Initial Environmental Examination

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IND: Tamil Nadu Urban Flagship Investment Program (Tranche 2) – Dedicated Water Supply Scheme for Madurai Municipal Corporation from Mullai Periyar River at Lower Camp PART A

Prepared by Madurai Municipal Corporation for the Asian Development Bank.

CURRENCY EQUIVALENTS

(as of 4 July 2019)

Currency Unit	–	Indian rupee (₹)
₹1.00	=	$0.0145
$1.00	=	₹68.7685

ABBREVIATIONS

ADB	-	Asian Development Bank
CPHEEO	-	Central Public Health and Environment Engineering Organization
CMSC	-	construction management and supervision consultant
CPCB	-	Central Pollution Control Board
CTE	-	consent to establishment
CTO	-	consent to operation
CWSS	-	combined water supply scheme
EAC	-	expert appraisal committee
EHS	-	environmental Health and Safety
EIA	-	Environmental Impact Assessment
EMP	-	environmental management plan
ESS	-	Environmental and Social Safeguards
GOTN	-	Government of Tamil Nadu
IEE	-	initial environmental examination
MOEFCC	-	Ministry of Environment, Forest and Climate Change
NOC	-	no objection certificate
OHT	-	over head tank
PIU	-	program implementation unit
PMU	-	program management unit
PPTA	-	project preparatory technical assistance
REA	-	rapid environmental assessment checklist
ROW	-	right-of-way
SEIAA	-	State Environmental Impact Assessment Authority
SPS	-	Safeguard Policy Statement, 2009
TNPCB	-	Tamil Nadu Pollution Control Board
TNUFIP	-	Tamil Nadu Urban Flagship Investment Program
TNUIFSL	-	Tamil Nadu Urban Infrastructure Financial Services Limited
UGT	-	underground tank
WHO	-	World Health Organization
WTP	-	water treatment plant
WDS	-	water distribution station

WEIGHTS AND MEASURES

°C	-	Degree Celsius
Km	-	kilometer
lpcd	-	litres per capita per day
m	-	meter
MCFT	-	million cubic feet
Mgd	-	million gallons per day
MLD	-	million litres per day
mm	-	millimeter
nos	-	numbers
km^2	-	square kilometer

NOTE

In this report, "$" refers to United States dollars.

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EXECUTIVE SUMMARY

The program will develop priority water supply, sewerage, and drainage infrastructure in at least 10 cities in strategic industrial corridors in Tamil Nadu. The Municipal Administration and Water Supply Department (MAWS), acting through Tamil Nadu Urban Infrastructure Financial Services Limited (TNUIFSL), is the executing agency. Urban local bodies are the implementing agencies for the subprojects.

Components. The Tamil Nadu Urban Flagship investment Program (TNUFIP) is structured under three main components: (i) investment in municipal infrastructure namely water supply and sewerage, (ii) municipal reform-based activities, and (iii) technical assistance for design, supervision, program management, reforms, and climate change.

The Subproject. Dedicated water supply scheme for Madurai Municipal Corporation (MMC) from the Mullai Periyar River at Lower Camp, as source of water is proposed to fulfill the water supply demand for the intermediate stage 2034 (for a population of 1,923,936) by tapping 1,630 million cubic feet (MCFT) (125 million liters per day [MLD]). Already MMC is tapping 1,500 MCFT (115 MLD) from Vaigai dam, 30 MLD from River Cauvery source under Melur combined water supply scheme and 47 MLD from Vaigai river bed. The total water supply demand gap for MMC (100 wards) in 2034 is estimated to be 125 MLD. There is no nearby reliable source of water to fulfill the total water supply demand gap of 125 MLD. Hence, this subproject is proposed to be implemented under the TNUFIP (Tranche 2) to meet the water demand. The subproject includes the construction of check dam, intake arrangements and laying of 1,118 mm and 1,067 mm mild steel raw water pumping main to the proposed water treatment plant at Pannaipatty and feeder main and distribution system.

The raw water (125 MLD) will be collected from the proposed check dam across Mullai Periyar River at Lower Camp in the immediate downstream of 18th canal scheme by providing necessary intake arrangements. The water from the intake well is conveyed through proposed 1,118 mm and 1,067 mm mild steel raw water pumping main to the proposed water treatment plant (WTP) at Pannaipatti. The 130 MLD raw water treatment plant is proposed at Pannaipatti within the site where the existing water treatment plant is located. After treatment, 125 MLD of clear water will be conveyed through clear water gravity transmission main and onwards to the proposed Overhead tanks (OHTs) through a network of feeder mains.

Project implementation arrangements. The MAWS of Government of Tamil Nadu acting through TNUIFSL is the state-level executing agency. A program management unit (PMU) will be established in TNUIFSL headed by a Project Director and Deputy Project Director (senior official from Commissionerate of Municipal Administration [CMA]), and a dedicated full-time staff from TNUIFSL for overall project and financial management. The MMC is the implementing agency for this subproject. A program implementation unit (PIU) will be established in MMC for day-to-day implementation of the subproject. The PIU will be assisted by construction management and supervision consultant (CMSC). Environmental and social safeguards (ESS) Managers in PMU/TNUIFSL will have overall responsibility of safeguard compliance with respect to environmental management plan (EMP) and environmental assessment review framework (EARF). Environmental Specialist of the CMSC will assist PIU in implementation of subproject in compliance with EMP and EARF and will carry out all necessary tasks.

Screening and assessment of potential impacts. ADB requires the consideration of environmental issues in all aspects of the bank's operations, and the requirements for environmental assessment are described in ADB's Safeguard Policy Statement (SPS), 2009. As

per the Government of India environmental impact assessment (EIA) Notification, 2006, this subproject do not require EIA study or environmental clearance. The potential environmental impacts of the subproject have been assessed using ADB rapid environmental assessment (REA) checklist (Appendix 1) for water supply. The potential negative impacts were identified in relation to pre-construction, construction and operation phases.

Categorization. Based on results of the assessment the subproject is classified as Environmental category "B", Subproject potential adverse environmental impacts are less adverse than those of category A, and are site-specific, and in most cases mitigation measures can be designed more readily than for category A projects. As per the ADB SPS, 2009, preparation of initial environmental examination (IEE) is mandatory for category "B" projects and accordingly this IEE has been prepared.

Description of the Environment. Madurai City is located in the south-central Tamil Nadu (470 km from Chennai) and it is the third largest city in Tamil Nadu. Geographically Madurai City is located at 9˚55' North and 78˚07' East Longitude and 330 feet above sea level on the banks of River Vaigai. The city has an area of 51.80 km^2. Madurai City experiences soaring heat in the month of May rangingabout 38.2˚C and a minimum temperature of about 21.0˚C in the month of December. The city receives the highest rainfall in the month of October and the lowest in January. The northeast monsoon brings a fair amount of rainfall with a maximum of 254.4 mm in October. The major portion of the city soil is red and black. The adjoining area of the city has vandal soil. The city is completely free of forest areas; there are no eco-sensitive areas located within or near the city. On the outskirts of the city, agriculture is followed predominantly. The crops cultivated includes fruits crops like mango, banana and aonla, vegetables like bhendi, gourds, tomato, brinjal, onion and chillies, plantation crops like cashew and betel vine, and flower crops like jasmine and tuberose. As per Census 2011, the population in Madurai City are 1,846,801; of which male and female are 925,228 and 921,573 respectively. Total literates in Madurai City are 1,485,340 of which 777,351 are males while 707,989 are females. Average literacy rate of Madurai City is 90.91%. The sex ratio of Madurai City is 999 per 1,000 males. The city is well connected by the National Highways NH 7, NH 45B, NH 208 and NH 49. Madurai Junction is the major railway station serving the city, there are direct trains connecting major cities and towns across India. Madurai Airport located at Avaniyapuram offers domestic flight services to key cities in India and international services to Middle East and south Asian countries.

Potential environmental impacts and mitigation measures. The subproject is unlikely to cause significant impacts that are irreversible, diverse or unprecedented because: (i) the components will involve straightforward construction and operation, so impacts will be mainly localized; (ii) there are no significant sensitive environmental features in the project sites although careful attention needs to be paid to minimizing disruption to local population; and (iii) predicted impacts are site-specific and likely to be associated with the construction process.

