles and infants. Adult male bonnet macaques will regularly join in play with juveniles, who appear to have the freedom to leap on, kick, cling to, and bite adult males without punishment. Males will keep watch over juvenile males during sleep.

Ranging behaviour

Most bonnet macaque troops have fairly well delimited home ranges, varying in size from 26 ha to 5 km^2. Certain urban troops, particularly those with access to rich food sources, are, however, strongly territorial and both the sexes aggressively defend their feeding areas. Troop home ranges, in general, may be relatively stable over many years but may also change drastically over a short period of time, especially for troops moving into human habitations from natural forests. Movement within and out of the often loosely defined home range appears to be influenced by seasonal diurnal temperature and, perhaps more importantly, availability of food and drinking water. During seasons of insufficient food and water, therefore, the troop movement may extend well beyond the limit of the home range, but usually into known, earlier explored areas. The bonnet macaque is a good swimmer and readily takes to water, entering the water smoothly and often swimming submerged for short distances. Juveniles readily play in pools of water, often pushing each other into the water and preventing them from climbing out.

Ecosystem roles

With a diet high in fruit and seeds, forest-dwelling bonnet macaques likely play a role in tree propagation by dispersing seeds throughout the forest floor.

Threats

The International Union for Conservation of Nature lists bonnet macaques as Vulnerable (IUCN, 2015), appearing on the IUCN's Red List of Threatened Species. The species has undergone massive declines over its entire distribution range. It is estimated that the declines are over 30% in the last three generations (36-39 years) due to hunting, persecution, faulty translocations altering group compositions, road expansion, removal of native avenue trees, feeding by humans, and displacement by Rhesus macaques in the northern parts of the range. Known predators, other than humans, include in the wild include pythons, tigers, leopards, eagles, and in habituated areas are mainly feral dogs. However in certain parts bushmeat is also noted.

Impacts during the construction phase

Impacts due to labour force for construction activities will lead to establishment of campsites, generation of sewage, waste water and solid waste. Further, they may engage in activities that

are detrimental to natural habitat such as hunting, illegal extraction of timber for fuel wood and non-timber forest products.

Air and noise pollution will arise due to activities such as excavation, cutting, drilling and filling and compaction work, as well as operation of construction related vehicles during the construction phase will cause disturbance to the wild animals.

This can be avoided by following appropriate mitigative measures.

Mitigation of impacts during project implementation phase

- Water shall be sprayed during dust generating construction activities e.g., excavation, crushing/demolishing, concrete mixing, material handling etc. to suppress dust; and vehicles delivering loose and fine materials like sand and fine aggregates shall be covered by tarpaulin to reduce spills on roads.
- All roads (internal and external) to be used by the project authorities should be made Sprinkled with water to mitigate the dust generation along the roads.
- Exhausts of other equipment used for construction (e.g. generators), if any shall be positioned at a sufficient height to ensure dispersal of exhaust emissions and meet the standards set by CPCB. Idle running of vehicles will be minimized during transport and handling activities.
- The noise pollution will be checked and maintained by installing sound barricades around crushing plants and by taking up regular maintenance of heavy earth moving vehicles. Selection of equipment with less noise generation will be used.
- On site workers near the noise generating equipment shall be provided with noise protection devices like earmuffs/earplugs. Controlled blasting and drilling will be undertaken to avoid the noise pollution.
- No labour camps are allowed inside the forest areas.
- Labours will be trained for protection of trees and conservation and importance of wildlife. Smoking is prohibited in the forest areas and regular monitoring will be undertaken to avoid forest fires.
- Labour camps will be provided with LPG for cooking and hence illegal felling of trees will be avoided.
- Any unnatural or suspicious death of *M. radiata* shall be immedialetly inormed to the forest offcicials for further investigation.

- During construction phase, PMU/PMC and the contractor staff shall monitor the construction activities and suitable measures shall be suggested if any disturbance is envisaged to *M. radiata* or any other faunal assemblages.

Apart from the above measures the following care shall be taken to prevent any disturbance to *M.radiata* in the construction and camp sites.

- Awareness on the habitation of *M. radiata* shall be provided to the labourers and community.
- Any encounter (with the nature of encounter) with *M. radiata* shall be reported to the WRD engineers and taken up with the forest officials.
- Periodic inspection of the campsites viz. daily inspection by the HSE personnel of the contractor, Weekly inspection by the WRD engineers and monthly inspection by the PMU/PMC should be taken
    - To ensure food wastes are properly disposed off.
    - No timber from trees adjacent to the canal is used as fuel for cooking.
    - Dust suppression is adequate.
    - Noise is under control.
    - No trees are felled without prior approval.

The tree lining in the areas in the Kandithambattu and beyond are not disturbed. This helps in preserving the habitat of the *M.radiata*. however the construction activities pose a temporary disturbance to the animals. This helps in keeing the canopy cover intact for *M.radiata* to traverse during the days. The construction activities are taken up during the months of February to June. The breeding season of *M.radiata* is usually during the months of September to October. In addition to the preservation of the large trees, planting of more than 2 lakh trees will enable them to find a better habitat in the future.

Since the primates will be the first occupants of the afforested areas and limited natural predators this will also help in the thriving of the species. In the plantation plan it is suggested to plant fruit and berry trees that will encourage the gradual migration from the villages and towns to the afforested areas. Most of the preferred food for *M.radiata* will be available in the afforested area and hence their interaction with the human habitation will become limited, thus reducing the threats due to man animal conflicts. Biannual monitoring of the environmental parameters also helps assess the levels of stress on the environment.

Annexure 6: Minimum Requirements for the Contractors Code of Conduct (Environmental, Social, Health and Safety-ESHS)

1. The Contractor shall prepare and include Debris Disposal Plan, Silt Disposal Plan, Camp Site Management Plan, Traffic Management Plan, Quarry and Borrow Area Plan, Material Sourcing Plan, Tree Felling and Replantation Plan and any other site specific ES issues in the site specific Environmental and Social Management Plan (ESMP), project ESMP in Contract Document, endorsed by the Engineer, and follow Environmental Code of Practices as per Indian legislation and follow Environment Social Framework of the AIIB guidelines agreed in the project.

2. Apart from Debris and Silt disposal plan, based on the ground information collected and final locations of all construction site and ancillary sites, contractor ESHS officer to prepare camp site management plan, traffic management plan (In all cases, the contractor shall employ proper precautions. Wherever operations undertaken are likely to interfere with public traffic, specific traffic management plans shall be drawn up and implemented by the contractor in consultation with the approval of local police authorities and/or the concerned civil authorities as the case may be), quarry and borrow area plan, material sourcing plan, tree felling and replantation plan etc.

3. The Engineer shall be responsible for reviewing and approving the Debris Disposal Plan, Silt Disposal Plan, Camp Site Management Plan, Traffic Management Plan, Quarry and Borrow Area Plan, Material Sourcing Plan, Tree Felling and Replantation Plan and any other site-specific ES issues in the site specific Environmental and Social Management Plan (ESMP) submitted by the Contractor before start of Works.

4. The Contractor shall be responsible for providing the list and permits for all heavy equipment and machinery to be deployed on site to the Engineer before start of Works. It shall be the responsibility of the Contractor to ensure that the permits are not expired for the entire duration of the Contract.

5. The Contractor is to obtain all necessary consents for construction before mobilization including the consents for Establishment and Operate from TNPCB/Local Administration/Municipal/Corporation.

6. The contractor will report on implementation of all the above-mentioned plans and the site specific ESMP in their monthly progress reports to be submitted to the WRD.

Compliance with Labour Regulations:

During continuance of the contract, the Contractor and his sub-contractors shall abide at all times by all existing labour enactments and rules made there under, regulations, notifications and bye laws of the State or Central Government or local authority and any other labour law (including rules), regulations, bye laws that may be passed or notification that may be issued under any labour law in future either by the State or the Central Government or the local authority.

The Contractor shall keep the Employer indemnified in case any action is taken against the Employer by the competent authority on account of contravention of any of the provisions of any Act or rules made there under, regulations or notifications including amendments. If the Employer is caused to pay or reimburse, such amounts as may be necessary to cause or observe, or for non-observance of the provisions stipulated in the notifications/bye laws/Acts/Rules/regulations including amendments, if any, on the part of the Contractor, the Engineer/Employer shall have the right to deduct any money due to the Contractor including his amount of performance security. The Employer/Engineer shall also have right to recover from the Contractor any sum required or estimated to be required for making good the loss or damage suffered by the Employer. The employees of the Contractor and the Sub-Contractor in no case shall be treated as the employees of the Employer at any point of time. In addition to the compliance of labour laws in force, the Contractor shall also be responsible for ensuring that the applicable code of conduct for workers is followed at working place and camps

Code of Conduct for Labour Population

- There should not be any adverse interaction of the labour with the local community.
- Labour population shall not extract any resources from the village without the concurrence of the community, outside the project area.
- Project area shall be completely and effectively demarcated.
- It shall be ensured that no labour, other than people from local community, are allowed to enter the villages, if objected to by the villagers, outside the project area by any means unless he/she is permitted by the competent authority designated by the project for this purpose.
- No such permission shall be granted unless the person is proceeding on bonfire work relating to the project activities or essential living functions.
- Essential interaction with the local population will take place only with the consultation of local administration, panchayat leaders and such movements regulated.
- All workers / officers shall be provided with the identity card.
- Strict action shall be taken against the worker not adhering the norms and regulations.
- Contractor shall be responsible for the implementation of the aforesaid policy.
- A committee with participant of local leaders/prominent person shall be constituted to deal with the problems arising due to any illegal activities by the workers.

Code of Conduct for Contractor's Workers

We are the Contractor, [*enter name of Contractor*]. We have signed a contract with **The Superintending Engineer, WRD., Lower Cauvery Basin Circle, Thanjavur.** for [*enter name of Project / package*]. These Works will be carried out at our projet locations. Our contract requires us to implement measures to address environmental and social risks related to the Services and Works, including the risks of misdemeanor in workplace / worker's camps, sexual exploitation, abuse, harassment, and gender-based violence.

This Code of Conduct is part of the measures to deal with environmental and social risks involving the workers, related to the labour camps and the workplace. It applies to all our staff, labourers and other employees at the Works Site or other places where the Works are being carried out. It also applies to the personnel of each subcontractor and any other personnel assisting us in the execution of the Works. All such persons are referred to as "**Contractor's Personnel"** and are subject to this Code of Conduct.

This Code of Conduct identifies the conduct that is required from all Contractor's Personnel.

In our workplace, unsafe, offensive, abusive, or violent behavior will not be tolerated, and all persons should feel comfortable raising issues or concerns without fear of retaliation.

Contractor's Personnel shall:

1. Make earnest efforts to understand his/her responsibilities detailed in this Code of Conduct and any other documents and trainings, as directed by the Employer. Proactive seek clarifications to enable work to be undertaken in strict compliance with this Code of Conduct.
2. Carry out his/her duties competently and diligently.
3. Comply with this Code of Conduct and all applicable laws, regulations, and other requirements, including requirements to protect the health, safety and well-being of other Contractor's Workers and any other person.
4. Maintain a safe working environment including by:
   a. Ensuring that workplaces, machinery, equipment, and processes under each person's control are safe and without risk to health.
   b. Wearing required personal protective equipment.
   c. All works are conducted with safety clearance and under appropriate supervision.
   d. Using appropriate measures relating to chemical, physical, and biological substances and agents.
   e. Following applicable emergency operating procedures.
   f. Providing separate, safe, and easily accessible working and accommodation facilities for women and men working on the site.
5. Report work situations that he/she believes are not safe or healthy and remove himself/herself from a work situation which he/she reasonably believes presents an imminent and serious danger to his/her life or health.
6. Treat other people with respect, and not discriminate against specific groups such as women, gays, people with disabilities, migrant workers, or children.
7. Not engage in sexual harassment which includes unwelcome sexual advances, requests for sexual favors, and other unwanted verbal or physical conduct of a sexual nature.
8. When engaging with the community and/or project affected persons, this should be done professionally and with utmost respect. Intimidation, threats, and coercive behavior will not be tolerated.
9. Not engage in sexual exploitation and abuse, which means any actual or attempted abuse of position of vulnerability, differential power or trust, for sexual purposes, including,

but not limited to, profiting monetarily, socially or politically from the sexual exploitation of another.

10. Not engage in sexual assault, which means any form of non-consensual sexual contact.
11. Not engage in any form of sexual activity with individuals under the age of 18.
12. Not make any inappropriate and unwanted sexual advances to people in the adjoining communities or settlements.
13. Not work or be present in the worksite(s) under the influence of any intoxicating substances, such as alcohol or drugs.
14. Not possess alcohol or any other intoxicating substances while on duty or in the labor camps.
15. Return to the labor camp no later than 22:00, unless working on night shift.
16. Complete relevant training courses that will be provided related to the environmental and social aspects of the Contract, including on health and safety matters, Gender-based violence (GBV), Sexual Exploitation, Abuse and Harassment (SEAH).
17. Report violations of this Code of Conduct.
18. Not retaliate against any person who reports violations of this Code of Conduct, whether to AIIB or the Employer, or who makes use of the grievance mechanism for Contractor's Workers or the project's Grievance Redress Mechanism.

RAISING CONCERNS

If any person observes behavior that he/she believes may represent a violation of this Code of Conduct, or that otherwise concerns him/her, he/she should raise the issue promptly. This can be done in either of the following ways:

1. Contact [*enter name of the Contractor's Social Expert*] in writing at this address [X] or by telephone at [X] or in person at [X]; or

2. Call [X] to reach the Contractor's hotline *(if any)* and leave a message.

The person's identity will be kept confidential, unless reporting of allegations is mandated by the country law. Anonymous complaints or allegations may also be submitted and will be given all due and appropriate consideration. We take seriously all reports of possible misconduct and will investigate and take appropriate action. We will provide warm referrals to service providers that may help support the person who experienced the alleged incident, as appropriate.

There will be no retaliation against any person who raises a concern in good faith about any behavior prohibited by this Code of Conduct. Such retaliation would be a violation of this Code of Conduct.

CONSEQUENCES OF VIOLATING THE CODE OF CONDUCT

Any violation of this Code of Conduct by Contractor's Personnel may result in serious consequences, up to and including termination and possible referral to legal authorities.

The information contained in this note will be disseminated to all Contractor's Personnel. At the time of engagement of any worker/ personnel, the above information will be provided verbally, and a copy of the Code of Conduct will be provided signed by the Personnel and countersigned by the Contractor. A prototype is provided below:

FOR CONTRACTOR'S PERSONNEL:

I have received a copy of this Code of Conduct written in [X] language that I comprehend. I understand that if I have any questions about this Code of Conduct, I can contact [*enter name of Contractor's contact person with relevant experience in handling gender-based violence*] requesting an explanation.

Name of Contractor's Personnel: [insert name]

Signature: _____

Date: (day month year): _____

Countersignature of authorized representative of the Contractor: [insert name]

Signature: _____

Date: (day month year): _____

Annexure 7: Pest Management Plan

Introduction

The project investments may increase the use of higher pesticides and other chemical inputs by promoting improved management practices in agriculture and horticulture as well as through increasing crop intensification due to improved access to water resources and area under irrigation. While such improvements on one hand will augment the production and income of the farmers, on the other hand due to its excessive and inappropriate use it would affect the natural resources, environmental services and food systems. In order to protect the environment and its services the project will promote the adoption of Integrated Pest Management approach. As part of the ethical practices, the project will not recommend or use pesticides which are banned, refused registration and restricted in use by The Directorate of Plant Protection, Quarantine & Storage in any of its demonstrations and promotion.