Potential impacts that might arise during construction shall be considered as significant but temporary. These impacts of construction are common in urban areas, and there are well-developed methods to mitigate the same. Except laying of conveying main and distribution main, all other construction activities like headwork's, clear water main and water treatment plant will be confined to the selected sites, and the interference with the general public and community around is minimal. In these works, the temporary negative impacts arise mainly from construction dust and noise, hauling of construction material, waste and equipment on local roads (traffic, dust, safety, etc.), occupational health and safety aspects. Laying of pipeline will be conducted along the edge of road. Therefore, water pipe laying works will have impacts on the movement of the traffic; safety risk to workers and impediment to public restricting their access, disposal of

construction waste, etc. These are all general impacts of construction and there are well-developed methods of mitigation that are suggested in the EMP.

Source Sustainability. Presently, there are 58 combined and dedicated water supply schemes existing in Mullaperiyar River and Vaigai River between Mullaperiyar dam (source) and Vaigai dam (downstream). Total required quantity for 58 existing schemes is 84.80 MLD (35.63 cusecs). Drinking water supply demand of Madurai Municipal Corporation is 125 MLD (51.09 cusecs). Therefore, total of 209.80 MLD (86.72 cusecs) is required by total 59 drinking water supply schemes between Mullaperiyar dam and Vaigai dam.

From Public Work Department (PWD) data, it is observed that average of minimum monthly storage from January 2012 to December 2018 is approximately 1,001 MCFT. Details of water release schedule on year-round basis as per Tamil Nadu PWD (Ref.: Lr. No. DB/ JD01/ 384/ C.10 (P)/2018, dt. 26 December 2018) is shown in Table below. Required quantity for MMC is scheduled as continuous release for drinking water supply requirements.

Water Release Schedule from Mullaperiyar Dam

No.	Description	Demand Type	Duration	Water Release
	EXISTING			cusecs
1	Cumbum Valley Irrigation Scheme	irrigation	240 days on or after 1 June	200.00
2	PT Rajan Channel	irrigation	100 days after 1 Oct	100.00
3	Theni District (58 Schemes - Table 1)	drinking water	Year Round	100.00
	PROPOSED			
4	Madurai Municipal Corporation Scheme	drinking water	Year Round	51.09

Source: Public Work Department, Government of Tamil Nadu.

Therefore, year round demand for drinking water supply of 151.09 cusecs per day works out to monthly requirement of approximately 391.65 MCFT per month.Since average value of minimum monthly storage of Mullaperiyar dam from January 2012 to December 2018 is 1,001 MCFT per month and also drinking water supply is given highest priority in National Water Policy and State Government, it is concluded that Mullaperiyar dam source is sustainable for proposed Madurai water supply Improvement Scheme of Madurai Municipal Corporation.

Environmental Management Plan. An EMP has been developed to provide mitigation measures to reduce all negative impacts to acceptable levels, along with the delegation of responsibility to appropriate agency. As stated above, various design related measures are already included in the project design. During construction, the EMP includes mitigation measures such as (i) proper planning of pipe laying works to minimize the public inconvenience; (ii) barricading, dust suppression and control measures; (iii) traffic management measures for works along the roads and for hauling activities; (iv) provision of walkways and planks over trenches to ensure access will not be impeded; and (v) finding beneficial use of excavated materials to extent possible to reduce the disposal quantity. The EMP will guide the environmentally sound construction of the subproject. The EMP includes a monitoring program to measure the effectiveness of EMP implementation and include observations on- and off-site, document checks, and interviews with workers and beneficiaries.

The EMP will be included in the bid and contract documents to ensure compliance to the conditions set out in this document. The contractor will be required to submit to PIU, for review and approval, a site environmental management plan (SEMP) including (i) proposed sites/ locations for construction work camps, storage areas, hauling roads, lay down areas, disposal areas for solid and hazardous wastes; (ii) specific mitigation measures following the approved

EMP; and (iii) monitoring program as per EMP. No works are allowed to commence prior to approval of SEMP. A copy of the EMP/approved SEMP will be kept on site during the construction period at all times.

Consultation, Disclosure and Grievance Redress Mechanism. The stakeholders were involved in developing the IEE through discussions on-site and a public consultation workshop at project area level, after which views expressed were incorporated into the IEE and in the planning and development of the project. The IEE will be made available at public locations and will be disclosed to a wider audience via the ADB, Madurai Municipal Corporation and TNUIFSL websites. The consultation process will be continued during project implementation as required. A grievance redress mechanism (GRM) is described within the IEE to ensure any public grievances are addressed quickly.

Monitoring and Reporting. Contractor will submit a monthly EMP implementation report to PIU. PIU with the assistance of CMSC will monitor the compliance of contractor, prepare a Quarterly Environmental Monitoring Report and submit to PMU. The PMU will oversee the implementation and compliance and will submit semi-annual monitoring reports to ADB. ADB will post the environmental monitoring reports on its website. Monitoring reports will also be posted on MMC and TNUIFSL websites.

Conclusions and Recommendations. Therefore, as per ADB SPS, 2009 the project is classified as environmental category ‘B’ and does not require further environmental impact assessment. However, to conform with the government guidelines Water Treatment Plant requires consent to establishment and consent to operate (CTO) from Tamil Nadu Pollution Control Board, which shall be obtained for the WTP prior to construction and operation, respectively. This IEE shall be updated by PIU in Madurai Municipal Corporation during the implementation phase to reflect any changes, amendments and will be reviewed and approved by PMU.

I. INTRODUCTION

A. Background

1. The program will develop priority water supply, sewerage, and drainage infrastructure in at least 10 cities in strategic industrial corridors in Tamil Nadu. The Municipal Administration and Water Supply Department (MAWS), acting through Tamil Nadu Urban Infrastructure Financial Services Limited (TNUIFSL), is the executing agency. Urban local bodies are the implementing agencies for the subprojects.

2. **Components.** The TNUFIP is envisaged to be structured under three main components: (i) investment in Municipal infrastructure namely water supply and sewerage; (ii) municipal reform-based activities; and (iii) technical assistance for design, supervision, program management, reforms, and climate change.

3. **Impact and outcome.** Project 2 is aligned with the following impacts of the investment program: (i) universal access to basic water and sanitation services achieved; (ii) "world-class" cities and industrial corridors across the state developed; and (iii) water security, reduced vulnerability to climate change in urban areas, achieved. The investment program will have the following outcome: livability and climate resilience in five cities (Ambur, Tiruppur, Vellore, Madurai, and Tiruchirappalli) in priority industrial corridors enhanced.

(i) **Output 1: Climate-resilient sewage collection and treatment, and drainage systems developed in four cities.** Works in Tiruchirappalli, Ambur, Tiruppur, and Vellore include: (i) 2 new sewage treatment plants (STPs) with a combined treatment capacity of 72.71 million liters per day (MLD) constructed; (ii) 1 STP (15 MLD capacity) rehabilitated; (iii) 3,000 cubic meters (m^3) treated wastewater reused per day; (iv) 1,256 kilometers (km) of new sewage collection pipelines constructed, with 100% households connected (152,580 households); (v) 28 pumps and 44 lift stations (combined capacity of 3,690 kilowatts [kW]) constructed; and (vi) 8 (2 in each city) all-female community water and sanitation committees formed. The breakdown by city is: (i) in Tiruchirappalli new sewage collection system constructed; (ii) in Ambur new sewage collection system and 16.71 MLD STP constructed with 3,000 m^3 treated wastewater reused; (iii) in Tiruppur new sewage collection system with new 56 MLD STP constructed and one 15 MLD STP rehabilitated; and (iv) in Vellore new sewage collection system constructed.

(ii) **Output 2: Water supply systems in two cities improved with smart features.** Works in Tiruppur and Madurai include: (i) 1,260 km of new distribution pipelines commissioned with 100% households connected (188,900 households) in 66 newly established district metering areas (DMAs) with new supervisory control and data acquisition systems to manage and reduce nonrevenue water (NRW); (ii) 66 new storage reservoirs with combined capacity of 92 million liters constructed; (iii) 3 pump stations (combined capacity of 7,225 kW) constructed; (iv) 196 km new transmission mains and 230 km of feeder mains constructed; (v) 3 new intakes and 3 new water treatment plants of combined capacity of 321 MLD constructed; and (vi) 80% of technical staff from each implementing agency of 2 cities trained in NRW reduction including 100% women staff. The breakdown by city is: (i) in Tiruppur, 1,060 km of distribution pipelines in 29 DMAs, 29 storage reservoirs, 2 pump stations (5,975 kW), 46 km of transmission mains and 121 km of feeder mains, and a new intake with 196 MLD water treatment plant; and (ii) in Madurai, 200 km of distribution pipelines in 37 DMAs, 37 storage reservoirs, 1 pump station

(1,250 kW), 150 km transmission mains and 109 km feeder mains, and a new intake structure with 125 MLD water treatment plant.