***Main pests and diseases*:** The main crops grown in project area are paddy, coconut, banana, pulses and vegetables. The major risks due to the breakout of pests and diseases in paddy crop especially in Cauvery delta zone are yellow stem borer (*Scirpophaga incertulas*), leaf folder (*Cnaphalocrocis medinalis*) and brown plant hopper (*Nilaparvata lugens*) and blast and blight during the main growing seasons (TNAU, 2017) at moderate to severe intensity. Some of the pests like thrips, gall midge, earhead bug and whorl maggot have emerged as major pests in paddy. During 2009 onwards, certain new insects like rice leaf mite (*Oilgonychus oryzae*) attained the pest status and occurring at the intensity of light to moderate. Black headed caterpillar (*Opisina arenosella*) in Coconut, blister beetle *(Mylabris pustulata)* in redgram and Fusarium wilt in Banana have also become important pests.

***Awareness and current practices*:** The field visits in the consultation process as well as Focus Group Discussions indicates that the main reason for the indiscriminate use of chemical pesticides are lack of sufficient knowledge in identification pest and diseases, its symptoms, mode of infection and integrated management practices. Hence farmers perceive the practice of pest and disease management as a routine cultivation practice similar to tillage and weeding. As a result of 4-5 rounds of indiscriminate usage of chemical spraying are adopted by vegetable growers. At present, farmers access to information on pest management is largely restricted to input dealers and support from Dept of agricultural extension services are limited. Due to vested interests and company's push input dealers are marketing chemicals to farmers without considering its adverse impacts.

Major crops and pests

The major pests and diseases occurring in the main crops grown in project areas, its time of occurrence as well as stages of crop in which its impact was more are given in table-1 below

Table 1: Important pests and diseases – major crops

S. No.	Major Crop	Key Pests	Disease(s) caused	Time of occurrence and duration of attack
1	Paddy	✓ Leaf folder (*Cnapholocrocis medinalis*) ✓ Stem borer (*Scirpophaga incertulas*) ✓ Thrips (*Stenchaetothrips biformis*) ✓ Brown plant hopper (*Nilaparvata lugens*) ✓ Leaf mite (*Oilgonychus oryzae*) ✓ Ear head bug (Leptocorisa oratorius)	✓ *Sheath Blight (*Rhizoctonia solani*)* ✓ *Leaf and neck blast (*Pyricularia grisea)	Leaf folder, stem borer, ear head bug and thrips attack can be seen throughout the crop stages as well as irrespective of the seasons whereas brown plant hopper attack is more in samba season when humidity is more and leaf mite attack is more in first and summer season from vegetative to flowering stage Sheath blight infection is more during samba season during panicle development phase of the crop, Leaf and neck blast infection will be more in both June-July and Oct-Nov planting seasons at the stage of active tillering and flowering phases
2	Ground nut	Aphids*(Aphis craccivora)* Red hairy caterpillar(*Amsacta albistriga)*		Aphids attack is more in vegetative and drier part of the growing season and red hairy caterpillar incidence will be more in the time of onset of monsoon
3	Coconut	Rhinocerous beetle (*Oryctes rhinoceros*) Red palm weevil (*Rhynchophorus ferrugineus*) Black headed caterpillar (*Opisina arenosella*)	Ganoderma wilt *(Ganoderma lucidum)*	All the three pests attack the grown-up trees which are bearing the nuts are most affected and wilt also affect the tree in all stages of the crop
4	Pulses – black gram and greengram	Pod borer (*Helicoverpa armigera*)	Powdery mildew (*Erysiphe polygoni*)	During the pod formation stage and powdry mildew during the vegetative to flowering phase and infection multiply faster in late kharif and early rabi season

Step-wise PMP and Strategies

Details of PMP with its strategies

PMP		
Negative list of pesticides	The project will not finance procurement of these pesticides	See table 2 banned pesticides and also a list of The Directorate of Plant Protection, Quarantine & Storage approved pesticides
IPM – key PMP strategy	Project will finance demonstration, procurement of, training on available IPM packages	Refer table 3 for proposed IPM principles for the detailed pests and IPM packages for specific crops
Recommended list of pesticides and/or suggested alternatives	The project will generate awareness on procurement of these alternatives	Lists of registered biopesticides are given in table 6 and 7
Training and Capacity Building	lists/locations/approximate season and potential target beneficiaries to be covered under training which includes raining on handling, safe use and disposal	Training calendar is provided

As indicated above, the project will not finance or recommend the procurement of any of these pesticides or formulations. The List of banned pesticides in India as per The Directorate of Plant Protection, Quarantine & Storage is given in Table 2. The list also has the details related to pesticides which are refused for registration and restricted in use in India.

Table 2. LIST OF PESTICIDES WHICH ARE BANNED, REFUSED REGISTRATION AND RESTRICTED IN USE by DIRECTORATE OF PLANT PROTECTION, QUARANTINE & STORAGE (As on 01.06.2023)

I. **PESTICIDES / FORMULATIONS BANNED IN INDIA**

	Pesticides Banned for manufacture, import and use.	
	1.	Alachlor (Vide S.O. 3951(E), dated 08.08.2018)
	2.	Aldicarb (vide S.O. 682 (E) dated 17th July2001)
	3.	Aldrin
	4.	Benzene Hexachloride
	5.	Benomyl (vide S.O 3951(E) dated 8th August, 2018)
	6.	Calcium Cyanide
	7.	Carbaryl (vide S.O 3951(E) dated 8th August, 2018)
	8.	Chlorbenzilate (vide S.O. 682 (E) dated 17th July 2001)
	9.	Chlordane
	10.	Chlorofenvinphos
	11.	Copper Acetoarsenite
	12.	Diazinon (vide S.O 3951(E) dated 8th August, 2018)
	13.	Dibromochloropropane (DBCP) (vide S.O. 569 (E) dated 25th July1989)

A.	14.	Dichlorovos (Vide S.O. 3951(E), dated 08.08.2018)
	15.	Dieldrin (vide S.O. 682 (E) dated 17th July 2001)
	16.	Endosulfan (vide ad-Interim order of the Supreme Court of India in the Writ Petition (Civil) No. 213 of 2011 dated 13th May, 2011 and finally disposed of dated 10th January, 2017)
	17.	Endrin
	18.	Ethyl Mercury Chloride
	19.	Ethyl Parathion
	20.	Ethylene Dibromide (EDB) (vide S.O. 682 (E) dated 17th July 2001)
	21.	Fenarimol (vide S.O 3951(E) dated 8th August, 2018)
	22.	Fenthion (vide S.O 3951(E) dated 8th August, 2018)
	23.	Heptachlor
	24.	Lindane (Gamma-HCH)
	25.	Linuron (vide S.O 3951(E) dated 8th August, 2018)
	26.	Maleic Hydrazide (vide S.O. 682 (E) dated 17th July 2001)
	27.	Menazon
	28.	Methoxy Ethyl Mercury Chloride (vide S.O 3951(E) dated 8th August, 2018)
	29.	Methyl Parathion (vide S.O 3951(E) dated 8th August, 2018)
	30.	Metoxuron
	31.	Nitrofen
	32.	Paraquat Dimethyl Sulphate
	33.	Pentachloro Nitrobenzene (PCNB) (vide S.O. 569 (E) dated 25th July 1989)
	34.	Pentachlorophenol
	35.	Phenyl Mercury Acetate
	36.	Phorate (Vide S.O. 3951(E), dated 08.08.2018)
	37.	Phosphamidon (Vide S.O. 3951(E), dated 08.08.2018)
	38.	Sodium Cyanide (banned for Insecticidal purpose only vide S.O 3951(E) dated 8th
	39.	Sodium Methane Arsonate
	40.	Tetradifon
	41.	Thiometon (vide S.O 3951(E) dated 8th August, 2018)
	42.	Toxaphene (Camphechlor) (vide S.O. 569 (E) dated 25th July 1989)
	43.	Triazophos (Vide S.O. 3951(E), dated 08.08.2018)
	44.	Tridemorph (vide S.O 3951(E) dated 8th August, 2018)
	45.	Trichloro acetic acid (TCA) (vide S.O. 682 (E) dated 17th July 2001)
	46.	Trichlorfon (Vide S.O. 3951(E), dated 08.08.2018)
	Pesticide formulations banned for import, manufacture and use	

B.	1.	Carbofuron 50% SP (vide S.O. 678 (E) dated 17th July 2001)
	2.	Methomyl 12.5% L
	3.	Methomyl 24% formulation
	4.	Phosphamidon 85% SL
C.	**Pesticide / Pesticide formulations banned for use but continued to manufacture**	
	1.	Captafol 80% Powder (vide S.O. 679 (E) dated 17th July 2001)
	2.	Dichlorvos (vide S.O. 1196 (E) dated 20th March 2020)
	3.	Nicotin Sulfate (vide S.O. 325 (E) dated 11th May 1992)
	4.	Phorate (vide S.O. 1196 (E) dated 20th March 2020)
	5.	Triazophos (vide S.O. 1196 (E) dated 20th March 2020)
D	**Pesticides Withdrawn** (Withdrawal may become inoperative as soon as required complete data as per the guidelines is generated and submitted by the Pesticides Industry to the Government and accepted by the Registration Committee. (S.O 915(E) dated 15thJun,2006)	
	1.	Dalapon
	2.	Ferbam
	3.	Formothion
	4.	Nickel Chloride
	5.	Paradichlorobenzene (PDCB)
	6.	Simazine
	7.	Sirmate (S.O. 2485 (E) dated 24th September 2014)
	8.	Warfarin (vide S.O. 915 (E) dated 15th June 2006)

II. PESTICIDES REFUSED REGISTRATION

S.No.	Name of Pesticides
1.	2,4, 5-T
2.	Ammonium Sulphamate
3.	Azinphos Ethyl
4.	Azinphos Methyl
5.	Binapacryl
6.	Calcium Arsenate
7.	Carbophenothion
8.	Chinomethionate (Morestan)
9.	Dicrotophos
10.	EPN

11.	Fentin Acetate
12.	Fentin Hydroxide
13.	Lead Arsenate
14.	Leptophos (Phosvel)
15.	Mephosfolan
16.	Mevinphos (Phosdrin)
17.	Thiodemeton / Disulfoton
18.	Vamidothion

III. PESTICIDES RESTRICTED FOR USE IN THE COUNTRY

S.No.	Name of Pesticides	Details of Restrictions
1.	Aluminum Phosphide	The Pest Control Operations with Aluminum Phosphide may be undertaken only by Govt./Govt. undertakings / Govt. Organizations / pest control operators under the strict supervision of Govt. Experts or experts whose expertise is approved by the Plant Protection Advisor to Govt. of India except Aluminum Phosphide 15 % 12 g tablet and Aluminum Phosphide 6 % tablet. [RC decision circular F No. 14-11(2)-CIR-II (Vol. II) dated 21-09-1984 and G.S.R. 371(E) dated 20th may 1999]. Decision of 282nd RC held on 02-11-2007 and, Decision of 326th RC held on 15-02-2012. The production, marketing and use of Aluminum Phosphide tube packs with a capacity of 10 and 20 tablets of 3 g each of Aluminum Phosphide are banned completely. (S.O.677 (E) dated 17th July, 2001)
2.	Captafol	The use of Captafol as foliar spray is banned. Captafol shall be used only as seed dresser. (S.O.569 (E) dated 25th July, 1989) The manufacture of Captafol 80 % powder for dry seed treatment (DS) is banned for use in the country except manufacture for export. (S.O.679 (E) dated 17th July, 2001)
3.	Cypermethrin	Cypermethrin 3 % Smoke Generator is to be used only through Pest Control Operators and not allowed to be used by the General Public. [Order of Hon,ble High Court of Delhi in WP(C) 10052 of 2009 dated 1407- 2009 and LPA-429/2009 dated 08-09-2009]

S.No.	Name of Pesticides	Details of Restrictions
4.	Dazomet	The use of Dazomet is not permitted on Tea. (S.O.3006(E) dated 31st Dec, 2008)
5.	DichloroDiphenyl Trichloroet hane (DDT)	The use of DDT for the domestic Public Health Programme is restricted up to 10,000 Metric Tonnes per annum, except in case of any major outbreak of epidemic. M/S Hindustan Insecticides Ltd., the sole manufacturer of DDT in the country may manufacture DDT for export to other countries for use in vector control for public health purpose. The export of DDT to Parties and State non- Parties shall be strictly in accordance with the paragraph 2(b) article 3 of the Stockholm Convention on Persistent Organic Pollutants (POPs). (S.O.295 (E) dated 8th March, 2006) Use of DDT in Agriculture is withdrawn. In very special circumstances warranting the use of DDT for plant protection work, the state or central Govt. may purchase it directly from M/s Hindustan Insecticides Ltd. to be used under expert Governmental supervision. (S.O.378 (E) dated 26th May, 1989)
6.	Fenitrothion	The use of Fenitrothion is banned in Agriculture except for locust control in scheduled desert area and public health. (S.O.706 (E) dated 03rd May, 2007)
7.	Methyl Bromide	Methyl Bromide may be used only by Govt./Govt. undertakings/Govt. Organizations / Pest control operators under the strict supervision of Govt. Experts or Experts whose expertise is approved by the Plant Protection Advisor. [G.S.R.371 (E) dated 20th May, 1999 and earlier RC decision]
8.	Monocrotophos	Monocrotophos is banned for use on vegetables. (S.O.1482 (E) dated 10th Oct, 2005)
9.	Trifluralin	(i) The Registration, import, manufacture, formulation, transport, sell and its all uses except use in wheat shall be prohibited and completely banned from 8th August, 2018. (ii) A cautionary statement has to be incorporated in the label and leaflet that it is toxic to aquatic organism,

S.No.	Name of Pesticides	Details of Restrictions
		hence should not be used near water bodies, aquaculture or pisciculturearea. (vide S.O 3951(E) dated 8th August, 2018)

Integrated Pest Management (IPM)

The details of IPM – the available and recommended IPM measures for key crops of project areas are given below. The following are the broad components and strategy of IPM in increasing order of complexity.

Table 3. Key components of IPM approach

IPM Component	Notified Component Practices
Cultural practices	• Preparation of nurseries or main fields free from pest infestation by removing plant debris, trimming of bunds, treating of soil and deep summer ploughing which kills various stages of pests. • Proper drainage system in field be adopted. • Testing of soil for nutrients deficiencies on the basis of which fertilizers should be applied. • Selection of certified seeds and treating seeds with fungicide or biopesticides before sowing for seed borne disease control. • Selection of seeds of relatively pest resistant/tolerant varieties which play a significant role in pest suppression. • Adjustment of time of sowing and harvesting to escape peak season of pest attack. • Rotation of crops with non-host crops. It helps in reduction of incidence of soil borne diseases. • Proper plant spacing which makes plants more healthy and less susceptible to pests. • Optimum use of fertilizer. Use of FYM and biofertilizers to be encouraged. • Proper water management (alternate wetting and drying to avoid water stagnation) as the high moisture in soil for prolonged period is conducive for development of pests especially soil borne diseases. • Proper weed management. • Root dip or seedling treatment in pest infested area. • Inter-cropping or multiple cropping wherever possible. All the crops are not preferred by each pest species and certain crops act as repellents, thus keeping the pest species away from preferred crops resulting in reduction of pest incidence. • Harvesting as close as to ground level. This is because certain developmental stages of insect pests/diseases remain on the plant parts which act as primary inoculums for the next crop season. Hence, harvesting crops at ground level will lessen the incidence of pests in next season. • Before planting, nursery plants be sprayed/dipped in copper fungicide/biopesticide solutions to protect the plants from soil borne

IPM Component	Notified Component Practices
	diseases. • Keeping bee hives or placing flower bouquets of pollinizer cultivars facilitate better pollination and subsequent fruit set.
Mechanical practices	• Removal and destruction of egg masses, larvae, pupae and adults of insect pests and diseased parts of plants wherever possible. • Installation of bamboo cage cum bird perchers in the field and placing parasitized egg masses inside them for conservation of natural enemies and withholding of pest species wherever possible. • Use of light traps and destruction of trapped insects. • Installation of bird scarer in the field where required. • Installation of bird perches in the field for allowing birds to sit and feed on insects and their immature stages viz., eggs, larvae and pupae. • Use of pheromone traps for monitoring and suppression of pest population. • Use of pheromone traps for mass trapping.
Biological practices	• Biocontrol is use of living organisms to control unwanted living organisms (pests). It involves deliberate use of parasitoids, predators and pathogens to maintain pest population at level blow those causing economic loss either by introducing a new bioagent into the environment of pest or by increasing effectiveness of those already preset in the field. Different kinds of bioagents are biopesticides or bio-parasitoids, bio-fungicides, bio-nematicides etc
Chemical practices	• Use of chemical pesticides is the last resort when all other methods fail to keep the pest population below economic loss. Although there is a great advancement in pest management research, yet pesticides would continue to play an important role in crop protection in view of complexity of pest problems. Therefore, use of pesticides should be need based, judicious, based on pest surveillance and economic threshold level (ETL) to minimise not only the cost involved, but also to reduce associated problems, following aspects need to be considered: • ETL and pest defender ratio must be observed • Relatively safer pesticides should be selected • If pest is present in strips or isolated patches, whole field should not be sprayed.

Strategies for implementation

Farmer Field school method adopting AEA approach: Agro-Ecosystem Analysis (AEA) approach is recommended to facilitate the holistic understanding and knowledge building on pest and diseases considering the soil conditions, plant growth, weather parameters, stage of crop etc. The approach promotes field observation and group discussion which leads to discussion among farmers and take a collective decision to manage the pests. This AEA approach can be facilitated adopting Farmer Field School method of building the capacity of men and women farmers. Since the IPM strategy is a knowledge intensive process and activity, improving women and men farmer's capacity on pest and diseases and its management by understanding its life cycle and skills to identify pests and diseases is necessary.

Plant Clinic Approach: The second potential strategy planned to promote is facilitating 'Plant Clinics' that is promoted by CABI international at the village level to provide technical inputs in identifying pests, monitoring the extend of damage and effective control measures. It provides an array of technological solutions for crop issues along with cultural, biological and chemical for enhancing plant health and economic benefits. The Plant Clinic is equipped with digital microscope, tablet and laptop with qualified agriculture expert as plant doctor. It will be regularly conducted during the cropping season at the interval of 15 days. Both men and women farmers are encouraged to visit the clinic with samples of the affected crops and discuss the potential solutions. The farmers will collect the recommendations for affected crops immediately in face to face and also get it in their mobile phone as SMS for keeping that message for input preparation or purchase. The plant doctors also spread awareness about judicious use of pesticides and recommend locally available cultural, biological, and chemical field inputs.

Suggested methods for the implementation of IPM

Activity	Suggested Methods
Awareness building	▪ Cover at least 30% farmers per village in first year from project start ▪ Cover the remaining 70% by the end of second year (in both cases 40% are women farmers)
Identification of potential farmers and organizing Farmer Field Schools	▪ Identify 30 interested women and men farmers according to the project norm in each village (which have been selected under the project) within 15 days of awareness building and promote Farmer Field Schools(FFS) for the major crops
Capacity building	▪ Staff and line department training completed in 1st year ▪ One FFS/season /village facilitated for two years – 30 farmers per FFS with 40% - women farmers ▪ Training for other interested farmers completed after FFS through Training of Trainers approach (TOT) – one farmer to ten farmer – Horizontal transfer of knowledge on IPM and totally reaching 300 farmers in a season on IPM methods per village with 40% women farmers
Facilitating Plant Clinics	▪ Promote the practice of IPM package by organizing Plant Clinic sessions in the villages (one plant clinic per 750-1000 households) ▪ 50% of the farmers in each village practice IPM in atleast one acre per farmer per season to observe results and link it with learning
Use of Bio-fertilizers/bio-pesticides	▪ At least 10% reduction in use of chemical fertilizers achieved every year ▪ At least 25% increase in the use of biopesticides achieved every year ▪ 50% reduction achieved in use of chemical fertilizers and pesticides after 5 years
Monitoring and Evaluation	▪ Formation of joint monitoring team (staff and community) within one year from project start ▪ Monitoring schedule for each half-yearly prepared and implemented ▪ Monitoring reports be prepared for each monitoring visit and compiled annually to show progress

Activity	Suggested Methods
Process documentation	▪ Annual progress reports on IPM status prepared giving coverage, replication and sustainability ▪ Knowledge, practice and coverage change documented

IPM measures

The specific IPM measures suggested for the commonly occurring pests are as follows

1. **Paddy – Stem borer (*Scirpophaga incertulas*)**
   The ETL of stem borer attack is 2 egg mass per M2 or 10% dead heart or one moth per m2 or 25 moths per trap per week.
   - Practice of destruction of stubbles after the harvest break the life cycle of the pests and reduce the carry over load to next crop
   - Removing the tip of the seedlings while transplanting the seedlings because the adults lay eggs on the leave tips.
   - Reduce the use of nitrogenous fertilizers and practice split application of fertilizers – three to four times helps to avoid the over growth
   - Recommended to harvest the straw close to the ground level
   - Setting up of bird perches using wooden sticks and ropes @ 20-25/ha
   - Setting up of pheromone traps for yellow stem borer @ 20-25/
   - Biopesticide release such as Egg parasitoid namely *Trichogrammajaponicum, T. chilonis* an @ 50,000 –1,00,000 adult/ ha by tying the cards in the field ha starting from 15 days after planting at 7-10 days intervals 5-6 times
   - Spraying of *Beauveriabassiana* product @ 1kg/ha or *Bacillus thuringiensis* @1kg or 1lit/ha
   - When the infestation is above ETL safer/less toxic/easily bio degradable chemical pesticides are recommended
2. **Paddy – Brown Plant Hopper (*Nilaparvata lugens*)**
   The ETL of BPH is 10-15 hoppers per hill
   - Plant early in the season and plan for synchronous planting
   - Wider spacing between plants and rows are recommended since its multiplication is more under high humidity conditions
   - Reduce the application of chemical nitrogenous fertilizers and split the application during different stages of the crop growth
   - Avoid water stagnation in the field at the time of pest infestation, field should be dry and enough aeration should be facilitated by titling the plants on the borders
   - Alternate wetting and drying practice of cultivation can be adopted in the prone areas
   - Control the population of myrid bugs by physical means as it helps to transmit the eggs and nympal stages of the hopper to other plants
   - Early maturing varieties as well as crop rotation with non-rice crops helps to break the cycles
   - Setting up of yellow sticky traps to attract and kill hoppers

- Pour kerosene in the flooded fields and drag a rope to dislodge the plants, during this stage insects fall in to water and drain the water after six hours
- Foliar application of Neem Seed Kernal Extract @5% or neem oil 0.5%
- When the infestation is above ETL safer/less toxic/easily bio degradable chemical pesticides are recommended

3. **Paddy – Leaf folder (*Cnaphalocrocis medinalis*)**

The ETL of the pest is 2 damaged leaves with larva per hill

- Early planting of paddy seedlings
- Providing wide spacing between plants and rows helps to get more sunlight and aeration which prohibits its growth
- Reduced application of nitrogenous fertilizers since the fresh green growth invites female flies to lay eggs which should be avoided to pest population surge
- Practice crop rotation with pulses and oil seeds
- Setting up of light traps to attract and kill adults.
- Keeping the bunds without much grass growth helps to avoid the pests survival
- Shade around the field should be avoided because shading provides conducive atmosphere for its multiplication
- The infected leaves can be mechanically removed and larvae can be destroyed manually
- Dragging a rope across the field to dislodge larvae of leaf-folder to kerosenized water in the field
- Release of egg parasotoid*Trichogrammachilonis* @ 1 lakh / ha starting from 15 Days after planting for 2-3 times at 7-10 days intervals.
- Spray biopesticides like *Bacillus thuringiensis* @1kg or 1lit/ha twice at 7-10 days
- When the infestation is above ETL chemical pesticides are recommended intervals in the evening hours. Foliar spray of NSKE @5% or neem oil 0.5%

4. **Ear Head bug – (*Leptocorisa acuta)***

The ETL level is one bug/hill

- Bait - place fermented parts of either rotten frog or snail or crab or dry fish as bait in 20-25 places in a ha to attract and divert pests from sucking milk of rice grain
- Spray theextract of 2.5kg garlic + 500g tobacco leaves with wetting agent in one ha field at the time of milky stage
- When infestation crosses the ETL use safer/less toxic/easily bio degradable.

5. **Blast (*Pyricularia grisea*)**

- Practice summer ploughing to reduce the load of fungal spores
- Cultivate tolerant or resistant varieties wherever suitable
- Plan for early planting
- Seed treatment with *Trichodermaviridii* @ 4g /kg of seeds before sowing
- Apply balanced fertilizers and less amount of nitrogenous fertilizers

- Keep the fields free from weeds that acts as an alternate host
- Destroy crop residues of last crop to eradicate the source of spores
- Spray leaf extract of tulsi @ 250g in 10 litres of water for two times at 10 days interval

6. **Coconut Rhinozerous beetle (***Oryctes nasicornis* **)**

- Mechanically remove the different life stages of the beetle from the attacked palms using beetle hook and destroy it.
- Set up pheromone trap for rhinoceros beetle @ 1 trap/10 trees by fixing it to the plant at 0.6 to 1 m height to trap and kill the beetles.
- Soak castor cake at 1 Kg in 5 litres of water in small mud pots and keep them in the coconut gardens to attract and kill the adults.
- Apply mixture of neem seed powder + sand (1: 2) @ 150 g/palm or neem seed kernel powder + sand (1: 2) @ 150 g/palm in the base of the 3 inner most leaves in the crown or Place medium size naphthalene balls in the leaf axils in the top and cover it with fine sand.
- Use of biocontrol agents like green muscardine fungus (*Metarrizhium anisopliae*) by spraying 250ml mixed with 750ml water in manure pits and other breeding sites of the beetle. Or release of *Baculovirus oryctes* inoculated adult rhinoceros beetle @ 6 beetles/acre reduces the leaf and crown damage caused by this beetle.
- Maintain the coconut garden should be clean without tree residues

7. **Coconut – Red Palm weevil *(Rhynchophorus ferrugineus*)**

- Avoid the cutting of green leaves.
- Place pheromone trap @ 1 trap/10 trees by fixing it to the plant at 0.6 to 1 m height to trap and kill the beetles.
- Set up of attractant traps (mud pots) containing sugarcane molasses 2½ Kg or toddy 2½ l (or pineapple or sugarcane activated with yeast or molasses) + acetic acid 5 ml + yeast 5 g + longitudinally split tender coconut stem/ logs of green petiole of leaves of 30 numbers in one acre to trap adult red palm weevils in large numbers

Training and capacity building programmes: The training and capacity building programmes for both the agriculture officers and men and women farmers will be conducted by focusing on the following two main themes:

A) IPM demonstrations – recommend and set targets for covering project areas with IPM demonstrations and
B) providing pesticide handling training to potential project beneficiaries, including demonstration and use of proper equipment for spraying of pesticides

Table 4. Training calendar

Content	Target group	Resource organizations
IPM demonstrations		
i). Awareness building	Women and men farmers in the villages of selected sub basins	Tamil Nadu Government Departments / Agriculture Universities / Research

Content	Target group	Resource organizations
ii). Social mobilization	Group of Farmers	organisations
iii) Agro Ecosystem Analysis (AEA)	Group of Farmers and Department officers	
iv) Different IPM technologies	Department officers	
v) Demonstrations and use of proper equipment for spraying pesticides	Men and women farmers	
vi) Facilitation skills on Farmer Field school – communication and monitoring	Department officers	
vii) conducting demonstrations and facilitating FFS	Men and women farmers	
viii) Biopesticides and other bioproducts	Men and women farmers	
ix) Conducting Plant Clinics at the village level	Men and women farmers	

Safe handling measures: Safe handling of the pesticides play an equal importance to ensure the safety issues while using it. Hence training programme will give due importance to promote best practices on Safe Practices on Procurements, Storage, Handling, Use and Disposal of pesticides by user groups. The programme will make an attempt to address the following measures (Table 5).

Table 5. Do's and Don'ts in safe use of pesticides by the farmers while purchasing and using

Areas	Do's	Don'ts
While Purchasing	▪ Purchase pesticides/biopesticides only from registered pesticide dealers having valid Licence. ▪ Purchase only just required quantity of pesticides for single operation in a specified area. ▪ See approved labels on the containers/packets of pesticides. ▪ See Batch No., Registration Number, and Date of Manufacture / Expiry on the labels. ▪ Purchase pesticides well packed in containers.	▪ Do not purchase pesticides from foot path dealers or from un-licenced person ▪ Do not purchase pesticide in bulk for whole season ▪ Do not purchase pesticides without approved label on the containers ▪ Never purchase expired pesticide ▪ Do not purchase pesticides whose containers are leaking/loose/ unsealed
During Storage	▪ Store the pesticides away from house premises. ▪ Keep pesticides in original containers.	▪ Never store pesticide in house premises. ▪ Never transfer pesticides from original to another containers.

	▪ Pesticides/weedicides must be stored separately. ▪ Where pesticides have been stored, area should be marked with warning signs. ▪ Pesticides be stored away from the reach of the children and live stocks. ▪ Storage place should be well protected from direct sunlight and rain	▪ Do not store insecticides with weedicides. ▪ Do not allow children to enter the storage place. ▪ Do not allow children to enter the storage place. ▪ Pesticides should not be exposed to sunlight or rain water
While handling	▪ Keep pesticides separate during transportation. ▪ Bulk pesticides should be carried tactfully to the site of application. ▪	▪ Never carry/transport pesticides along with food/fodder/other eatable articles. ▪ Never carry bulk pesticides on head, shoulder or on the back. ▪
While preparing spray solution	▪ Always use clean water. ▪ Use protective clothing's viz., hand gloves, face masks, cap, apron, full trouser, etc. to cover whole body. ▪ Always protect your nose, eyes, ears, hands, etc. from spill of spray solution ▪ Read instructions on pesticide container label carefully before use. ▪ Prepare the solution as per requirement. ▪ Granular pesticides should be used as such. ▪ Avoid spilling of pesticides solutions while filling the spray tank. ▪ Always use recommended dosage of pesticide. ▪ No activities should be carried out which may affect your health	▪ Do not use muddy or stagnant water. v Never prepare spray solution ▪ Without wearing protective clothing's. Do not allow the pesticide/its solution to fall on any body parts. ▪ Never avoid reading instructions on container's label for use. ▪ Never use left out spray solution after 24 hours of its preparation. ▪ Do not mix granules with water. ▪ Do not smell the spray tank. ▪ Do not use overdose which may affect plant health and environment. ▪ Do not eat, drink, smoke or chew during whole operation of pesticides.
Selection of Equipment's	▪ Select right kind of equipment's. ▪ Select right sized nozzles. ▪ Use separate sprayer for insecticides and weedicides.	▪ Do not use leaky or defective equipment's. ▪ Do not use defective/non-recommended nozzles. ▪ Do not blow/clean clogged nozzles with mouth. Instead use tooth brush tied with sprayer. ▪ Never use same sprayer for both weedicides and insecticides.

Sources: Farmer's portal - http://farmer.gov.in/IpmDoDont.aspx

Promotion of Biopesticides: There are several beneficial microbial and botanical extracts are function as suitable safe alternatives are available in the state. Efforts will be made to identify the suitable products and project will make special efforts and design strategies to promote the use at the farmer level. Following are the list of registered Biopesticides (Table 6). The potential sources to purchase the above products in Tamil Nadu are given in Table 7.