(iii) **Output 3: Institutional capacity, public awareness, and urban governance strengthened.** This includes a performance-based urban governance improvement program implemented for 10 project cities to (i) achieve targeted household connections for water and sewerage projects; (ii) timely completion of projects under the MFF as per the original implementation schedule; (iii) actions in fecal sludge management in areas not covered by centralized sewerage system; (iv) reuse of treated wastewater; and (v) implementation of gender action plan. Governance improvement and awareness consultants recruited under Project 1 will support output 3.

B. Scope of Project

4. The Madurai Municipal Corporation (MMC) drinking water need is being managed with the allotted quantity of 1,500 million cubic feet (MCFT) (115 MLD) at Vaigai dam, 30 MLD from River Cauvery source under Melur combined water supply scheme (CWSS) and 29 MLD from Vaigai river bed. The intermediate water supply demand for 2034 with the population of 1,923,936 is estimated to be 317 MLD including 15% transmission losses. From all existing sources, the designed quantity of water available is only 174 MLD. The water supply demand gap for 2034 is 125 MLD. To meet out the demand gap of 125 MLD the MMC has analysed the possibilities of drawl of water from Mullai Periyar River at Lower camp through closed conduits.

(i) In G.O. No. 872, Public Works Department (PWD) dated 4 June 1985 Government has allotted 1,500 MCFT from Vaigai dam, through this 115 MLD quantity of water is being drawn every day. There is a huge gap between available quantity and demand.

(ii) Vaigai dam receives water mainly from Mullai Periyar River. During summer 200 cusecs of water is being released for water supply demand of Theni and Madurai Districts. The head works in the upstream side of Vaigai dam are tapping 100 cusecs of water for the local bodies in the Theni District but due to evaporation and percolation of loss the remaining 100 cusecs is not reaching Vaigai dam, only 40 cusecs are reaching Vaigai dam. Hence, to avoid evaporation percolation losses, it is proposed to draw 125 MLD of water from Mullai Periyar River at Lower Camp through closed conduits.

(iii) The water will be collected by accumulating it through the construction of a check dam across Mullai Periyar River at Lower Camp in the immediate downstream of 18th canal scheme by providing necessary intake arrangements. The water from the intake well is conveyed through newly proposed 1,422 mm mild steel raw water pumping main to the newly proposed water treatment plant (WTP) at Pannaipatti.

(iv) 125 MLD raw water treatment plant is proposed at Pannaipatti in the same place where the existing WTP is located.

(v) After treatment, 125 MLD of clear water is conveyed through clear water gravity transmission main to MMC.

(vi) Then the water is conveyed through proposed feeder mains to the newly proposed service reservoirs for proper distribution to the beneficial use.

(vii) Distribution system to few areas under MMC is proposed under this project.

5. The Government has allotted 8.97 MLD of water from Melur CWSS for MMC. The allotted quantity is tapped at LS 1,560 m of feeder main to Melur Municipality in Alagar koil–Melur Road and conveyed to MMC for beneficial use.

C. Purpose of this Initial Environmental Examination (IEE) Report

6. ADB requires the consideration of environmental issues in all aspects of the Bank's operations, and the requirements for environmental assessment are described in ADB's Safeguard Policy Statement (SPS), 2009. The potential environmental impacts of the subproject have been assessed using ADB rapid environmental assessment (REA) Checklist for water supply (Appendix 1). The potential negative impacts were then identified in relation to pre-construction, construction and operation of the improved infrastructure, and results of the assessment show that the subproject is unlikely to cause significant impacts. Thus, this initial environmental examination (IEE) has been prepared in accordance with ADB SPS's requirements for Environment Category 'B' projects.

7. The IEE is prepared based on the detailed project report (DPR),[1] field reconnaissance surveys and secondary sources of information. No field monitoring (environmental) survey was conducted, however, the environmental monitoring program developed as part of the environmental management plan (EMP) require the contractors to establish the baseline environmental conditions prior to commencement of civil works. The results will be reported as part of the environmental monitoring report and will be the basis to ensure no degradation will happen during subproject implementation. Stakeholder consultation was an integral part of the IEE.

D. Structure of the Report

8. This Report contains the following sections including the executive summary at the beginning of the report:

(i) Introduction;
(ii) Description of the project;
(iii) Policy, legal and administrative framework;
(iv) Description of the environment;
(v) Anticipated environmental impacts and mitigation measures;
(vi) Public consultation and information disclosure;
(vii) Grievance redress mechanism;
(viii) Environmental management plan; and
(ix) Conclusion and recommendation.

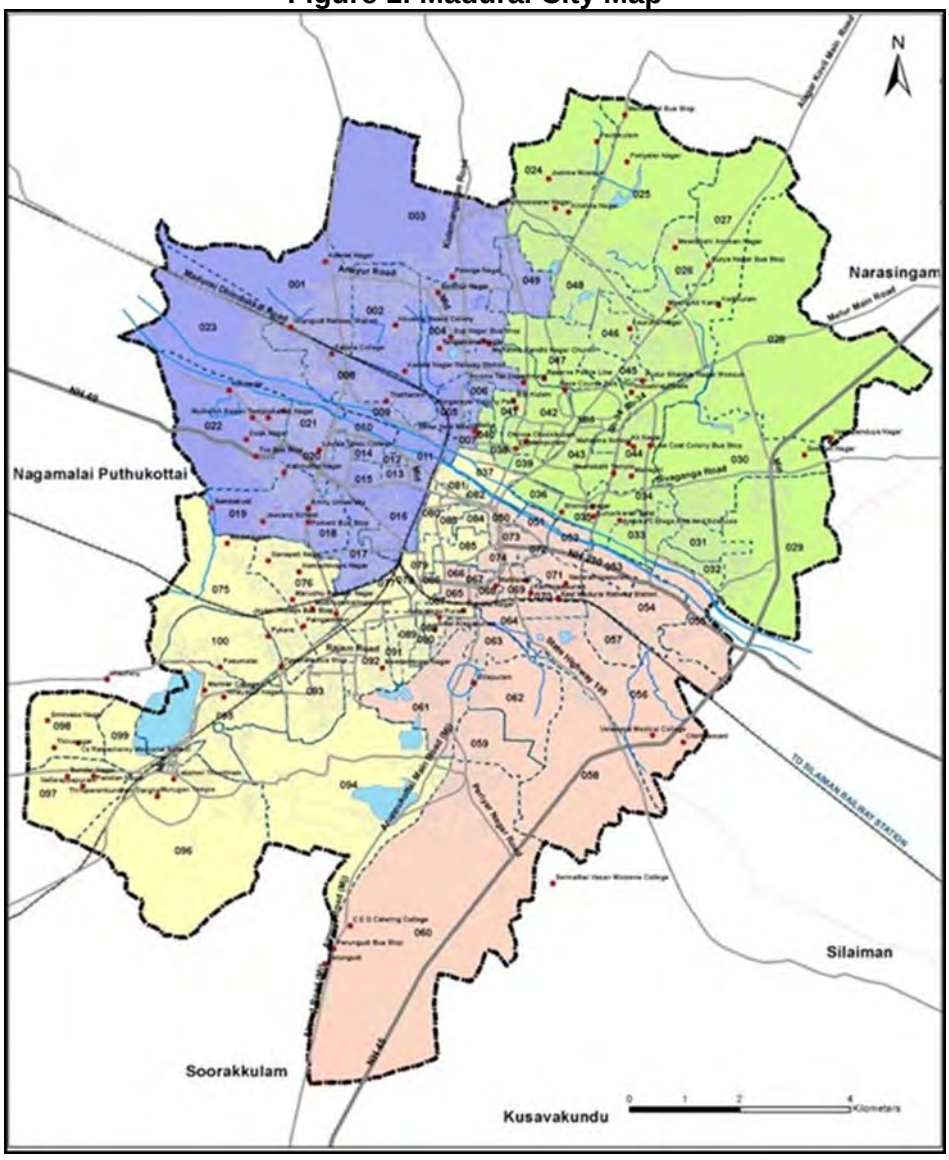
[1] Prepared by Madurai Municipal Corporation.