Table 6. List of Approved bio pesticides – alternatives to chemical pesticides

No.	Name of the Biopesticide
1.	Bacillus thuringiensis var. israelensis
2.	Bacillus thuringiensis var. kurstaki
3.	Bacillus thuringiensis var. galleriae
4.	Bacillus sphaericus
5.	Trichoderma viride
6.	Trichoderma harzianum
7.	Pseudomonas fluoresens
8.	Beauveria bassiana
9.	NPV of Helicoverpa armigera
10.	NPV of Spodoptera litura
11.	Neem based pesticides
12.	Cymbopogan
13	*Verticilium lecanii*
14	*Metarhizium anisopliae*
15	*Ampelomyces quisqualis*
16	*Hirsutella thompsonii*

Table 7. List of firms producing Bio-pesticides

Department of Agricultural Microbiology, **Agriculture College and Research Institute,** **Tamil Nadu Agricultural University** Dr. S. Anthoniraj MADURAI-625 104 (0452-422956 fax: 422785 e-mail: s_anthoniraj@yahoo.com	**Biofertilizer Production Unit,** **Department of Agriculture,** **Govt. of Tamil Nadu** Gundusalai Road, Sommandalam, CUDDALORE-607 001 (TN)
Biofertilizer Production Unit, **Department of Agriculture,** **Govt. of Tamil Nadu** Agricultural Chemist Sakkottai, THANJAVUR-612 401 (TN)	**Biofertilizer Production Unit,** **Department of Agriculture,** **Govt. of Tamil Nadu** Jamal Mohd. College Post, Khajamalai, TRICHY-620 020 (TN)
KRIBHCO Sidco Garment Complex, Thiruvika Industrial Estate, Guidy,	**Regional Research Station** **Tamil Nadu Agricultural University,** PIYUR-635 112 Via-Kaveripattinam Dharmapuri District

CHENNAI-32	04343-50043
Monarch Bio-Fertilisers and Research Centre 12, SIDCO Industrial Estate, Thirumazhisai, CHENNAI-602 107 (TN) (6272780	**Lakshmi Bio-Tech** Mr. V. Sithanandham Nellikuppam Road, Thottapattu, CUDDALORE-607 109 (TN) (04142-210136
Marygreen Afrotech (P) Ltd. Dr. Y. Joe 5/302, Srisaibaba St., Santosh Nagar, Kandanchavadi, Perungudi Post, CHENNAI-600 096 (TN) 4964202, 4745957 e-mail: marygreen45@hotmail.com	**Tamil Nadu Agricultural University** Prof. & Head Deptt. of Agricultural Microbiology, COIMBATORE-3 (TN) (431222 ext. 294 Fax: 0422-431672 e-mail: vctnau@vsnl.com
T Stanes & Company Limited Dr. S. Ramarethinam 8/23-24, Race Course Road, COIMBATORE-641 018 (TN) (0422-211514, 213515 Fax: 217432 e-mail: tstanes@vsnl.com	**Esvin Advanced Technologies Limited** Mr. T. S. Venkataraman "Esvin House" Perungudi, CHENNAI-600 096 (TN) (4961056,4960690 Fax: 4961002 e-mail: tsv@vsnl.com
Southern Petrochemical Industries Corporation Limited, Mr. K. Raju SPIC Ltd. Biotechnology Division, Chettiar Agaram Road, Gandhi Nagar, Porur, CHENNAI-600 116 (TN) (044-4768064 Tele-Fax: 044-4767347 e-mail: biotech.por@spic.co.in	**Biofertiliser Unit-Manali, Madras Fertilizers Limited** Mr. P. Mallikarjuna Reddy Chief Manager –Bioproducts Commercial Group, Madras Fertilizers Ltd., Manali, CHENNAI-600 068 (TN) (044-5941001 ext. 2750 Fax: 5941010 e-mail: edcomm@mfl.tn.nic.in
Biofertilizer Production Unit Mr. S. Murugan Agricultural Chemist, Biofertilizer Production Unit, Seelanaickenpatty, SALEM-636 201 (TN)	**Biofertilizer Production Unit,** Mr.Thiru P. Raman Agricultural Chemist, Biofertilizer Production Unit, KUDUMIAMALAI-622 104 Distt. Pudukkottai

Main Biocontrol Research Laboratory (Unit of Tamil Nadu Cooperative Sugar Federation) 2E/1, Rajeshwari Vedhachalam Street, CHENGALPATTU-603 001 (TN) (04114-431393	**The SIMA Cotton Development and Research Association** Dr. M.A. Shanmugham "Shanmukha Manram", Post Box No. 3871, Race Course, COIMBATORE-641 018 (TN) (0422-211391 Tele-Fax: 0422-216798

Source: http://agritech.tnau.ac.in/org_farm/orgfarm_biofertilizertechnology.html#List

Annexure 8: Impacts and Mitigation Measures due to COVID-19

Impacts due to COVID-19 Pandemic

There will be chances of infection by COVID-19 at construction sites/labour camps by concerned contractors and the risks are as follows:

- Contamination from existing or new workmen/laborers, who might be a carrier of COVID-19.
- Contaminations from neighboring communities through inter mingling.
- Contamination from incoming project materials which might have boon contaminated during transportation /handling.
- Malfunctioning of tools due to non- operation for longer period of lockdown.
- Biological hazards, while handling materials at sites / stores which are lying untouched due to long period of lockdown.

Mitigation Measures

- Social distancing shall be ensured in labour camps by providing adequate number of rooms for workers / laborers.
- Food items, vegetables and other items of daily requirement for the laborers /staff shall be arranged by the concerned contractor from one or more reliable sources in the camp itself and no one from the camp would be allowed to move out for these requirements.
- Concerned officials of PIU have to help in arranging permits for contractors, workers and vehicles engaged in arranging essential items and payments.
- Consumption of liquor, smoking, pan, gutka, tobacco etc and spitting shall be strictly prohibited in labour camps.
- Hospitals / Clinics in the nearby areas, which are authorized to treat COVD-19 patients, would be identified and list of the same is needed to be made available in the camp.
- Concerned contractors would arrange regular visits of doctor/medical staff in the labour camp.
- Tie up with nearby hospital dealing with COVID-19 testing and treatment is to be ensured.
- Mobile number of the doctor/medical assistance shall be displayed in the camp at number of locations.
- Routine medical checkup of each labour /staff by qualified medical staff shall be ensured, at least once in a weak.
- Any person with symptoms of COVID-19 infection shall be immediately placed in designated isolation rooms. In case of positive test results, he would be admitted to designated hospitals or Government Quarantine Center.
- Camp rooms and toilets shall be kept clean with good hygiene.

- Camp area shall be disinfested completely with user friendly disinfectant medicines at prescribed frequency.
- Concerned contractor would provide adequate hand wash facility with soap and sanitizers, preferable with touch free mechanism at the entry & exit points and in common areas of work sites. The workers / laborers would be regularly educated to become habitual of washing their hands with the soap / liquid soap/sanitizers.
- Posters / sign ages with do's and don'ts issued by the Government would be displayed in the camps / construction sites to improve awareness among the people.
- Bathing and washing facilities should be such that fresh water is available for every user. In no case, common tanks would be used for direct wasting and bathing into it. Used water would be draining off immediately.
- It would be mandatory to all the workers/staff members to wear face mask and full sleeve shirt / kurta, trousei /pajama all the time, so that their faces, hands and arms are covered. Concerned contractor would arrange sufficient number of face masks, safety shoes, helmets, etc for all workers.
- It is to be ensured that workers do not share their belongings like food, water bottles, utensils, mobile phones etc. in the camp/ at the construction sites.
- There would be total ban on non- essential visitors in camps / work sites. No outside worker/staff would be permitted to stay in the labour camps.
- All vehicles and machinery entering the camp should be disinfected by spraying mandatorily.
- For effective implementation of the strategies, a strict M&E system is needed to be developed / implemented having adequate provision of punishment to the culprits in case of failure of its compliance.
- The terms and conditions already mentioned in the tender documents for the workers are also to be implemented along with the emergency response plan developed and labor management plan, keeping in view the COVID-19 problem.
- For effective implementation of SOP (Standard Operating Procedure) in the field, awareness generation programs like organizing meetings /discussions etc. are also needed to be organized for all the stakeholders. Besides, adequate numbers of signages / posters in local language are also needed to be developed as part of IEC material.
- Meetings with the concerned contractors are essential to make them aware about the risks envisaged at construction sites, labor camps and towns due to COVID-19 scenario.

Annexure 9: Consultation and Participation Plan

	Target Group	Activity	Timeline / Frequency	Responsibility	Remarks
1.	Community members	Health camps and health awareness to the community	One meeting	PIU and Contractors key personnel	-
2.	Community and adolescent girls and youth	Training and sensitization to be provided on Gender equality and violence against women	One program per year	PIU/contractor	Community meeting to be done.
3.	Community	HIV/AIDS awareness to be provided	One program per year	PIU/contractor	Community meeting to be done.
4.	Community	COVID awareness to be provided	One program per year	PIU/contractor	Community meeting to be done.
5.	Community	Public and stake holders' consultations to be conducted for the tanks and branch canals.	One program per year	PIU/contractor	Community meeting to be done.
6.	Community	Health camps and health awareness to the workers	One program per year	PIU/contractor	Community meeting to be done.
7.	Community	Training and sensitization to be provided on Gender equality and violence against women	One program per year	PIU/contractor	Community meeting to be done.
8.	Community	HIV/AIDS awareness to be provided	One program per year	PIU/contractor	Community meeting to be done.
9.	Community	COVID awareness to be provided	One program per year	PIU/contractor	Community meeting to be done.
10.	Labourers	Health camps and health awareness to the workers	After commencement of project activities	PIU/contractor	The PIU contractors should ensure that it is conducted and PMU and PMC specialists should verify during field inspections

	Target Group	Activity	Timeline / Frequency	Responsibility	Remarks
11.	Labourers	Training and sensitization to be provided on Gender equality and violence against women	After commencement of project activities	PIU/contractor	The PIU contractors should ensure that it is conducted and PMU and PMC specialists should verify during field inspections
12.	Labourers	HIV/AIDS awareness to be provided	After commencement of project activities	PIU/contractor	The PIU contractors should ensure that it is conducted and PMU and PMC specialists should verify during field inspections
13.	Labourers	COVID awareness to be provided	After commencement of project activities	PIU/contractor	The PIU contractors should ensure that it is conducted and PMU and PMC specialists should verify during field inspections
14.	Labourers	HSE&PPE kits to be provided	During working time	PIU/contractor	The PIU contractors should ensure that it is conducted and PMU and PMC specialists should verify during field inspections
15.	Labourers	All the Labors to be provided with accident insurance	After commencement of project activities	PIU/contractor	The PIU contractors should ensure that it is conducted and PMU and PMC specialists should verify during field

	Target Group	Activity	Timeline / Frequency	Responsibility	Remarks
					inspections
16.	PIU staff	Labor camp records, First aid kit, accident registers, Legal formalities for the labor engagements, GRM details	Before commencing the project activities	PMU	The PMU team has to orient and train the staff team of the PIUs
17.	PIU staff	Stake holders' consultations- public meetings and line department meetings conducted	Before commencing the project activities	PMU	The PMU team has to orient and train the staff team of the PIUs
18.	PIU staff	IEC materials like notice and hand bills distributed-LS	Before commencing the project activities	PMU	The PMU team has to orient and train the staff team of the PIUs

Annexure 10: Environmental & Social Management Plan (ESMP) Implementation Data
(To be filled by Contractor (Monthly) and PIU with necessary enclosures, to be verified and certified by PMC and PMU

Month: _____

1. **Package Description**

Contractor Name	
Contract Package	
Name of Project Component or activity	Site Specific Environmental & Social Management Plan (ESMP) Implementation
Work Completed for the Month	
Agreement Date	
Date of completion as per agreement	
Date of Commencement of Civil work	

2. **Details of Labour Licence and Insurance**

Sl.No	**Name of Contractor / Sub Contractor**	**Labour License Validity**		**Labour Insurance validity**	
		From	**To**	**From**	**To**

3. **Details of Statuary regulatory clearances**

Sl.No	**Name of Project Component or activity**	Clearance required	**Clearance According agency**	**Clearance validity**	
				From	**To**
		Consent to Establish (CTE)- Batching Plant, Hot Mix Plants, DG	TNPCB		

Sl.No	Name of Project Component or activity	Clearance required	Clearance According agency	Clearance validity	
				From	To
		Sets etc.			
		Consent to Operate (CTO) - Batching Plant, Hot Mix Plants, DG Sets etc.	TNPCB		
		Tree Cutting	State DFO		
		Establishment of Labour Camp	Local Panchayat or authority		
		Storing and dumping of waste material	Local Panchayat or authority		
		Pollution Under Control Certificate	Transport Authority		

Other if any may be added

4. **Establishment of Contractors Camp** – Yes / No

   Usage of Camp – Plant / machineries / labours

Machinery Stocking Details – Location (location wise)

Sl.No	Type of Machinery	Pollution Under Control Certificate		Fitness/ PCB certificate Validity
		From	To	
	Excavators			
	Tippers/ Dumpers			
	Power Roller			
	Buses			
	Tractors			

Other if any may be added

Labour Camp - Location (location wise)

Sl.No	Description	Particulars
	Total number of labourers employed	
	Total number of male labourers	
	Total number of female labourers	
	Total number of local labourers employed (not residing in camp)	
	Total number of male labourers (not residing in camp)	
	Total number of female labourers (not residing in camp)	
	Total Number of Labourers residing (Migrant labourers)	
	Total number of male labourers (Migrant labourers)	
	Total number of female labourers (Migrant labourers)	
	Number of living units in the camp	
	Whether water supply is provided	
	Whether drinking water supply is provided	
	Number of Toilets provided	
	Drainage facility provided	
	Availability of Health centre and distance of nearest health centre	
	First Aid Facility Available	
	Health awareness programmes conducted - HIV	
	Health awareness programmes conducted - COVID19	
	Health awareness programmes conducted - Sanitation	
	General Medical / Health Camp	
	Fuel used in the Camp	
	Solid waste Management Practices	
	Gender Violence against women / Forced Labour / Child Labour Awareness – POCSO Act	
	Occupational Health Hazards awareness	
	Safety safeguards (Awareness)	

Storage / Dumping Sites –

Sl.No	Storage / Dumping site location	Material stored / Dumped	License required (Yes / No)	License Validity	
				From	To
		Storage of Fuel			
		Blasting Material			
		Silt Disposal Sites			
		Construction Debris			

5. Details of Quarries / Vendors

Sl.No	Name of the vendors	Details of Vendors Environmental Clearances Validity					
		Sand		Stone Products		Boulders	
		From	To	From	To	From	To

6. Management Measures

Sl.No	Parameters	Measures in Place
	Dust Control	
	Noise Control	
	Emission Control (Air Emissions)	
	Erosion Control	

	Solid Waste	
	C&D waste	
	Hazardous Waste	
	Labour Safety (First Aid / accident Kit with register / PPE Kits)	

7. Details of Environmental Monitoring / Testing from NABL approved laboratory

Sl.No	**Name of Project Component or activity**	**Environment Monitoring / Testing particulars**		
		Parameters	**Number of Samples tested**	**Date of testing**
		Air Quality		
		Noise Quality		
		Ground Water		
		Surface Water		
		Soil / Silt		

8. Were any endangered or threatened species encountered during the works?

If Yes were forest department and Fisheries department notified? Yes / No

Signature of Contractor: Name of Specialist: Date:	Signature of PIU: Designation: Date:	Signature of PMU: Executive Engineer Date:

Environmental Specialist PMU	Social Specialist PMU	Environmental Expert PMC	Social Expert PMC
Signature: Name of Specialist: Date:	Signature: Designation: Date:	Signature Name of Specialist: Date:	Signature Name of Specialist: Date:

Annexure 11: Environmental & Social Management Plan (ESMP) Implementation Data
(To be submitted by PIU (Quarterly) with necessary enclosures)

Quarter: _____

1. **Tree Felling**

Sl.No	Type of Species	WRD	Forest	Total Numbers

2. **Compensatory Afforestation**

Sl.No	Location	Species Planted	Numbers

3. **Awareness program for the community**

Sl.No	Program	Number of programs conducted upto previous Quarter	Number of programs conducted in current Quarter	Total programs conducted
1	General Health camp			
2	Gender Awareness, Violence against women			
3	Awareness on sanitation and health awareness, COVID-19 and HIV/AIDS			
4	Stake holders consultations-public meetings and line department meetings conducted			
5	IEC materials like notice and hand bills distributed			

5	Envioenmental protection and Biodiversity Conservation			

4. Training to PIUs

Sl.No	Program	Number of programs conducted upto previous Quarter	Number of programs conducted in current Quarter	Total programs conducted
1	Labour camp records, First aid kit, accident registers, Legal formalities for the labour engagements, GRM details			
2	Gender Training and POCSO awareness			

5. Grievance Redresses

Sl.No	Month	Type of grievance	Number of grievances registered	Number of grievances resolved	Pending grievances
1					
2					
3					

6. Public Participation Activates

Sl.No	Program	Target Group	Number of Participants	Outcomes
1	Rallies			
2	Creating a model on Climate Resilient farming technologies and sustainable agriculture practices in collaboration with NGOs/Universities			
3				
4				
5				

6				
7				

Signature of Contractor:
Name of Specialist:
Date:

Signature of PIU:
Designation:
Date:

Signature of PMU:
Executive Engineer
Date:

Environmental Specialist PMU	Social Specialist PMU	Environmental Expert PMC	Social Expert PMC
Signature: Name of Specialist: Date:	Signature: Designation: Date:	Signature Name of Specialist: Date:	Signature Name of Specialist: Date:

Annexure 12: Format for E&S Management Monitoring Report

(To be submitted by PMC Semi Annual)

Chapter I: Project Background:

1.1 Project Overview
1.2 Project Development Objectives
1.3 Project Components and Activities
1.4 Environmental and Social Management Plan

Chapter II: Regulatory Requirement and Compliances

2.1 Environmental Regulatory Requirements and Compliances (Project Specific)

- 2.1.1 Consent to Establish and Consent to Operate under Air & Water Pollution
- 2.1.2 Letter of Authorization for handling hazardous Waste (if applicable)
- 2.1.3 Tree cutting permission from DFO
- 2.1.5 Clearance for Disposal of desilted materials if any
- 2.1.6 Agreement letter with Pvt. Land owner for borrowing earth (if required)
- 2.1.7 Gram Panchayat Clearance for establishment of Labour Camp and Temporary Disposal of Waste material
- 2.1.8 PUC Compliance / Certificate from RTO
- 2.1.9 Authorization / Permission of Material Supplier
- 2.1.10 Any other compliances that are required

2.2 Social Regulatory Requirements and Compliances

- 2.2.1 SIA Notification (if land acquisition is involved)
- 2.2.2 Notification for Land Acquisition (as per LARR Act), if any
- 2.2.3 Labour License
- 2.2.3 Labour Insurances
- 2.2.4 Any other compliances that are required

Chapter III: Environmental Performance

3.1 Soil Pollution
3.2 Water Pollution
3.3 Noise Pollution
3.4 Waste Management / Sediment Disposal & Management
3.5 Pest Management
3.6 Management of Flora and Fauna / Local Bio-diversity
3.7 Physical Cultural Resources, its Protection and Management
3.8 Compensatory Afforestation

Chapter IV: Social Performance

4.1 People's Understanding and Awareness of the Project
4.2 Land Acquisition, Rehabilitation and Resettlement (if required)
4.3 Gender Inclusion
4.4 Tribal Inclusion and Safeguards

Annexure 13: ToR for the Third-Party Audit / Monitoring and Evaluation Agency

1.0 Background

The Grand Anicut Canal System (GACS) comprises of the GA Main Canal, which traverses a length of 148.65 kms and branch channels totaling to about 1,232 kms which includes laterals also. The Main Canal is divided into 28 reaches according to hydraulic features like Bed Width, FSD etc. The Grand Anicut (Barrage) is 328 metres long; 12.20 to 18.30 metres in width and 4.57 to 5.49 metres in height. The Main Canal passes through three administrative Districts namely Tiruchirappalli (5 kms), Thanjavur (104 kms) and Pudukkotai (39.65 kms) in the state of Tamil Nadu, India. In its course, along the alignment, the Grand Anicut Canal intercepts a right side catchment of 780 Sq. miles. The ayacut under the canal was fixed as 2, 27,472 acres under the GA Canal and 29,000 acres under the Vadavar Extension. A total of 694 Tanks in the Command Area gets benefitted thrugh GA canal system.

The Extension, Renovation and Modernization (ERM) works of GACS shall be implemented by the WRD, GoTN. In this connection, the WRD, through the Department of Economic Affairs (DEA), Ministry of Finance, Government of India have approached the Asian Infrastructure Investment Bank (AIIB) for part financing of ERM of GACS. Currently, DEA has requested AIIB to provide a loan facility of INR 1,609.125 Crores (USD 229.87 Million) which is 70% of Project Cost of INR 2,639.15 Crores (USD Million 377.02) at price level 2014-15. The balance amount of INR 689.625 Crores (U0SD 98.52 Million) will be the share of GoTN.

The Project components include Extension, Renovation and Modernization (ERM) works of the following.

Particulars	Unit	Existing	Proposed (ERM)
Bed and Side Lining	km	1323.32	364.030
Regulators	Nos	45	26
Syphons	Nos	102	66
Well Syphons	Nos	132	15
Canal Syphons	Nos	76	25
Aqueducts	Nos	72	7
Under Tunnel	Nos	131	58
Drops	Nos	966	245
Head Sluices	Nos	293	169
Direct Sluices	Nos	358	283

Particulars	Unit	Existing	Proposed (ERM)
Rear Channel Sluices	Nos	8	-
Pipe Sluices	Nos	2146	609
Bridges	Nos	184	3
Gauging Bridges	Nos	10	0
Tanks	Nos	694	33
Buildings	Nos	116	74
Roads	km	452	31.56
End Dams	Nos	127	8
Bank Strengthening	km	619	744.094
Steps & Ramps	Nos	721	418
SCADA	-	-	Entire Project

2.0 Scope of Work

The Third Party Audit / Monitoring and Evaluation Agency will inspect the work being executed in the divisions w.r.t compliance to various National / State environmental requirements and other statutory aspects.

The Third Party Environmental Monitoring Agency is expected to assess compliance of various aspects detailed in the ESMP of the project at site and provide necessary recommendations for better performance of the project. The outline off the aspects to be assessed and not limited to are detailed below.

- Applicability of the various National and State Environmental regulatory compliances of the project
- Solid Waste generation, storage and Management
- Compensatory Afforestation
- Labour Camp management
- Traffic management
- Review of Monitoring reports of environment parameters and implementation of mitigation measures as required.
- Beneficiary satisfaction and views.

Based on the above collected data, semi-annual reports should be submitted.

3.0 Data, Services and facilities to be provided by WRD:

a) WRD will make available all relevant background documents, data, progress reports, studies and evaluations data and information that is available.
b) WRD will coordinate the consultant's field and counterpart offices.

c) WRD will make all necessary arrangements for supporting the work of the Consultant(s), by facilitating access to sites, field staff.
d) Periodically review the work and performance of the Consultant and provide feedback.

4.0 Reporting Requirements

1. The Consulting Firm shall submit report to WRD for the execution of the scope of services and deliver the outputs.
2. All required reports shall be submitted to the EE, PMU. The Consulting Firm will coordinate closely with the PMU as well as with the division level engineer in charge in executing all aspects of this work. In addition, the Consulting Firm will engage in the following:

a) Documentation: The Consulting Firm will establish and maintain a comprehensive inventory of all relevant documents and data collected. Any confidential material provided to the consultants will be returned in an organized fashion to the WRD at the end of the contract.
b) Personnel: The Consulting Firm must provide and maintain all key personnel proposed. Any changes are subject to approvals from the contracting authority.
c) Logistics: The Consulting Firm will be responsible for all their logistical need in-country, including workspace, office support, communications and transportation.
d) All deliverables shall be submitted in electronic form and in hardcopy (3 copies each deliverable) in English. All hardcopy documents shall be two sided printed to conserve paper.
e) All reports will be submitted to EE, PMU.

5.0 Deliverables

S.No.	Deliverable	Time Schedule
1.	Inception report highlighting Approach and methodology for the assignment	Within 1 week **after award of work**
2.	Semi annual Audit Report along with test reports and photographs	Within 2 weeks **after the visit**
3.	End of the Project Audit Report along with test reports and photographs	Within 2 weeks **after the visit**

Annexure 14: Template for ESMP

An Environmental and Social Management Plan has to be formulated for construction and operation phases to monitor the major environmental and social parameters along with the frequency of monitoring, methods of monitoring, parameters to be measured and responsibility of monitoring by the contractor.

The following aspects should be considered by the contractor for preparation of ESMP but not limited to:

- Generation of solid waste
- Insufficient / mismanagement of ESHS plan will bring construction nuisances to environment and local community, Health and Safety (H&S) issues etc.
- Occupational H&S
- Site clearance activities may increase dust and noise level, cause soil erosion, bring H&S risks and cause ecological damage.
- Generation of solid waste
- Air pollution generated through construction activity, construction machinery and vehicular traffic
- Water Pollution in canals and water bodies
- Noise pollution generated through construction activities
- Contamination of land and water from Hazardous materials and petroleum products
- Mushrooming of unplanned developments
- Occupational H&S
- Community H&S
- Chance Find
- Exposure of Top soil due to denudation leading to soil erosion
- Impact on flora/ fauna during vegetation clearance
- Removal of Top Soil
- Littering on road due to transportation of construction materials from quarries / borrow
- Dust and air pollution from flying of dried-up sediment generated from ground work
- Spillage during transportation of excavated silt material
- Dismantling of Labour camp and Batching plants

Annexure 15: Public Consultations for ESIA disclosure at Nagudi Village

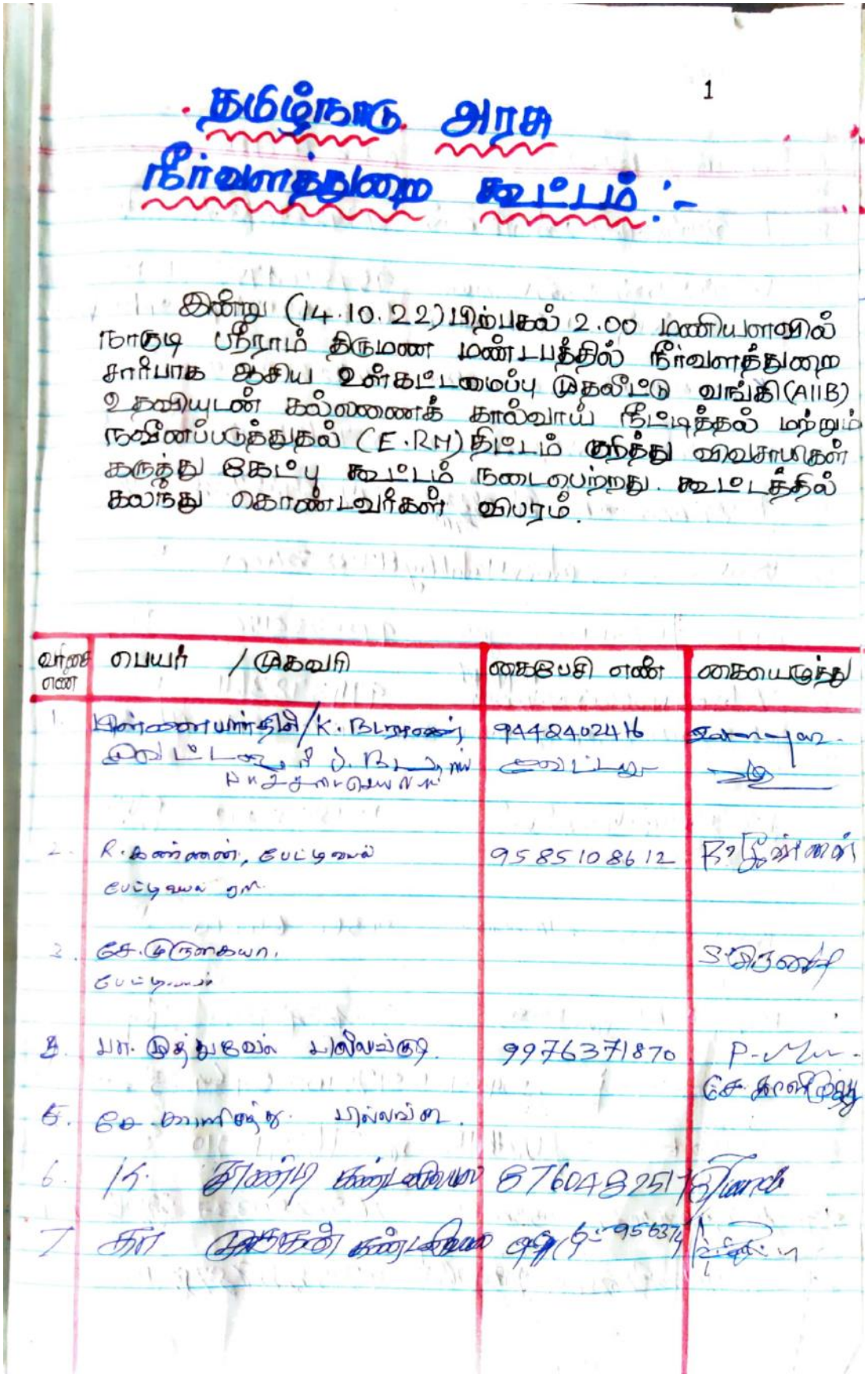
Date & Time of Community Consultation Meetings	14/10/2022
Location/ Venue of the Meetings	Nagudi Village, Pudhukottai District
Stakeholders who Attended the Consultation Meetings	Farmers, Farmer's association, Local political representatives, Religious leaders, Social and environmental activist, Agricultural labourers, and general public
No. of Participants	98
Project Disclosure	
• The WAPCOS ESIA experts team presented the outcome of the ESIA study, GRM and institutional setup for project execution • WRD officials explained about the project objectives and its benefits. • PIU Engineers enlightened about the project implementation components specifically for the lower stream. • WRD SE, explained about the importance of the project and he requested the public to cooperate during the implementation of the work and post construction period. • PIU engineers agreed on a few of the public and farmers grievances particularly, canal bunds strengthening, repairing the shutters, head regulators of the distribution channel, removing the unwanted trees subsequently with compensatory tree plantation as per the standard norms/ratio. • WRD officials and WAPCOS experts team enlightened about the importance of canal water cleanliness, water resources, conservation, community participation in the maintenance of the canal during and post construction of the work. • Created an awareness about the compensatory tree plantation and village people were requested to cooperate for the protection of the plantation. • SE, WRD agreed to provide steps, ramps and water tanks for cattle rearing as per the requirements of the people.	
Points raised by the community	
• Farmers are welcoming the proposed ERM project. • A farmer said that there are around 110 tanks in use for agricultural purposes and requested to renovate the tanks as much as possible during the execution of ERM proposed activities. • Canal and adjacent tank's bunds need to be strengthened. • Farmers requested to renovate the field channels so that the water reaches the tail end	

farmer's agricultural field.