II. DESCRIPTION OF THE PROJECT

A. Project Area

9. Madurai City, located in south central Tamil Nadu, is the third largest city after Coimbatore. The total population is around 18.47 lakh (as per 2011 census) and is the headquarters of Madurai District. The city is well connected by road and railway network to the urban centers in the state and the neighboring states. The MMC administers the city with the administrative jurisdiction extending over an area of 147 square kilometers (km^2).

Figure 1: Madurai City Map

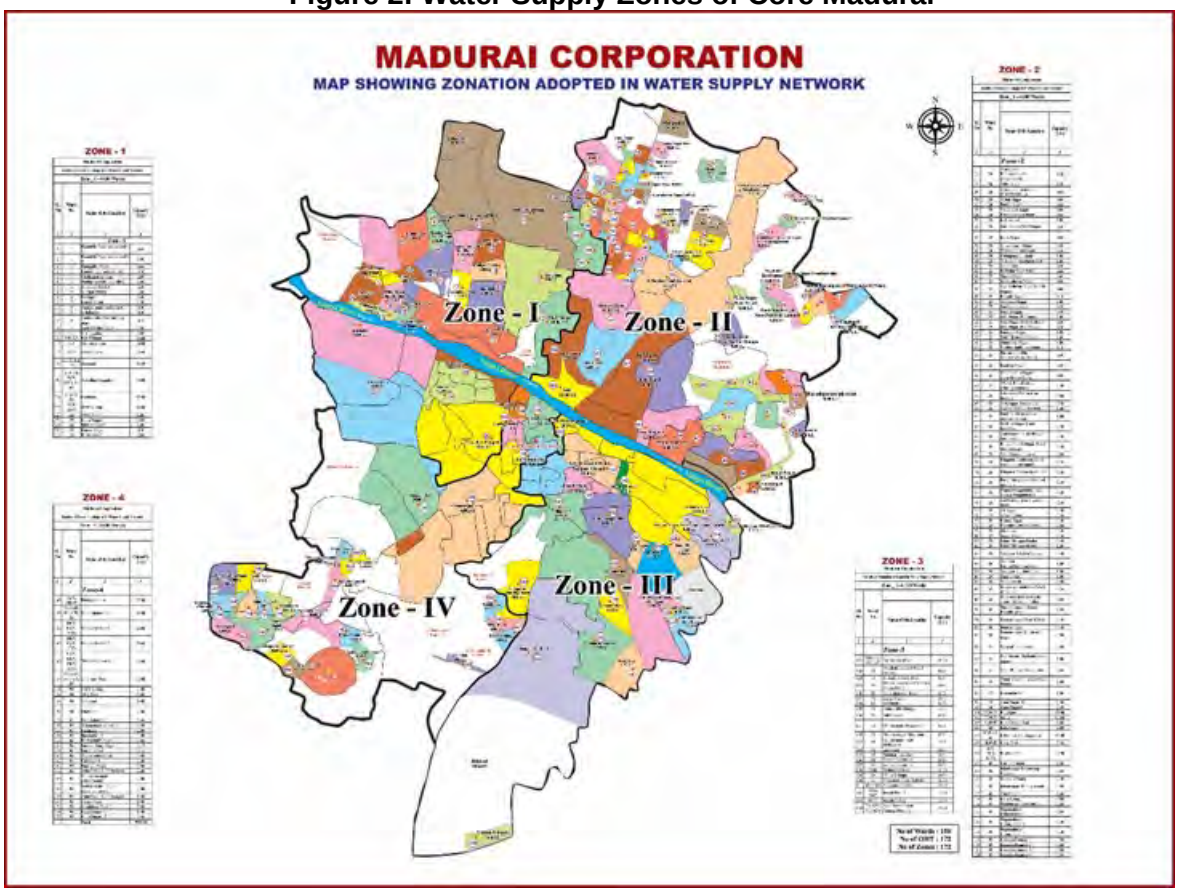


B. Existing Water Supply System

10. **General.** The core city of MMC consists of 100 wards (including the added area of 28 wards). The existing water supply schemes are functioning separately for core area and added

area of MMC. The details of existing water supply schemes (distribution system covering 52 km^2 area) are discussed in the following sections.

Figure 2: Water Supply Zones of Core Madurai



11. **Main Source of Water.** The main source of water supply for Core City of Madurai City Municipal Corporation is Vaigai Dam. The total storage capacity of Vaigai dam is 6,091 MCFT. Vaigai dam reservoir is primarily intended to meet the irrigation requirements of southern districts in Tamil Nadu, apart from providing water supply to Madurai, other wayside towns such as Usilampatti, Nilakottai, Sholavandhan, Vathalagundu and many villages are also benefited through the water supply schemes from River Vaigai. The main source of water to Vaigai dam is the release of surplus water from Mullai Periyar dam. The details of the Vaigai dam and the Mullai Periyar dam are given in the following tables.

Table 1: Vaigai Dam Water Levels

Sl. No.	Vaigai Dam		
	Year	Maximum Level	Minimum Level
1	1993	69.75	69.24
2	1994	69.50	48.65
3	1995	58.15	35.95
4	1996	57.30	27.70
5	1997	70.40	22.15

Sl. No.	Vaigai Dam		
	Year	Maximum Level	Minimum Level
6	1998	69.95	49.20
7	1999	70.20	57.20
8	2000	63.10	44.70
9	2001	63.55	52.35
10	2002	52.25	24.00
11	2003	54.10	22.60
12	2004	60.95	24.23
13	2005	66.84	25.34
14	2006	67.90	44.88
15	2007	64.11	28.35
16	2008	70.93	56.09
17	2009	62.09	26.01
18	2010	69.21	26.25
19	2011	67.76	46.09
20	2012	66.08	33.67
21	2013	57.05	34.66
22	2014	70.33	21.06

Source: Madurai Municipal Corporation.

Table 2: Details of Periyar Dam

Periyar Dam	
Coordinates	9°31′43″N 77°8′39″E
Opening date	1895
Dam and spillways	
Type of dam	Gravity
Impounds	Periyar River
Height (foundation)	53.66 m (176 ft)
Length	365.85 m (1,200 ft) (main)
Width (crest)	3.6 m (12 ft)
Width (base)	42.2 m (138 ft)
Spillways	13
Spillway capacity	3,454.62 m^3 per second
Reservoir	
Total capacity	443,230,000 m^3 (359,332 acre ft)
Active capacity	299,130,000 m^3 (242,509 acre ft)
Max. water depth	43.281 m (142 ft)

ft = feet, m^3 = cubic meter.
Source: Madurai Municipal Corporation.

12. **Allocation of water from Mullai Periyar at Lower Camp.** Nearly 100 cusecs of water can be drawn from the check dam located in the downstream of Mullai Periyar River. By considering the water demand of 35 cusec (including the evaporation loss of 7 cusecs [20 %]) for

the Theni local bodies, the remaining available water would be around 58 cusecs, However, for the proposed water supply scheme, it requires only 50 cusecs which shall be drawn from the available water. Month wise details on average storage, average discharge, quantity given for drinking water, irrigation purpose is tabulated and given below.

Table 3: Periyar Dam-Storage, Discharge for Drinking Water & Irrigation

Sl.No.	**Name of the Year**	**Average Storage** (in MCFT)	**Average Discharge per day** (in cusec)	**Discharge for Drinking Water Purpose per day** (in cusec)	**Discharge for Irrigation Purpose per day** (in cusec)	**Total Release of water for Irrigation Purpose per year** (in MCFT)
1	**2**	**3**	**4**	**5**	**6**	**7**
1	2013	2,339.96	672.05	103.59	568.46	17,926.96
2	2014	2,938.37	697.81	102.61	595.20	18,770.14
3	2015	2,839.86	663.56	105.11	558.45	17,611.43
4	2016	1,867.10	407.05	104.29	302.75	9,547.63
5	2017	1,791.78	440.96	100.07	341.01	10,752.27
6	2018 (as on 31 July 2018)	2,260.39	559.72	98.85	460.87	8,441.71

cusec = cubic feet per second, MCFT = million cubic feet.

Notes:

a) In Column 3 the average storage of water at Periyar Dam is calculated. The month wise average storage of the Dam is enclosed for reference.
b) In Column 4 average discharge from Mullai Periyar Dam is calculated. The month wise average discharge of the Dam is enclosed for reference.
c) In Column 5 average drawal of water for drinking water purpose from the total average discharge is calculated (assuming that an average of 100 cusec is being drawn for drinking water purpose). The month wise average drawl from the total average discharge is enclosed.
d) In Column 6 average drawal of water for irrigation purpose from the total average discharge is calculated. The month wise average drawal from the total average discharge is enclosed.
e) In Column 7 total quantity of water released for irrigation purpose in a year in million cubic feet (MCFT).

13. **Storage of water in dam before and after judgment of Supreme Court.** The water storage level in the Mullai periyar dam before the court judgment is 136 ft. After the court judgment to regarding increasing the storage level it has been increased from 136 ft to 142 ft (Hon'ble Supreme Court Judgment in original suit no. 3 of 2006 in page no. 97 – para. no. 122.9), due to increase in the storage level 1,598 MCFT can be stored in the dam. The circulation and evaporation loss is calculated as 20% of the released quantity.

14. **Stability of the Mullai Periyar Dam.** Hon'ble Supreme Court Judgment in original suit no. 3 of 2006 in page no. 99 – para. no. 126 clear order has been given by the experts "The obstruction by Kerala to the water level in the Mullai Periyar dam being raised to 142 ft. on the ground of safety was found untenable, and in its judgment, this court so pronounced". The Supreme Court has passed the judgment after getting the details technical report from the expert committee appointed by Supreme Court. The committee appointed by Supreme Court is examining the stability of the dam continuously interpreting or inferring the Supreme Court order is not possible. A separate note based on Supreme Court. Order on dam safety and related aspects has been attached as Appendix 11.

15. **The Source Sustainability.** Proposal is to augment and improve water supply system in Madurai City Municipal Corporation with Mullaperiyar Dam as source. Scheme is designed to draw 125 MLD (Intermediate Stage 2034) from Mullaperiyar Dam at Lower Camp, raw water transmission to WTP at Pannaipatti and clear water shall be conveyed to 56 Overhead tanks (OHTs) by gravity flow.

16. Water Utilisation Committee of Government of Tamil Nadu (Ref. G.O.4D No.6 dated 23 July 2018 of Public Works [W2] Department) has approved water supply proposal for 125 MLD drawal from intake works at Lower Camp, Cumbum.

17. Presently, there are 58 combined and dedicated water supply schemes existing in Mullaperiyar River and Vaigai River between Mullaperiyar dam (source) and Vaigai dam (downstream). Total required quantity for 58 existing schemes is 84.80 MLD (35.63 cusecs). Drinking water supply demand of MMC is 125 MLD (51.09 cusecs). Therefore, total of 209.80 MLD (86.72 cusecs) is required by total 59 drinking water supply schemes between Mullaperiyar dam and Vaigai dam. Details shown in Table 4.

Table 4: Drinking Water Supply Schemes in Mullaperiyar and Vaigai River from Mullaperiyar Dam up to Vaigai Dam

No.	Name of Scheme	O&M Agency	Head works Location	Type of WS Scheme	Scheme Capacity (MLD)
PERIYAR AND VAIGAI RIVER					
A) AT LOWER CAMP					
1	**Madurai Municipal Corporation**	**ULB**	**Lower Camp**	**Dedicated**	**125.00**
Total I					**125.00**
B) FROM LOWER CAMP TO VAIGAI DAM					
2	CWSS TO CUMBUM ValleyTown	TWAD	At Lower camp	CWSS	14.03
3	Kombai – Thevaram - Pannaipuram CWSS (new)	TWAD	Downstream of Periyar Powerhouse	CWSS	2.70
4	C. Pudupatty T.P. WSIS	TWAD	Downstream of Periyar Powerhouse	CWSS	6.94
5	Kombai -Thevaram-Pannaipuram CWSS (new)	TWAD	Downstream of Periyar Powerhouse	CWSS	3.45
6	Kullappagoundanpatty & Kamayagoundanpatty CWSS	LB	K.G. Patty	Dedicated	2.00
7	Kullappagoundanpatty & Kamayagoundanpatty CWSS	LB	At Surulipatty	CWSS	0.14
8	Surulipatty WSS	LB	At Surulipatty	Dedicated	0.48
9	Naarayanathevanpatty CWSS	LB	At Surulipatty	Dedicated	0.48
10	Rayappanpatty WSS	LB	At Surulipatty	Dedicated	0.24
11	Anamalaiyanpaty WSS	LB	Anamalaiyanpatty	Dedicated	0.23
12	Kohilapuram CWSS	TWAD	Anamalaiyanpatty	CWSS	0.85
13	Odaipatty CWSS	TWAD	u/s Uthamapalayam weir	CWSS	2.11
14	Ambasamudram WSS (Near Ammapatty)	LB	Ambasamudram	Dedicated	0.05
15	Ammapatty WSS	LB	Near Ammapatty	Dedicated	0.16

No.	Name of Scheme	O&M Agency	Head works Location	Type of WS Scheme	Scheme Capacity (MLD)
16	Chinnamanur Mpty WSIS	LB	West of Chinnamanur Mpty	Dedicated	1.92
17	Markayankottai and Ellaipatty	LB	U/s Markayankottai bridge	CWSS	0.28
18	Odaipatty TP	LB	U/s Markayankottai bridge	Dedicated	1.94
19	T. Sindalacherry CWSS	TWAD	D/s Markayankottai bridge	CWSS	1.40
20	Kamatchipuram CWSS	TWAD	U/S Kutchanur weir	CWSS	1.10
21	Sankarapuram CWSS	TWAD	U/S Kutchanur weir	CWSS	1.60
22	Veppampatty CWSS	TWAD	U/S Kutchanur weir	CWSS	1.20
23	Seelayampatty	LB	U/S Kutchanur weir	Dedicated	0.36
24	Kutchanur WSS	LB	U/S Kutchanur weir	Dedicated	0.63
25	Kottur	LB	Kottur	Dedicated	0.36
26	B. Meenakshipuram	LB	At Uppukkottai	Dedicated	0.77
27	Kundalnaickenpatty WSS	LB	Kundalanaicken patty	Dedicated	0.24
28	Upparpatty WSS	LB	Kundalanaicken patty	Dedicated	0.13
29	DombuCherry	LB	Kundalanaicken patty	CWSS	0.24
30	Melachokkanathapuram TP WSIS	LB	Kondalnaicken patty	Dedicated	1.57
31	INO WSS	TWAD	Kondalnaicken patty	Dedicated	0.40
32	Kamarajapuram CWSS	TWAD	U/S Uppukottai weir	CWSS	0.70
33	Sillamarathupatty CWSS	TWAD	U/S Uppukottai weir	CWSS	1.70
34	Govindanagaram CWSS	TWAD	U/S Uppukottai weir	CWSS	2.15
35	Veerapandy TP	LB	U/s Veerapandy Bridge	Dedicated	1.33
36	Veerapandy TP WSIS	LB	Veerapandi	Dedicated	1.00
37	Palanichetty patty WSIS	LB	U/s Veerapandy Bridge	Dedicated	1.02
38	Palanichetty patty TP WSIS	LB	Veerapandi	Dedicated	2.00
39	Kodangipatty	LB	D/sVeerapandy	CWSS	0.24
40	Manjanaickenpatty	LB	D/sVeerapandy	CWSS	0.24
41	Thadicherry CWSS	TWAD	U/S Palanichettypatty weir	CWSS	1.40
42	Palanichettypatty WSS	LB	U/S Palanichettypatty weir	Dedicated	0.82
43	Aranmanaipudur	LB	U/S Palanichettypatty weir	Dedicated	0.24
44	Aranmanaipudur WSS	LB	U/S Palanichettypatty weir	Dedicated	0.24
45	Kandamanur & 15 Habitations	CWSS	U/S Palanichettipatti weir	TWAD	0.88
46	Pandian sericulture	Private	Palanichettipatti	Dedicated	0.03
47	Theni Municipality WSS (1 and 2)	LB	Palanichettipatti	Dedicated	4.29
48	Kottaipatty & Mariyayipatty CWSS	LB	Kottaipatty	Dedicated	0.24