- Some of the sluices are damaged so the water is leakaging. Farmers requested to renovate the same.
- Canal water distribution channels should be strengthened.
- During the harvesting period farmers are suffering to carry the agricultural products due to lack of transport access facilities in the bund.
- The farmers are requested to remove the unwanted trees in the distribution channel and field channel.
- A farmer requested to renovate the most important tanks which are highly dependent by the farmers in this region as follows: *Chithalai tank, Perungattan tank, Sirungattan tank, Vijayapuram tank* and Rettamangalam *vaikkal*.
- Farmers requested to renovate the damaged shutters.
- Local political representatives requested the WRD officials to ensure the ground water recharge level and quality of the raw material and construction.
- Farmer's association requested to construct an association building separately at District level.
- During the execution of the work the main canal, distribution canal, and field channel need to be renovated.
- Adjacent tanks water storage capacity is reduced because renovation was not done for many years so the farmers are requested to renovate the tanks to improve the water storage capacity.
- The water flow of the main canal needs to be increased because lower stream/tail end farmers are suffering particularly during the cultivation season.
- All the farmers appreciated that the project is very useful and it will benefit their agriculture activities and solve water scarcity.
- Adjacent communities of the canal, cattle rearing farmers, and agricultural labourers were requested to construct the steps, ramps and water tank for cattle rearing and for their domestic purposes.




Attendance Register



1

தமிழ்நாடு அரசு
நீர்வளத்துறை கூட்டம் :-

இன்று (14.10.22) பிற்பகல் 2.00 மணியளவில் நாகுடி பிராம் திருமண மண்டபத்தில் நீர்வளத்துறை சார்பாக ஆசிய உள்கட்டமைப்பு முதலீட்டு வங்கி (AIIB) உதவியுடன் கல்லணைக் கால்வாய் நீட்டித்தல் மற்றும் நவீனப்படுத்துதல் (E.RM) திட்டம் குறித்து விவசாயிகள் கருத்து கேட்பு கூட்டம் நடைபெற்றது. கூட்டத்தில் கலந்து கொண்டவர்கள் விபரம்.

வரிசை எண்	பெயர் / முகவரி	கைபேசி எண்	கையெழுத்து
1.	[illegible]	9442402416	[illegible]
2.	R. கண்ணன், பேட்டவலம் பேட்டவலம் அஞ்சல்	9585108612	[illegible]
3.	கே. திருநாவுக்கரசு, பேட்டவலம்		[illegible]
4.	[illegible]	9976371870	[illegible]
5.	[illegible]		
6.	[illegible]	8760482517	[illegible]
7.	[illegible]	[illegible]	[illegible]

2

வ எண்	பெயர் / இதவரி	கைபேசி எண்	கையெழுத்து
8	[illegible]	9342276737	
9	[illegible]	9578504757	
10	[illegible]	6383020314	
11	[illegible]	9442438199	
12	[illegible]	9578696910	
13	[illegible]	9976435232	
14	[illegible]	9788504001	
15	G. Ravi / [illegible]	9788770156	
16	V. GOVINDARAJ / [illegible]	9943783611	
17	[illegible]	9715038148	
18	[illegible]	9095532512	
19			
20	[illegible]	9360864210	
21	[illegible]	9842490[illegible]	
22	[illegible]	9751025464	
23	SNatesh [illegible]	7639155910	
24	[illegible]	9698280337	
25	[illegible]	9345598713	

3

வ எண்	பெயர் / முகவரி	கைபேசி எண்	கையெழுத்து
26	V. S. பழனிவேல், திண்டிவனம்	9688040295	[illegible]
27	R. [illegible]	6379425877	[illegible]
28	M. [illegible]	9865428815	[illegible]
29	[illegible]	9486803741	[illegible]
30	[illegible]	9047541660	B. Rajendran
31	[illegible]	9787917611	[illegible]
32	[illegible]	9976342421	[illegible]

தமிழ்நாடு அரசு நீர்வளத்துறை கூட்டம் :-

இன்று (14.10.22) பிற்பகல் 2.00 மணியளவில் நாகுடி பிரதாம் திருமண மண்டபத்தில் நீர்வளத்துறை சார்பாக ஆசிய உள்கட்டமைப்பு முதலீட்டு வங்கி (AIIB) உதவியுடன் கல்லணைக் கால்வாய் நீட்டித்தல் மற்றும் நவீனப்படுத்துதல் (ERM) திட்டம் குறித்து விவசாயிகள் கருத்து கேட்பு கூட்டம் நடைபெற்றது. கூட்டத்தில் கலந்து கொண்டவர்கள் விபரம்.

வரிசை எண்	பெயர் / முகவரி	கைபேசி எண்	கையொப்பம்
1	1. நல்லான் சந்திரன் திருமருகல்	7639153839	
2	2. [illegible]	9655837907	
3	K. மணிமுத்து மாதானி மேற்குதெரு	9363503934	K. மணிமுத்து
4	4. [illegible]	9751921376	
5	5. [illegible]	9965824631	
6	6. [illegible]	9942088921	

2

வரிசை எண்	பெயர் / முகவரி	கைபேசி எண்	கையொப்பம்
07.	T. [illegible]	9976482064	[signature]
08.	[illegible]	9865892035	[signature]
09.	R. [illegible]	9585343844	R. [signature]
10.	S. [illegible]	9585770830	S. [signature]
11.	V. Manigandan [illegible]	6385565740	V [signature]
12.	P. [illegible]appan [illegible]	9965719641	[signature]
13.	[illegible]	9965870279	V [signature]
14.	M. Albinnanathan Vijayapuram	9842393622	[signature]
15.	N. [illegible] Vettar	9159854212	N. [signature]
16.	S. Nagooran Vettanur	9629588221	[signature]
17.	[illegible]	9865840926	[signature]
18.	K. [illegible]	9965279594	K. [signature]
19.	[illegible]	7373864544	[signature]
20	[illegible]	96[illegible]	[signature]
21.	C. Sivasubramanian, Kalugumanai	9784371482	[signature]
22	[illegible]	8098591850	[signature]
23	A. Ramasamy Aithani	9715155520	[signature]
24	Pon Ganesan ([illegible])	8778248729	[signature]
25	S. Soundararajan v.jeyam	9486835954	[signature]

வரிசை எண்	பெயர் / முகவரி	கைபேசி எண்	கையொப்பம்
26	V. [illegible]	[illegible]	9965[illegible]09
27	P. [illegible]	[illegible]	[illegible]
28	[illegible]	[illegible]	9442571581
29	[illegible]	[illegible]	9655404[illegible]
30	[illegible]	[illegible]	8838249622
31	[illegible]	[illegible]	9976138843
32	K. NATHan	[illegible]	6384874227
33	A. [illegible]	[illegible]	9787699[illegible]
34	[illegible]	[illegible]	8508163113
35	N. [illegible]	[illegible]	8072832317
36	P.M. [illegible]	[illegible]	9442548664
37	A. [illegible]	[illegible]	9442340663
38	R. [illegible]	[illegible]	9486059284
39	[illegible]	[illegible]	9842358[illegible]
40	D. [illegible]	[illegible]	8464853784
41	[illegible]	[illegible]	9600820853
42	[illegible]	[illegible]	9942702[illegible]

வரிசை எண்	பெயர் / தொழில்		கைபேசி எண்	கையெழுத்து
43	K. செல்வேந்திரன்	தலைவர்	9585874432	[illegible]
44	M. [illegible]	[illegible]	9884394970	[illegible]
45	K. மனோகரன்	[illegible]	8883107827	[illegible]
46	A. மோகன்ராஜ்	பட்டணவர்	9176870065	A. Mohan
47	C. ரமேஷ்	பட்டணவர்	9787850779	C. Ramesh
48	R.K. [illegible]	[illegible]	9677089959	[illegible]
49	J. ராமச்சந்திரன்	[illegible]	9865098021	Ramchandr
50	M.S. [illegible]	[illegible]	9095848268	M.S.
51	V. [illegible] - [illegible]		9787813862	[illegible]
52	M. ராமச்சந்திரன் - தொழிலாளர்		9597826274	[illegible]
53	[illegible] தொழிலாளி		9976888777	[illegible]
54	அ. [illegible]	[illegible]	6383168242	D.M
55	P. சண்முகம்	தொழிலாளி	8098524724	P.
56	கா. அய்யனார்	[illegible]	6374810580	கா. அய்யனார்
57.	T. [illegible]	[illegible]	7904596902	T.
58	[illegible]		[illegible]	[illegible]

5

வ. எண்	பெயர் / முகவரி	கைபேசி எண்	கையொப்பம்
59	ப. [illegible] ([illegible])	9585129593	[illegible]
60	கா. [illegible] [illegible]	8489016840	[illegible]
61	[illegible] [illegible]	9865144767	M. [illegible]
62	[illegible] [illegible]	9965977793	[illegible]
63	[illegible]	8124453847	[illegible]
64	T. [illegible] [illegible]	9486248291	[illegible]
65	C. YUVAKAILASH [illegible]	9865695861	[illegible]
66	[illegible] [illegible]	9655911697	[illegible]

Paper Advertisement – Hindu – Tamil paper

இந்து தமிழ்

கல்லணைக் கால்வாய் புனரமைப்பு குறித்து நாகுடியில் அக்.14-ல் கருத்துக் கேட்புக் கூட்டம்

● புதுக்கோட்டை

பொதுப்பணித் துறையின் சார்பில் கல்லணைக் கால்வாய் புனரமைத்தல், நீட்டித்தல் மற்றும் நவீனப்படுத்துதல் திட்டத்தின் கீழ் புதுக்கோட்டை மாவட்டத்தில் கல்லணைக் கால்வாயின் பாசனப் பகுதிகளில் உள்ள நேரடி பாசன பகுதிகள் மற்றும் ஏரிகளும் புனரமைக்கப்பட உள்ளன.

இப்பணிகள் ஏற்படுத்தும் தாக்கங்கள் குறித்து விவசாயிகள் மற்றும் பொதுமக்களின் கருத்துக் கேட்புக் கூட்டம் அக்.14-ம் தேதி பிற்பகல் 2 மணிக்கு அறந்தாங்கி அருகே நாகுடி ஸ்ரீராம் திருமண மஹாலில் நடைபெற உள்ளது. இக்கூட்டத்தில், புதுக்கோட்டை மாவட்டத்தில் காவிரி தண்ணீரைக் கொண்டு பாசனம் செய்யும் விவசாயிகள் மற்றும் பொதுமக்கள் கலந்துகொள்ளலாம் என கல்லணைக் கால்வாய் பாசனப் பிரிவு உதவி பொறியாளர் செந்தில்குமார் தெரிவித்துள்ளார்.

Annexure 16: Community Level Project Stakeholder and public Consultations meeting report during implementation phase

Date & Time of Community Consultation Meetings	Package No	Location/ Venue of the Meetings	Stakeholders who Attended the Consultation Meetings	No. of Participants			Points raised by the community	Response of the Project
				Male	Female	Total		
05-03-2021 10.00 AM	Package-1	Thogur	Farmers , Village youth and Women Self Help Groups	23	38	61	• Farmers and public requested to explain the purpose of the project and requested steps and ramps for accessing the GA canal water. • Village youths asked about project benefits	• The project officials explained about benefits and project purpose to all farmers and people. Project official requested to use the water and asked not to pollute and stressed that it has to go to the last reach of the farm land. • This project will be beneficial to the farmers and community water will be reaching the field on time. • It was assured that the community needs will be met by the project.
13-06-2022 10.00 AM	Package-1	Indalur	Farmers , Village youth and Women Self Help Groups	18	45	63	● Farmers requested to strengthen the bund and asked for steps and ramps	● The project purpose and benefits was explained to all the farmers. ● It was sensitized that the water should not be polluted and this project will ensure to reach out to the unreached areas on time. ● It was also explained about the importance of water and how to maintain the cleanliness of water bodies.
08-05-2021 10.00 AM	Package-1	Kiliyur	Farmers , Village youth and Women Self Help Groups	18	45	63	● Farmers have requested cattle drinking water chamber. ● Farmers requested ramps for cattle. ● Farmers requested steps bathing purpose. ● Public requested road cleaning.	● It was sensitized that the water should not be polluted and this project will ensure to reach out the unreached areas on time. ● It was also explained about the importance of water and how to maintain the cleanliness of water bodies.

Date & Time of Community Consultation Meetings	Package No	Location/ Venue of the Meetings	Stakeholders who Attended the Consultation Meetings	No. of Participants			Points raised by the community	Response of the Project
				Male	Female	Total		
08-10-2022 10.00 AM	Package-1	Solagampatti	Farmers , Village youth and Women Self Help Groups	18	37	55	● Farmers have requested cattle drinking water tanks. ● Farmers requested ramps for cattle. ● Farmers requested steps bathing purpose. ● Requested the project period	● Project officials explained about the project purpose and benefits to all the farmers. ● The main aim of the project is to reach the entire areas of GAC farm land on time. ● The steps and ramps will be provided. ● It was explained that it is a 3 years project from 2022 to 2024
07-02-2021 10.00 AM	Package 2	Budalur	Farmers , Village youth and Women Self Help Groups	12	39	51	● Farmers requested by Steps bathing purpose ● Farmers requested by ramps cattle purpose ● Village youths raised doubts on project benefits and purpose	● Project officials gave a detailed explanation on project benefits, objects and uses. ● Further explained about conservation of water bodies and GA canal and its history. ● It was assured that the community needs will be fulfilled based on the funding. .
13-04-2022 10.00 AM	Package 2	Chitrakudi	Farmers , Village youth and Women Self Help Groups	17	37	54	● Farmers and community requested steps for bathing purpose ● Farmers requested ramps cattle purpose	● Explained about benefits, purpose of the project to all the community and farmers ● Further it was explained about the importance of water ways and cleanliness. ● Assurance was given to fulfill the community needs.
12-10-2022 10.00 AM	Package 2	Kangaeyanpatti	Farmers , Village youth and Women Self Help Groups	13	35	48	● Farmers requested steps for bathing purpose ● Farmers and community requested ramps for accessing water by the	● Project team explained about the project purpose and to all the farmers and stressed the importance of water ways and cleanliness. The main aim of the project is to ensure water reaches

Date & Time of Community Consultation Meetings	Package No	Location/ Venue of the Meetings	Stakeholders who Attended the Consultation Meetings	No. of Participants			Points raised by the community	Response of the Project
				Male	Female	Total		
							cattle	to all the fields quickly. ● It was assured that (5A channel) same will be provided by the project.
04-06-2021 10.00 AM	Package 3	Vannerapettai	Farmers , Village youth and Women Self Help Groups	20	40	60	● Farmers requested steps for bathing purpose ● Farmers requested ramps for the accessing water to the cattle ● Village youths asked about the projects benefits and purpose. ● Farmers and community requested to prevent the breaches and strengthen the bunds in GA canal	● The project officials explained about the purpose and benefits of the project. ● The project is to benefit all the farmers and objective is to provide the water to the last reaches; ensure water reaches faster and on time to the tail end users. ● It was assured that the steps and ramps will be provided. ● It was assured that (5A channel) same will be provided by the project.
07-10-2022 10.00 AM	Package 3	Rara Muthuraikottai	Farmers , Village youth and Women Self Help Groups	18	45	63	● Farmers requested steps and ramps and asked about the purpose of the project	● Officials explained about benefits and project's purpose. ● It was assured that the steps and ramps will be provided. ● It was explained about the importance of water and to maintain the water ways cleanly and asked the community to avoid pollution of the water. ● Further the officials briefed about the purpose of the project and explained that the canal is to be renovated and ensure that the water reaches the field on time and make sure that the canal water is fully utilized by all the farmers.