No.	Name of Scheme	O&M Agency	Head works Location	Type of WS Scheme	Scheme Capacity (MLD)
49	Palakombai CWSS	TWAD	Near Kunnur	CWSS	2.13
50	Vallalnathi CWSS	TWAD	Downstream of Kunnur bridge	CWSS	1.61
51	Theni Collector Complex WSS		Downstream of Kunnur bridge	Dedicated	0.24
52	Theni Collector Bungalow WSS	PWD	Downstream of Kunnur bridge	Dedicated	0.24
53	Theni Medical college	Private	Arapadidevanpatti	Dedicated	0.56
54	Unjampatty-WSS	LB	Downstream of Kunnur bridge	Dedicated	0.50
55	Unjampatty- Vadapudupatty CWSS	TWAD	Downstream of Kunnur bridge	CWSS	0.58
56	Andipatty rural CWSS (Arapadithevanpatty CWSS)	TWAD	Downstream of Kunnur bridge	CWSS	1.48
57	Andipatty UTP WSS	LB	Downstream of Kunnur bridge	Dedicated	2.30
58	Theni Municipality WSS	LB	Downstream of Kunnur bridge	Dedicated	8.64
Total II				**MLD**	**84.80**
Grand Total (I+II)				**MLD**	**209.80**
				Cusecs	**86.72**

CWSS = combined water supply scheme, MLD = million liters per day, O&M = operation and maintenance, TWAD = Tamil Nadu Water and Drainage, ULB = urban local body, WSS = water supply scheme, WSIS = water supply improvement scheme.

18. Honorable Supreme Court of India through Order in W.P. (C) No. 386/2001 dated 27 February 2006 and subsequently through order dated 7 May 2014 “Original Suit No.3 of 2006” permitted Government of Tamil Nadu to raise the water level from 136.00 ft. to 142.00 ft. and ultimately to 152.00 ft. after completion of further strengthening measures on the Mullaperiyar dam.

19. Based on Tamil Nadu Public Works Department (PWD), at storage level of 142.00 ft. as allowed by Supreme Court order, available useful storage capacity is 7,666 MCFT against total storage capacity of 12,758 MCFT. Monthly average storage in Mullaperiyar dam for past 7 years is shown in Table 5.

Table 5: Monthly Average Storage in Mullaperiyar Dam (January 2012 to December 2018)

Year	Monthly Average Storage (MCFT)											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2012	1,932	919	810	1,005	917	1,083	1,063	1,687	2,278	2,128	2,367	1,683
2013	1,327	1,026	1,364	1,288	1,289	2,042	3,607	5,135	3,443	2,559	2,076	2,119
2014	1,623	1,021	1,242	1,070	1,590	1,536	1,883	3,349	4,722	4,364	6,788	5,488
2015	3,034	1,456	1,168	1,200	1,884	2,267	3,559	2,497	1,962	2,262	4,937	7,330
2016	5,044	2,452	1,285	970	993	1,100	2,278	2,284	1,508	912	958	1,177
2017	953	884	917	877	766	755	1,142	1,497	3,260	2,918	3,045	3,914
2018	2,187	1,599	1,317	1,316	1,342	3,190	4,660	6,478	4,561	5,241	4,625	4,099

MCFT = million cubic feet.
Note: Monthly storage based on “average of daily storage level readings”.

Source: Public Works Department, Government of Tamil Nadu.

20. Minimum, maximum and mean values are also computed and shown in Table 6.

Table 6: Abstract of Monthly Storage of Mullaperiyar Dam
January 2012 to December 2018

No.	Year	Monthly Storage (MCFT)		
		Minimum	Maximum	Average
1	2012	810.48	2,366.58	1,489.35
2	2013	1,025.94	5,134.61	2,272.91
3	2014	1,021.42	6,788.13	2,889.58
4	2015	1,168.13	7,330.16	2,796.46
5	2016	911.90	5,043.77	1,746.77
6	2017	755.23	3,914.23	1,743.98
7	2018	1,316.20	6,477.84	3,384.59
Average of Monthly Average Values		**1,001.33**	**5,293.62**	**2,331.95**

MCFT = million cubic feet.

21. Based on above, it is observed that average of minimum monthly storage from January 2012 to December 2018 is approximately 1,001 MCFT. Details of water release schedule on year-round basis as per Tamil Nadu PWD (Ref.: Lr. No. DB/ JD01/ 384/ C.10 [P]/ 2018, dated 26 December 2018) is shown in Table 7. Required quantity for MMC is scheduled as continuous release for drinking water supply requirements.

Table 7: Water Release Schedule from Mullaperiyar Dam

No.	Description	Demand Type	Duration	Water Release
	EXISTING			cusecs
1	Cumbum Valley Irrigation Scheme	Irrigation	240 days on or after 1 June	200.00
2	PT Rajan Channel	Irrigation	100 days after 1 Oct	100.00
3	Theni District (58 Schemes - Table 1)	Drinking Water	Year Round	100.00
	PROPOSED			
4	**Madurai Municipal Corporation Scheme**	**Drinking Water**	**Year Round**	**51.09**

Source: Public Works Department, Government of Tamil Nadu.

22. Therefore, year round demand for drinking water supply of 151.09 cusecs per day works out to monthly requirement of approximately 391.65 MCFT per month.Since average value of minimum monthly storage of Mulla Periyar dam from January 2012 to December 2018 is 1,001 MCFT per month and also drinking water supply is given highest priority in National Water Policy and State Government, it is concluded that Mullaperiyar dam source is sustainable for proposed Madurai Water Supply Improvement Scheme of MMC.

23. **Existing Water Supply Schemes in Core City of Madurai Municipal Corporation.** The first protected water supply was provided to Madurai City in the year 1892, through head works at Aarapalayam. Subsequently, considering the increasing population and additional demand, the augmentation for the city supply has been implemented in the years 1924, 1963, 1973, 1985, 1987, 1995 and 2009 respectively.

Table 8: Details of Head Works

S.No.	Components	Description
1	**Kochadai Head works**	
	Type	Infiltration Gallery
	Year of construction	1924
	Year of Improvement	1940
	Distance from the town	7.00 km
	Motor HP	170 HP
	Pump Duty	Centrifugal, 3,000 GPM (13,620 lpm) at 85 ft (25.91 m) Head
	Length of Infiltration Gallery	218.29 m across the river; 146.35 m u/s & 36.59 m D/S
	Total length of Gallery	1348 ft (411m)
	Collection point	Five manhole wells, two collection wells, and one colletion well cum suction well.
	Conveying main	24" dia CI pipes to D' system for District 3,4,5 with byepass connection to Arasaradi GLSR.
	Average Discharge (Capacity)	20.00 MLD
2	**Collector Well Head works at Kochadai**	
	Year of construction	1973
	Distance from the town	7.50 km
	Diameter of Well	4.00 m
	Depth of well	17.7 m
	Motor HP	135 HP (1+1)
	Pump Duty	Vertical Turbine, 3470 GPM (15754 lpm) at 27.43 m Head.
	Length of Radial Arms	Six directions in two tiers 241 m in top tier and 348 m in the bottom tier.
	Conveying main	24" CI Pipes from Kochadai to GLSR at Arasaradi.
	Average Discharge (Capacity)	11.50 MLD
3	**Melakkal Head works**	
	Year of construction	1963
	Distance from the town	18.00 km.
	Type	Infiltration Gallery with four manhole wells, one suction well and one collection well.
	Motor HP	55 HP (1+1)
	Pump Duty	3100 GPM (14074 lpm) at 55 ft (16.77 m) Head
	Length of Infiltration Gallery	304.88 m (2 rows of 18"SW pipe with cement filled joints)
	Length of conveying main from Melakkal to Arasaradi Pump station	14.00 m (24" RCC) and 1,562 m (21" RCC)
	Average Discharge Capacity	16.00 MLD
4	**Thatchampattu Head works**	
	Year of Construction	1985
	Distance from the town	20 km.
	Infiltration wells	3 Nos.
	Diameter of well	4.50 m - 2 nos. & 3.50 m -1 no.
	Depth of well	9 m - 2 nos. and 10 m - 1 no.

S.No.	Components	Description
	Pump Duty (Submersible)	1,800 lpm / 13m H/ 10 HP - 2 Nos. & 1,140 lpm / 14m H/ 7.5 HP - 1 no.
	Motor HP	90 HP 4741 lpm X 56 m
	Length of conveying main from Thatchampattu to Arasaradi Pump Station	16.70 km; 300 mm Φ AC pipe
	Average Discharge (Capacity)	4.50 MLD
5	**Manaloor Head works**	
	Year of Construction	1987
	Distance from the town	15 km.
	Diameter of Collector well	5.0 m
	Diameter of pump house	6.0 m
	Length of Radials	300 mm dia slotted pipes - 210 m
	Pump Duty at Manaloor Head works	25 HP Turbine - 4,741 lpm / 17m Head
	Average Discharge (Capacity)	4.54 MLD
	Length of Pumping main	134 m.
	Thiruppuvanam Head works	
	Year of Construction	1987
	Distance from the town	15 km
	Diameter of Collector well	5.0 m
	Diameter of pump house	6.0 m
	Length of Radials	300 mm dia slotted pipes - 210 m
	Pump Duty at Manaloor Headworks	40 HP Turbine - 4,741 lpm / 27m Head
	Length of Pumping main From Thiruppuvanam to Manalur	300 mm AC pipes - 3830 m.
	Average Discharge (Capacity)	4.54 MLD
	Common Sump cum Pump house at Manalur	
	Capacity	100,000 liters
	Booster Pump Duty at Manaloor	230 HP - 9,482 lpm / 81m H
	Length of Pumping main From Manalur sump to Service reservoirs at New Ramnad Road and Joseph Park	450 mm AC cl 15 – 7,000 m 450 mm AC cl 10 – 5,630 m
	Pump Duty at Thiruppuvanam Head works	40 HP/ 4,741 lpm / 27m H
	Booster Pump Duty at Manaloor	230 HP/ 9,482 lpm / 81m H
	Length of pumping main	3.60 km; 350 mm Φ AC (Thiruppuvanam to Manaloor); 13.20 km.; 450 mm Φ AC (Manaloor to Joseph Park)
6	**Vaigai Scheme No 1**	
	Year of Construction	1995
	Source	Vaigai Dam
	Ditance from Town	66 km
	Treatment Plant Capacity	71.6 MLD
	Gravity Conveying main	1000 mm & 1100 mm PSC pipes - 66 km

S.No.	Components	Description
7	**Vaigai Scheme No 2**	
	Year of Construction	2009
	Source	Vaigai Dam
	Ditance from Town	66 km
	Treatment Plant Capacity	47 MLD
	Gravity Conveying main	1,000 mm & 1,100 mm PSC pipes - 66 km

ft = feet, GLSR = Ground Level Storage Reservoirs, GPM = gallons per minute, km = kilometer, m= meter, MLD = million liters per day, RCC = reinforced cement concrete.
Source: Madurai Municipal Corporation.

24. **Status of the existing water supply schemes for core city of Madurai Municipal Corporation.** The Madurai Municipal Corporation supplies water to the Core city from Vaigai dam and sub-surface water supply schemes from Vaigai River. Water supply details are given in the Table 9.

Table 9: Details of Sources and Head Works in Madurai Municipal Corporation

S.No.	Name of Source/Scheme	Type of Source	Present Supply (MLD)	Remarks
Scheme-I				
1	Kochadai	Infiltration Galleries	8.46	Sub-Surface Water/Ground Water
	Kochadai	Collector Well		Not Functioning
2	Thachampathu Melakkal WSS	Infiltration Galleries	14	Sub-Surface Water/Ground Water
Scheme-II				
3	Manalur and Thiruppuvanam	CollectorWells	7	Sub-Surface Water/Ground Water
Vaigai Water Supply Scheme				
4	Vaigai WSS, Line-I	Intake Well Vaigai Dam	68	Surface Water
5	Vaigai WSS, Line-II	Intake Well Vaigai Dam	47	Surface Water
Scheme-III				
6	Vaigai River bed Sources	Infiltration wells	17.54	Sub-Surface Water/Ground Water
Scheme-IV				
7	Melur CWSS	CollectorWells in River Cauvery	30	Sub-Surface Water/Ground Water
	Total		**192**	**--**

MLD = million liters per day, WSS = water supply scheme.
Source: Madurai Municipal Corporation.

25. **Total Requirement**. As per the guidelines of the Central Public Health and Environment Engineering Organization (CPHEEO) manual on water supply and treatment, the total daily requirement of water for Madurai Municipal Corporation is as follows:

Table 10: Water Supply Demand Assessments

S. No	Description	Water Demand			Remarks
		2019	2034	2049	
1	Population (in no's)	1,628,945	1,923,936	2,277,889	--
2	Domestic (MLD)	220	260	307	135 lpcd
3	Floating Population (in no's)	200,000	250,000	300,000	
4	Required for Floating Population (MLD)	9.0	11.5	13.2	45 lpcd
5	Fire Fighting Demand (MLD)	4.0	4.5	4.8	100x√Population in 1000s in kilo liters
6	Total Requirement (MLD)	233	276	325	
7	Transmission Loss at 15% (MLD)	35	41	49	As per CPHEEO Norms
	Total Demand	**268**	**317**	**374**	--

CPHEEO = Central Public Health and Environment Engineering Organization, LPCD = liters per capita per day, MLD = million liters per day.

29. **Existing Sustainable Supply.** The sustainable supply from all the existing water supply schemes is tabulated as below:

Table 11: Existing Sustainable Supply

S. No.	Source	Quantity Available
Perennial Source:		
1.	First Vaigai Water Supply Scheme	68.00 MLD
2.	Second Vaigai Water Supply Scheme	47.00 MLD
3.	Cauvery CWSS (allotment upto ultimate period)	30.00 MLD
	Sub-Total (A)	**145.00 MLD**
Non-Perennial Source (Vaigai River bed source):		
4.	Melakkal & Thachampathu	14.00 MLD
5.	Manaloor & Thiruppuvanam	7.00 MLD
6.	Kochadai	8.46 MLD
7.	Avaniyapuram	17.54 MLD
8.	Thiruparankundram	
9.	Thirunagar	
10.	Harveypatti	
11.	Anaiyur	
12.	Vilangudi	
	Sub-Total (B)	**47 MLD**
	Grand Total (A+B)	**192 MLD**

CWSS = combined water supply scheme, MLD = million liters per day.

26. **Net Water Supply Requirement for Intermediate Stage 2034.** The net water supply demand for the intermediate year 2034 calculated from the above tables is as follows:

(i) Total water supply demand for 2034 : 317 MLD
(ii) Existing Water Supply : 192 MLD
(iii) Water supply Demand Gap for 2034 : 125 MLD

27. The water supply demand gap for 2034, the intermediate requirements shall be fulfilled by this proposed 125 MLD dedicated water supply scheme for MMC from Mullai Periyar River as source of water.

Table 12: Water Supply Demand Gap Statement for the Existing and New Water Supply Distribution Zones

S.No.	Proposed Water Supply Zones	Demand in MLD		
		2019	2034	2049
1	Total Demand	268	317	374
2	Existing Water Supply	192	192	192
3	Proposed Water Supply	125	125	125
4	Total Supply (2) + (3)	317	317	317
5	Demand Gap (1) - (4)	Nil	Nil	57

MLD =million liters per day.
Source: Madurai Municipal Corporation.

28. **Scheme-I.** This scheme contributes a partial yield through existing collector well/ infiltration galleries installed on Vaigai River bed at Kochadai, Melakkal and Thatchampattu. Through this scheme, water is supplied to the north zone of the city from September to February. Though the design capacity of the head works is about 52.00 MLD, presently about 29.46 MLD of water is available from riverbed.