Date & Time of Community Consultation Meetings	Package No	Location/ Venue of the Meetings	Stakeholders who Attended the Consultation Meetings	No. of Participants			Points raised by the community	Response of the Project
				Male	Female	Total		
27.02.2021 11.00AM to 1.00PM	Package 4	Kandithampattu Village of Thanjavur District	Villagers, Ayacutdarars of GA Canal and Social Activists of the locality.	31	22	53	• Villagers requested to explain the scope of the project. • People of the area explained their need for the bridge to be constructed across GA Canal. • Civil Society Organizations requested steps and cattle ramps at necessary location. • Ayacutdarars of GA Canal explained the flaws in the Canal system and requested to fulfill their demands with the help of ERM project.	• The Project officials explained the scope and benefits of the project. • The project officials agreed to look into the demands raised by the farmers. • The officials explained the harmful effects of polluted water and requested public not to pollute water. • It was assured that the community needs will be met out with the help of the project.
05-03-2021 10.00 AM	Package-8	Sillathur, Vettikadu.	Farmers, Village youth and Women Self Help Groups	23	38	61	• Farmers and public requested to explain the purpose of the project and requested steps and ramps for accessing the GA canal water. • Village youths asked about projects benefits	• The project officials explained about benefits and project purpose to all farmers and people present. They requested the people to use the water and asked not to pollute the water. They stressed that water has to go to the last reaches of the farm land. • This project will be beneficial to the farmers and community water will be reaching the field on time. • It was assured that the community needs will be met out y the project

Date & Time of Community Consultation Meetings	Package No	Location/ Venue of the Meetings	Stakeholders who Attended the Consultation Meetings	No. of Participants			Points raised by the community	Response of the Project
				Male	Female	Total		
19.11.2022	Package-9,10	Athirampattinam	Villagers, Ayacutdarars of Rajamadam Branch Canal, civil society representatives of the locality.	112	48	160	• Villagers requested to explain the history of the Grand Anicut and canal project. • Farmer Veerasenan has requested to reconstruct the regulator across Rajamadam Branch canal in Pinnaiyur village of Orathanadu taluk, and he also requested to remove the Teak trees all along the Canal. • Farmer Aslam has requested to renovate the Rjamadam Branch No. 20 channel, As this channel fills around 10 number of Panchayat tanks in Adhirampattinam locality. These panchayat tanks are major source of drinking water for the people in and around Adhiramppattinam • Farmer Rajagopal has requested to rehabilitate the Narasingapuram channel, as tail end ayacut recieves less quantity of water for irrigation.	• The Superintending Engineer, Lower cauvery Basin Circle, Thanjavur has briefed about Cauvery River and history of Cauvery Mettur Project.Totally 694 tanks are in the GA canal fed areas and 574 tanks are in Tanjore District and 120 tanks are in Pudukottai Districts and all these tanks will be renovated. • The officials agreed that the teak trees will be removed in consultation with forest department and assured that the compensatory plantations will be done and also demands raised by the farmers will be fulfilled. • The Executive Engineer, Grand Anicut Canal Division, Thanjavur has assured to renovate the concerned Rajamadam channel and said that the quality of work will be ensured. Further, he requested the people to cooperate for successful completion of the project. • Member of Legeslative assembly Pattukkottai and project officials assured that the community needs will be met out with the help of the project. • It was assured that bunds will be strengthened and the tank will be restored. • Further, the Social and Environmental consultants explained the harm effects of polluted water and requested public not to pollute water. • Officials replied that the Rajamadam branch channel will be renovated and

Date & Time of Community Consultation Meetings	Package No	Location/ Venue of the Meetings	Stakeholders who Attended the Consultation Meetings	No. of Participants			Points raised by the community	Response of the Project
				Male	Female	Total		
							• Farmer Jamal Mohammed has requested to restore Sellikurichi tank to its full capacity by desilting the tank, as this tank has played an important role when they had faced drought season in 2013 • Farmer ramesh has requested to renovate Rajamadam Branch No.21 channel as this is the tailend channel of Rajamadam Branch canal and it feeds around 5 tanks in their locality • Eripurakkarai panchayat President Suresh has assured that all panchayat presidents will cooperate with Department Officials while implementing the project. • Civil Society representatives requested for the provision of cremation sheds, steps and cattle ramps at necessary location. • All other Ayacutdarars of Rajamadam Branch Canal are explained the flaws in the Canal	all the farmers at the tail end will get sufficient water. • The SE further requested all the farmers and general public to use natural fertilizers and go for organic farming practices to protect the health of humans and animals and it is the duty of every citizen to give back the good quality water bodies to our children as we enjoyed. • Officials assured that the social and community structures will be protected and that ramps and steps will be provided. • The officials assured that there will be scientific ways to measure and check quality of the work and maximum precautions will be put to ensure quality. • The project officials assured that all the sub channels and tanks will be properly renovated and scientifically measured their capacity to retain water and no such issue will arise in future and last reach farmers will get sufficient water for irrigation. • Officials replied that the check dams are proposed in the project and it will be constructed • The officials replied that the waste water from the cities will be treated through proper treatment plants in convergence with corporations and townpanchayat departments and after treating only, it will be allowed in to

Date & Time of Community Consultation Meetings	Package No	Location/ Venue of the Meetings	Stakeholders who Attended the Consultation Meetings	No. of Participants			Points raised by the community	Response of the Project
				Male	Female	Total		
							system and requested to fulfill their demands with the help of ERM project. • The Ayacutdarars of Rajamadam Branch Canal are explained the drought in 2015 and the water scarcity was there in the area and there was a big problem among the farmers of last reach areas and it was due to lack of desilting of the tanks and seasonal rainfall failures. Hence requested to renovate and desilt the tanks and channels. • Farmers requested to construct check dams one per every two kmts in Pamani Aru, Agni Aru • The farmers requested to prevent waste water from city locations getting in to the channel and tanks • The farmers requested to ensure the actual quantity to be ensured as per the earlier original design of the GA canal to ensure the reach of	the canal and tanks. The local presidents should support in preventing water pollution which will affect the health of animals, human and environment. The SE concluded that it is a joint venture in conservation of nature and everyone should start using cotton cloth bags and avoid plastic carry bags. • The project officials replied that the original designed capacity was 4200 cubic feet and it will be restored back by this ERM GACS project.

Date & Time of Community Consultation Meetings	Package No	Location/ Venue of the Meetings	Stakeholders who Attended the Consultation Meetings	No. of Participants			Points raised by the community	Response of the Project
				Male	Female	Total		
							water to the tail ends.	
19/11/2022	Package-5,6,7	Alathur	Villagers, Ayacutdarars of V.B Canal and Social Activists of the locality.	77	7	84	• Villagers requested to explain the scope of the project . • Civil Society representatives requested for the provision of cremation sheds, steps and cattle ramps at necessary locations. • Ayacutdarars of V.B Canal requested for the provision of shutters arrangements for all Sluices • Villagers requested to do tree plantation in V.B Canal • Ayacutdarars of V.B Canal requested to do rehabilitation of Musiri Channel drops. • Ayacutdarars of V.B Canal requested to do rehabilitation of Moothakurichi Channel Drops. • Ayacutdarars of V.B Canal requested to construct of grade wall in front of V.B No.6 channel head sluice.	• The SE explained about the history and of engineer W.M. Ellis who forrmed the GA canal which is 85 year old and his great work.He further explained about the scope of the project and importance of conservation of water and water ways. • He also stressed that the people should not use plastics and throw in to the River which will harm the water resources. • He insisted to plant more palm trees on the River bank. • The Project officials explained the scope and benefits of the project. • The Officials promised for the fulfillment of demand raised by the farmers and public.. • The Officials explained the harm effects of polluted water and requested public not to pollute water. • It was assured that the community needs will be met out with the help of the project. • Project officials replied that the existing forest cover will be protected and conserve the natural resources. In addition to this, requested the local panchayat presidents to ensure convergence of MGNREGA work for creating fencing and planting more

Date & Time of Community Consultation Meetings	Package No	Location/ Venue of the Meetings	Stakeholders who Attended the Consultation Meetings	No. of Participants			Points raised by the community	Response of the Project
				Male	Female	Total		
							• Villagers requested to construct a foot bridge across V.B canal and steps and cattle ramps at necessary locations. in Nattusalai Village • Villagers requested to construct a bridge across Pattuvanachi drain in Alathur Village • Villagers requested to strengthen the bund in VB Canal. • Ayacutdarars of KB Channel requested to decrease the existing sill level of Karuperi Tank supply channel sluice. • Local panchayat presidents from alathur, pulavankadu and mathukkur requested the department to pay more attention on renovating the tanks and repair the sluices for correct water distribution and regulations. • Ayacutdarars of KB Channel requested to renovate the Ammaiyandi Tank. • Ayacutdarars of V.B Canal explained the flaws of previous tank	trees on canal bund areas. • The department officials replied that all the tanks and sub-channels will be properly renovated and sluices will be repaired. • Project officials further added that the concrete threshing floors will be constructed for the benefit of the farmers on the selected locations as per the needs.

Date & Time of Community Consultation Meetings	Package No	Location/ Venue of the Meetings	Stakeholders who Attended the Consultation Meetings	No. of Participants			Points raised by the community	Response of the Project
				Male	Female	Total		
							works and requested to fulfill their demands with the help of ERM project. • Ayacuttudarars requested to protect the forest and conserve natural resources	
02.02.2023 11.00 AM to 3.00 PM	Package-7	Alathur Village of Thanjavur District	Villagers, Ayacutdarars of V.B Canal and Social Activists of the locality.	144	5	149	• Villagers requested to explain the scope of the project • MLA Requested to Construct Bridge Across No.3 Channel.in Veppankulam Village • MLA requested for the rehabilitaion of GA Canal and its branches. • Civil Society representatives requested for the provision of cremation sheds, steps and cattle ramps at necessary location. • Ayacutdarars of V.B Canal requested for construction of bridge, strengthening the Bank and Bed Lining Works in VB.No.5 Channel • Ayacutdarars of V.B Canal requested during the irrigation season	• The Project officials explained the scope and benefits of the project. • The officials explained the harmful effects of polluted water and requested public not to pollute water. • It was assured that the community needs will be met out with the help of the project. • MLA Requested for construction of bridge across Channel in Veppankulam was accepted • Provision of cremation sheds, steps and cattle ramps at necessary location was accepted by the offcials • construction of bridge, strengthening the Bank and Bed Lining Works in VB.No.5 Channel was accepted by the offcials • The officials explained the implementation of SCADA in the project againt their request for Irrigation Assistants. • The project officials agreed to look into the demands raised by the farmers. • Villagers requested for Tree Replantation in VB Canal was

Date & Time of Community Consultation Meetings	Package No	Location/ Venue of the Meetings	Stakeholders who Attended the Consultation Meetings	No. of Participants			Points raised by the community	Response of the Project
				Male	Female	Total		
							there are no Irrigation Assistants. Therefore, Irrigation Assistants should be appointed to rectify the deficiencies. • Villagers requested for Tree Replantation in VB Canal • Ayacutdarars of V.B Canal requested for Rehabilitation of Palakka Eri, Periya Eri, Ammaiyandi Eri. • Ayacutdarars of K.B Canal requested forRehabilitation of Maravakadu Channel No.1 &2, Kallangadu Channel, Pathankadu Channel, Sendankadu Channel, V.B No.10 and 11 Channel. • Ayacutdarars requested that water should be available throught the year in GA Canal. • Ayacutdarars of V.B Canal requested to increase the existing Creast Level of Vadacheri Tank • Ayacutdarars of V.B Canal requested to construct inlet in Pappaveli Palayakkottai	accepted and the details of afforestation program in the project was explained • Officials informed that various tanks as requested by the villagers will be taken up in this project of other schemes of GoTN for rehabilitation. • Officials informed that all the major channels of GA canal wil be taken up either in Phase 1 or Phase 2 • Officals informed that various check dams are proposed for rehabilitation / construction based on the required and technical studies. • Officails informed that all measures are being taken in the project to supply water for irrigation needs during crop seasons. • Officails explained that the flaws in the Canal system will be retified and all reuirements w.r.t water requirement will be fulfilled with the help of ERM project

Date & Time of Community Consultation Meetings	Package No	Location/ Venue of the Meetings	Stakeholders who Attended the Consultation Meetings	No. of Participants			Points raised by the community	Response of the Project
				Male	Female	Total		
							Eri • Ayacutdarars of V.B Canal requested to Construct Checkdam across all drains. • Ayacutdarars of V.B Canal explained the flaws in the Canal system and requested to fulfill their demands with the help of ERM project.	

Annexure 17: Gender Action Plan

Gender indicators in Tamil Nadu

Tamil Nadu's performance in terms of indicators on gender has been consistently better than that of other states. The sex ratio in the state is 908 females per 1000 males (https://iwwage.org/wp-content/uploads/2021/03/TN-Factsheet.pdf). The General Fertility Rate, defined as the number of live births per thousand women in the reproductive age group 15-49 years, is low at 51.2, as opposed to the national figure of 70.4.8 Maternal mortality ratio is also low at 66 (all India 130) as per Tamil Nadu State New Policy for Women 2021 (Draft) Department of Social Welfare and Women Empowerment. Tamil Nadu has the third lowest crime rate against women. Some of the gender indicators of the State are:

• Women's contribution in the paid economy is significant – female labor force participation rate (FLFPR) in the state is higher than the average recorded for India. The rural FLFPR for Tamil Nadu is 35.1%, which is 15.4% higher than the national figure. Urban FLFPR in TN is 23.6% that is 7.5% higher than all of India average. Though, women's effective participation in the workforce and their transition to formal employment opportunities continues to remain a challenge. Some indicators show very low reporting of crimes against women.

• Rate of Crimes against women per every 100000 female populations was 14.6 in 2019-20
• Conviction rate of crime against women was 18.3 in 2019-20

• Per Lakh women that have been subjected to dowry offences during the year 2019-20 is 4.3
• Conviction rate of women subject to dowry related offences is 7.7.

Government of Tamil Nadu's Policy for Women

The Government Tamil has a New Policy for Women 2021(draft), prepared by the Department of Social Welfare and Women Empowerment. This Policy aims to cover the entire women population of Tamil Nadu, however special focus shall be on:

a. Women-headed households (single women, widows, and deserted women);
b. Women from oppressed communities; (Scheduled Caste/Scheduled Tribe);
c. Women engaged in vulnerable occupations (sex work, rag picking, conservancy work, street vending, head-load vendors, and begging)
d. Women in bondage (rice mills, brick kilns, etc)
e. Women with disabilities
f. Elderly women
g. Women in informal sector of work (domestic workers, construction workers, daily wage works, salt-pan workers, agricultural labourers, casual labourers from different sectors among others) and
h. Women at workplace (formal sector)

The Tamil Nadu Government in 2021, has increased reservation for women in Government jobs from 30 percent to 40 percent.
Given the initiative of the Government of Tamil Nadu's Gender policy for the State and increase reservation for women, the project can aim to achieve some of the indicators

identified for the project which will help achieve the States vision ***to provide all women with access to all services and entitlements in an equitable manner, reduce discrimination and eliminate all forms of violence against women and provide them with equal opportunities for realizing their potential and aspirations*.**

The Gender Action activities, target/indicators, responsible organisation and timelines within the context of the project has been given in the Gender Action Plan below. The gender inclusion in design, consultations, grievance redress, employment opportunities at the site and within the Implementing Agency in the present ERM works of GA canal are some of the indictors identified.

Activities	Indicators/Targets	Responsibility	Time
Hire women for construction work and ensure fair wages.	(i) Campaign to attract local women to work as labourers at construction sites;	PIU, Contractors (Monitored by the PMC and PMU)	Agreed project reporting period
	(ii) Encouraging contractors to employ Women labourers to the extent possible.	PIU, Contractors (Monitored by the PMC and PMU)	Agreed project reporting period.
	(iii) Encouraging contractors to employ Women labourers in Maintenance	PIU, Contractors (Monitored by the PMC and PMU)	Agreed project reporting period
Ensure community's participation in Project implementation	(i) Consultation with the community members (including women)	PIU, Contractor (Monitored by the PMC and PMU)	During the Construction Phase
Ensure participation of women in afforestation and environmental awareness programs	(i) Consultations conducted with communities with participation of women in finalising modalities of the afforestation program	PIU, Contractor (Monitored by the PMC and PMU)	During the Construction Phase
	(ii) Participation of women in afforestation programs	PIU, Contractor (Monitored by the PMC and PMU)	During the Construction Phase
Orient contractors and Community on core labour standards and Gender Awareness and ensure women's participation in awareness programs	(i) Workshops on core labour standards, Gender Awareness, equal wages for work of equal value and the need to prioritize employment of women, including women from poor and female headed households	PIU, Contractor (Monitored by the PMC and PMU)	During the Construction Phase
	(ii) Participate (including women labourers) in awareness programs for labourers on HIV, COVID, STIs, trafficking etc.	PIU, Contractor (Monitored by the PMC and PMU)	During the Construction Phase

Activities	Indicators/Targets	Responsibility	Time
Develop capacities of staff in Gender responsive planning and management	(i) Training for all staff, including women staff, of EA, IA, consulting firm, NGOs	PIU, Contractor (Monitored by the PMC and PMU)	During the Construction Phase
Inclusion of women in the implementing agency	The Government of Tamil Nadu has increased women's reservation in Government jobs from 30% to 40 % in September 2021. The client shall strive towards increasing the women's strength in the project implementation.	PIU (Monitored by the PMC and PMU)	During the Construction Phase
Addressing gender concerns / issues	Gender sensitive, inclusive and accessible consultations should be done throughout the project period	PIU (Monitored by the PMC and PMU)	During the Construction Phase

Women's Helpline:

The Government of Tamil Nadu's women's Helpline No. 181 needs to be prominently displayed in the project site. This helpline is exclusively designed to support women in distress facing violence or threat of violence, both in private and public places, including in the family, community, workplace, etc. 181 Women Helpline (WHL) is a 24-hour confidential service for women and child survivors and victims of any form of violence including domestic & intimate partner. The multi-channel helpline is available through dialling 181, email and through online chatting. All calls are free and confidential.

The Helpline offers a range of options and information on common forms of violence against women like domestic violence, types of abuse, laws related to violence against women and government schemes for women and children.

State policy for registering complaints:

The State policy for women mentions ways to address specific complaints by women. It is proposed that the project can adopt these specific options:

I. Provide safe and women friendly public spaces and work spaces including Government Departments with a functional Internal Complaints Committee and Local Complaints Committee with regular third party gender safety audit.

II. Ensure filing of FIRs and reporting within 24 hours of the crime incident coming to light.

III. Establish a system of Victim support to all cases of abuse that focuses on rehabilitation and identity protection at the first instance without delay to ensure that women do not feel abandoned.

Gender-based Violence

The project will take measures to address any form of GBV and harassment, bullying, intimidation, and/or exploitation under the Project. When such cases are reported the will provide the following

i. Provide for full confidentiality of the of aggrieved person
ii. Ensure use of language familiar to the aggrieved person
iii. Ensure sensitivity and transparency in resolving the complaint
iv. Provide culturally appropriate channels for reporting incidents. It is proposed that Executive Engineer, PIU, shall be incharge of being the focal point of contact for addressing GBV and
v. Provide support to GBV survivors as necessary.

Budget and Implementation

PMU will engage a Social Specialist who will also take the responsibilities of Gender Specialist to support and guide the project in the implementation of the gender action plan. The remuneration for the Social Specialist and the cost of implementation of the GAP will be funded by the project. The PMU will be overall responsible for the implementation of the GAP supported by PIU supported will implement the GAP and submit quarterly progress to the Bank.

Budget Estimate

Item No	Item	Input Unit	Rate (INR)	Quantity	Amount
1.	Remuneration for the Gender Specialist				Included under Man power section in Table 54 in the Budget for ESMP
2.	Cost of campaign to encourage local women to participate in project labour and afforestation activities (distribution of pamphlets, village level FGDs, etc)	LS			200,000
3.	Workshop for contractors on core labour standards, GBV	Number of Workshops	1,00,000	3	3,00,000
4.	Awareness programs for labourers on GBV, HIV, COVID, STIs, trafficking etc.	Number of Awareness Camps	1,00,000	6	6,00,000
5.	Training for women construction workers	Number of Trainings	1,00,000	6	6,00,000
6.	Training on Gender for all staff, including women staff, of PMU PIU, consulting firm, NGOs	Number of Trainings	1,00,000	3	3,00,000
	Sub total				**20,00,000**
7.	Contingency @ 10%				2,00,000
	Total (In Rupees)				**22,00,000**
	Total in Lakh (In Rupees)				**22.00**

Monitoring and Evaluation

The indicators will be monitored quarterly by the PMC, PIU with the support of the Social Specialist to ensure that the GAP is smoothly implemented. The Social Specialist will visit the project area once every quarter and support and guide the PIU in implementing the GAP. The PIU with the support of the Social Specialist will undertake an evaluation of the implementation of GAP, at the end of the 3-year period and submit the evaluation report to the Bank.

Annexure 18: Entitlement Matrix[2]

Impact type	Entitled entity	Entitlement
1. Loss of Land		
Loss of Land (agricultural, homestead, commercial or otherwise)	Titleholder	i. Compensation at replacement cost as specified in the RFCTLARR Act, 2013 and Rules notified by GoTN ; ii. If the residual plot(s) is (are) not viable, either of the following two options are to be given to the affected family, subject to acceptance: Option 1- The affected person retains the residual plot, and the compensation and assistance are paid only for the required amount of land to be acquired; or Option 2- Compensation to be provided for the entire plot including residual part, if the owner of such land wishes that the residual plot should also be acquired by the executing agency; iii. A one time subsistence allowance of Rs.50,000 per family be provided to families requiring relocation; iv. One-time payment of cash in lieu of annuity INR 500,000 to any affected family whose livelihood is primarily dependant (loses one-third of the annual family income due to the acquisition of the said agricultural land) on the income from the acquired agricultural land ; v. All affected families will receive compensation for: (i) damage to land/ quality of land (if any) sustained by reason of severing land proposed for acquisition or adjoining lands from/to affected land; at the time of taking possession of the land; (ii) diminution of the profits of the land between the time of the publication of the declaration for taking possession of land and the time of the collector's taking actual possession of the land; and (iii) expenses incidental to such change if the affected landowner is compelled to change his place of residence or business due to the proposed land acquisition; vi. One time Transportation allowance of Rs. 50,000 per family will be provided to families relocating; vii. All fees, stamp duties, taxes and other charges, as applicable under the relevant laws, incurred in the relocation and rehabilitation process, are to be borne by the Implementing Agency. OR

[2] All rates will be updated as applicable

Impact type	Entitled entity	Entitlement
		viii. The title holders of land and structures have an option for private negotiation with WRD, in which the land will be acquired through Private Negotiation upon payment of Compensation upto 25 % of the market/guideline value of land.
2. Loss of Structures		
i. Loss of Residential Structures	Titleholder	i. Compensation of structure will be paid at the replacement cost to be calculated as per latest prevailing Basic Schedule of Rates (BSR) without depreciation. OR ii. An alternative house as per IAY specifications in rural areas and a constructed house/flat of minimum 50 sq.m. in urban areas or cash in lieu of house if opted (the cash in lieu of house will be Rs.1,70,000 in line with GoI IAY standards in rural areas and Rs.2,10,000 in case of urban areas), for those who do not have any homestead land and who have to relocate. iii. Where the loss of structure is partial and the remaining structure is unviable, compensation will be based on the total structure and benefits will be given as mentioned in this section; iv. One time Subsistence Grant of INR 50,000/- for families who have to relocate v. One time Transportation assistance of INR 50,000/- for shifting vi. One time resettlement allowance of INR 50,000/- in case of relocation vii. Residential structure owners, who are deriving rental income from the affected structure in the land acquired and whose livelihood is lost due to acquisition of land will be entitled for Rs.5,00,000 as onetime payment in lieu of annuity policy viii. Right to salvage material from demolished structure and frontage etc. excluding asbestos. ix. All fees, taxes and other registration charges incurred for the replacement structure shall be borne by the executing agency, as applicable
ii. Loss of commercial structures	Titleholder	i. Compensation of structure will be paid at the replacement cost to be calculated as per latest prevailing Basic Schedule of Rates (BSR) without depreciation. ii. Where the loss of structure is partial and the remaining structure is unviable, compensation will be based on the total structure and benefits will be given as mentioned in this section; iii. One time grant of Rs.25,000 for loss of trade/self-employment for the business owner. iv. Commercial structure owners, who are deriving business income and/or rental income from the affected structure in the land acquired and whose livelihood is lost due to the acquisition, will be

Impact type	Entitled entity	Entitlement
		entitled for Rs.5,00,000 as onetime payment in lieu of annuity policy ((i) Any affected family, whose livelihood is primarily dependent (loses one-third of the annual family income due to the loss of the business operation carried out from the acquired commercial structure) on the business income derived from the acquired commercial structure will be treated as livelihood loss and (ii) any affected family whose livelihood is primarily dependent (loses one-third of the annual family income due to the loss of the acquired commercial structure) on the rental income derived from the acquired commercial structure will be treated as livelihood loss.) v. One time Subsistence Grant of INR 50,000/- for families who have to relocate vi. One time Transportation assistance of INR 50,000/- for shifting vii. One time resettlement allowance of INR 50,000/- in case of relocation viii. Right to salvage material from demolished structure and frontage etc. excluding asbestos. ix. All fees, taxes and other registration charges incurred for the replacement structure shall be borne by the executing agency, as applicable
iii. All other assets such as bore-wells, cattle shed etc.	Titleholders	i. The replacement value of the asset/structure, calculated as per the latest prevailing schedule of rates without depreciation; ii. Right to salvage material from demolished asset/structure, except asbestos; iii. For the loss of cattle shed, a one-time assistance payment of INR 25,000 to be provided. iv. The notice period of 3 months to be given.
3. Tenants		
	Tenants residential	i. Rental assistance of INR 30,000/- towards temporary accommodation or Rental assistance as per the prevalent rate in the form of grant to cover maximum six month rentals, whichever is higher ii. One-time financial assistance of INR 50,000 as transportation cost for shifting; iii. Right to salvage material from a demolished structure, erected by tenants. iv. Any advance deposited by the tenants will be refunded from owners total compensation package to the tenant on submission of documentary evidence. v. The notice period of 3 months to be given
	Tenants Commercial	i. Rental assistance of INR 30,000/- towards temporary accommodation or Rental assistance as per the prevalent rate in the form of grant to cover maximum six month rentals, whichever is higher ii. One-time financial assistance of INR 50,000 as transportation cost for shifting; iii. A one-time allowance of INR 50,000 for loss of livelihood

Impact type	Entitled entity	Entitlement
		iv. Right to salvage material from a demolished structure, erected by tenants. v. Any advance deposited by the tenants will be refunded from owners total compensation package to the tenant on submission of documentary evidence. vi. The notice period of 3 months to be given
	Agricultural tenants	i. 3 months advance notice to harvest crops or ii. compensation for lost crop at market value of the yield determined by the Agricultural Department iii. One-time financial assistance of INR 50,000 as transportation cost for shifting;
4. Non-title holders		
Loss of structures	Residential	i. Compensation for loss of structures at replacement cost. House construction grant of Rs.70,000 for all those who have to relocate. ii. Additional house site grant of Rs.50,000 to those who do not have a house site, iii. Subsistence Grant of INR 50,000/- iv. Transport/ Shifting assistance of INR 20,000/-. v. Right to salvage material from a demolished structure. vi. The notice period of 60 days to be given
	Commercial	i. Compensation for loss of structures at replacement cost. ii. One time assistance of INR 50,000/- for those losing livelihood. iii. Subsistence Grant of INR 50,000/- iv. Transport/ Shifting assistance of INR 20,000/-. v. Right to salvage material from a demolished structure. vi. The notice period of 60 days to be given
	Encroachers	**Structure**: i. Compensation for loss of structures at replacement cost ii. Right to salvage material iii. Notice period of 60 days to be given **Agriculture** i. For agricultural encroachers 2-month notice to harvest standing crops or market value of compensation for standing crops, if notice is not given.
	Impact on Kiosks	i. One time rehabilitation grant of Rs.20,000 for severe affected kiosks

Impact type	Entitled entity	Entitlement
5. Loss of trees and Crops		
Loss of Crops and Trees	Titleholders/ Share Croppers/Non-title holders	i. Displaced persons will be notified and given 60 days' advance notice to remove trees. For seasonal crops and fruit trees six months' notice is to be given; ii. Compensation for cash crops at prevalent market rates[3], to be calculated as annual net product value multiplied by the number of productive years remaining; iii. Compensation for one years' net harvest for seasonal crops at prevalent market rates; iv. Compensation at the market value of timber in case of timber-bearing trees; v. For fruit-bearing trees compensation to be calculated at the market value of the annual net product multiplied by the number of productive years remaining[4]
6. Loss of livelihood		
Loss of Primary Source of Income / Livelihood	Agricultural Labourers/ Share Croppers / wage employees	i. Subsistence allowance equivalent to minimum agricultural wages for 3 months ii. Employment opportunity for PAPS in the sub-project construction work, if available and if so desired by them. iii. National/State level job card under National Rural Employment Guarantee Program
7. Common Property Resources		
Loss of Common Property Resources	Community	i. Replacement or restoration of the affected community facilities – including public water stand posts, public utility posts, temples, shrines, such as places of worship, community buildings, schools, etc. in consultation with the community.
8. Support to Vulnerable groups/persons		
Further assistance to all vulnerable persons	Households categorized as vulnerable.[5]	i. A onetime assistance of INR 50,000/- over and above other entitlements. ii. Displaced vulnerable families will be linked to the government welfare schemes, if found eligible and not having availed the scheme benefit till date.
9. Temporary Impacts		

[3]Valued by an experienced person in the field of agriculture.

[4]To be valued by persons experienced in the field of agriculture, horticulture forestry etc. as necessary.

[5] Vulnerable are those households that are BPL, headed by the elderly - above 60 years of age, female headed households, households headed by persons with disabilities persons, non-titled households, landless households Scheduled Tribes and Scheduled Castes.

Impact type	Entitled entity	Entitlement
Damages to assets (such as structure / assets / tree / crops) during construction Use of private land		i. The contractor is liable to pay damages to assets/ trees/ crops in private/public land, caused due to civil works ii. The contractor should obtain prior written consent from the landowner and pay mutually agreed rental for use of private land for storage of material or movement of vehicles and machinery or diversion of traffic during civil works.
10. Other Unforeseen/ Unanticipated Impacts		
Any unanticipated impacts due to project intervention		i. Any unforeseen/ unanticipated impacts due to the sub-projects will be documented and mitigated based on the spirit of the principle agreed upon in this framework.

Annexure 19: Grievance Registration Form

(To be available in Tamil and English)

The Proposed Extension, Renovation and Modernization works of Grand Anicut Canal System project welcomes complaints, suggestions, queries, and comments regarding program implementation. We encourage persons with a grievance to provide their name and contact information to enable us to get in touch with you for clarification and feedback.

In case you want to include your personal details but want information to remain confidential, please type CONFIDENTIAL above your name.

Date		**Place of Registration**	
Contact Information/Personal Details			
Name:		**Gender:** Male / Female	**Age:**
Home Address			
Village/Town			
District			
Phone no.			
E-mail			
Complaint/Suggestion/Comment/Question Please provide the details (who, what, where and how) of your Grievance below: If included as an attachment/note/letter, please mention here:			
How do you want us to reach you for feedback on your comment/grievance?			
FOR OFFICIAL USE ONLY			
Registered by: (Name of Official registering grievance) **Date:**			
Verified through: **Date:**	Note/Letter	E-mail	Verbal/Telephonic
Reviewed by: (Names/Position of Official(s)reviewing grievance)			
Action Taken:			
Whether Action Taken Disclosed:	Yes	No	

Annexure 20: RoW details of the Project