29. **Scheme-II.** In this scheme, the head works are located at Manalur and Thirupuvanam on Vaigai River bed. Through this scheme, water is supplied to the south zone, through the existing collector well/infiltration well during monsoon season. The design capacity of the scheme is about 9.08 MLD but presently only 7.00 MLD of water is extracted from the head works. Both the collector wells are in the downstream of MMC. Due to the pollution in River Vaigai, the quality of water from the above collector wells are deteriorated and the TDS is in the range of 1300 mg/l. Bacteriological pollution was also observed during lean flow season no flow in the River for dilution. Hence, the collector wells are not functioning for the past four years. A WTP of capacity 5 MLD was constructed near the Manalur Collector well to treat the water with aerator and filter beds having anthracite coal as filter media. Further, the conveying main of 450 mm AC pipes from Manalur to the New Ramnad Road were damaged in many places during road widening. Hence, the above pipes are now replaced with 450 mm DI K7 pipes by MMC.

C. Proposed Project

30. It is proposed to draw 125 MLD (1630 MCFT/year) of surface water from the proposed check dam in Mullai Periyar River at Lower Camp to fulfill the intermediate demand gap of 125 MLD for MMC.

31. The MMC drinking water need is being managed with the allotted quantity of 1,500 MCFT (115 MLD) at Vaigai dam, 30 MLD from River Cauvery source under Melu CWSS and 47 MLD from Vaigai River bed. The intermediate water supply demand for 2034 (with projected population of 1,923,936) is 317 MLD. From all existing sources the designed quantity of water available is 192 MLD. The water supply demand gap for 2034 is estimated to be 125 MLD. To meet the

demand gap of 125 MLD the Madurai City Municipal Corporation has analysed the possibilities of drawal of water from Mullai Periyar River at Lower camp through closed conduits.

(i) In G.O. No.872, PWD dated 04 June1985 Government has allotted 1,500 MCFT from Vaigai dam, through this 115 MLD of water is being drawn every day. There is a huge gap between available quantity and demand.

(ii) Vaigai dam receives water from Mullai Periyar dam. During summer 200 cusecs of water is being released for water supply demand of Theni & Madurai Districts. The head works in the upstream side of Vaigai dam are tapping 100 cusecs of water for the local bodies in the Theni District but due to evaporation and percolation of loss the remaining 100 cusecs is not reaching Vaigai dam, only 40 cusecs are reaching Vaigai dam.

(iii) Hence, to avoid evaporation percolation losses, it is now proposed to draw 125 MLD of raw water from Mullai Periyar River at Lower Camp through closed conduits.

32. **Subproject Components.** The detailed project report (DPR) is prepared for the construction of key subproject components including the check dam, intake arrangements and laying of 1,118 mm and 1,067 mm mild steel raw water pumping main to the proposed WTP at Pannaipatti. The detailed description of the subproject components are as follows:

1. Head works

33. The headwork's site is proposed in the right riverbank of Mullai Periyar River, near the downstream of 18th canal check dam. The main components in the Head works are:

(i) Construction of check dam
(ii) Construction of 3m dia Semicircular Intake Wells : 4 nos.
(iii) Construction of collection wells : 1 no.
(iv) 700 mm mild steel connecting pipe : 4 nos.
(v) Construction of protection wall for Head Works site : 1 no.

Figure 3: Satellite imagery of Mullai Periyar Dam

Snapshot 1: Proposed Head Work Site and check dam location

2. Check dam

34. It is proposed to draw 125 MLD raw water from Mullai Periyar River at Lower Camp by the construction of check dam across the River in the downstream of 18th canal check dam. The MSL of the riverbed at 18th canal check dam and the proposed check dams are 477.40 m and 474.00

m respectively. Due to this steep gradient of river course, the depth of flow shall be 2.0 m for maximum flow of 2,100 cusecs and 45 cm for minimum flow of 200 cusecs.

35. During the peak summer season (lowest flowrate), the minimum quantity of 200 cusecs (17,800 MLD) is released to meet the drinking water requirement of Madurai and Theni Districts. In this subproject, there will be four 700 mm diameter mild steel connecting pipes that will abstract 130 MLD (4 x 32.50 MLD) of raw water from the river. Minimum 1.5 m depth of water head is required in the river. To ensure the minimum 1.5 m water is achieved all throughout the year, a check dam will be constructed across the River Mullai Periyar. The check dam for this subproject will have sluice gates (upstream and downstream of the shutters) and smooth concrete bed apron to ensure free water flow occurs even during lean flow season thus ecological flow in the river will be maintained. The PWD authorities will manage and supervise the construction of the check dam.

Snapshot 2: Existing Check Dam for Cumbum Valley Water Supply Project

3. Intake Arrangements

(i) 3 m diameter Semicircular Intake wells – 4 nos.

36. It is proposed to construct 4 nos. of 3 m diameter semicircular intake wells along the protection wall proposed in the riverbank side at 3 m interval. These intake wells are provided with suitable screening arrangements. Through each intake wells, 32.50 MLD of water shall be drawn from the proposed check dam.

(ii) Construction of collection wells

37. It is proposed to construct a collection well with silt trap at head works to collect 125 MLD of water from 4 nos. of intake wells through 4 rows of 700 mm mild steel connecting pipes.

(iii) Protection wall

38. The existing ground level of the head works site is 476.50 m. The actual ground level of the existing head works of Cumbum Valley Water Supply Project is 478.50 m. Hence, it is necessary to raise up the existing ground level up to 478.50 m. Therefore, a protection wall is proposed all around the head works site to raise the ground level up to 478.50 m by filling with imported earth. The proposed protection wall at Head Works site is 185 m x 55 m.

Salient details of proposed head works at lower camp

Check dam

Average G L	:	478.50
River Bed Level	:	474.00
Crest Level	:	476.50

Head works site

Existing Average G L	:	476.500
Proposed G L	:	478.500

Semi Circular Intake

Wells – 3 m Dia	:	**4 nos**
Average G L	:	478.500
Bed Level	:	474.300
MFL	:	478.000

Collection Wells	:	**1 no**
Average G L	:	478.500
LWL	:	473.500
MFL	:	478.000

Connecting main	:	**4 nos**
700 mm Dia mild steel pipes	:	4 x 30 m

Protection wall around Head works site	:	**185 m x 55 m**

39. **Raw water pumpset.** The pumpsets are designed for the requirements at an intermediate stage (year 2034). It is proposed to install 6 vertical turbine pump sets (each 280 HP), each with a capacity of 23,555 lpm against a head of 40 m, four would be working and two would be standby with a total pumping capacity of 94,210 lpm to meet the intermediate stage demand. The design is based on 23 hours pumping rate.

40. **Raw water pumping main.** As sufficient land is not available near the head works location for the construction of WTP, it is proposed to pump the raw water to Pannaipatti, where the new WTP (125 MLD capacity) is proposed. The raw water pumping main is proposed for a length of about 95,740 m for conveying raw water from intake well, located at the bank of the River Mullai Periyar, to the proposed water treatment plant to deliver 125 MLD of raw water to

meet the estimated demand for the Year 2034. The materials for pipelines will be selected as per the guidelines and pipe policy issued by Tamil Nadu Water and Drainage Board or Government of Tamil Nadu pipe policy. The pipeline is designed to meet the ultimate demand.

41. The proposed raw water pumping main has to cross the bridges as shown in the Table 13 and accordingly suitable pipe carrying bridges are proposed. The status of approval is enclosed in Appendix 13.

Table 13: Proposed Pipe carrying bridges

S. No.	Location	MS Pipe size	Length in meters
I.	**Headworks - Sengkulam stand post**		
1.	Kovanoothu bridge at LS: 2,355 m	1,422 mm	110 m
2.	Uthamapalayam at LS: 25,400 m	1,219 mm	100 m
II.	**Sengkulam stand post - Pannaipatti WTP**		
1.	Aranmanai Pudur at LS: 22,100 m	1,219 mm	100 m
2.	Kunnoor at LS: 23,590 m	1,219 mm	150 m
3.	Vaigai Dam Pickup Weir at LS: 37,410 m	1,219 mm	200 m
4.	Varaganathi at LS: 45,270 m	1,219 mm	140 m
5.	Punnukuthi Odai at LS: 47,850 m	1,219 mm	140 m

m = meter, mm = millimeter, WTP = water treatment plant.
Source: Madurai Municipal Corporation.

42. Further, there are two railway crossing come across the raw water pumping main at Theni - Aranmanai Pudur road junction. Necessary provision has been provided in the estimate for this railway crossing.

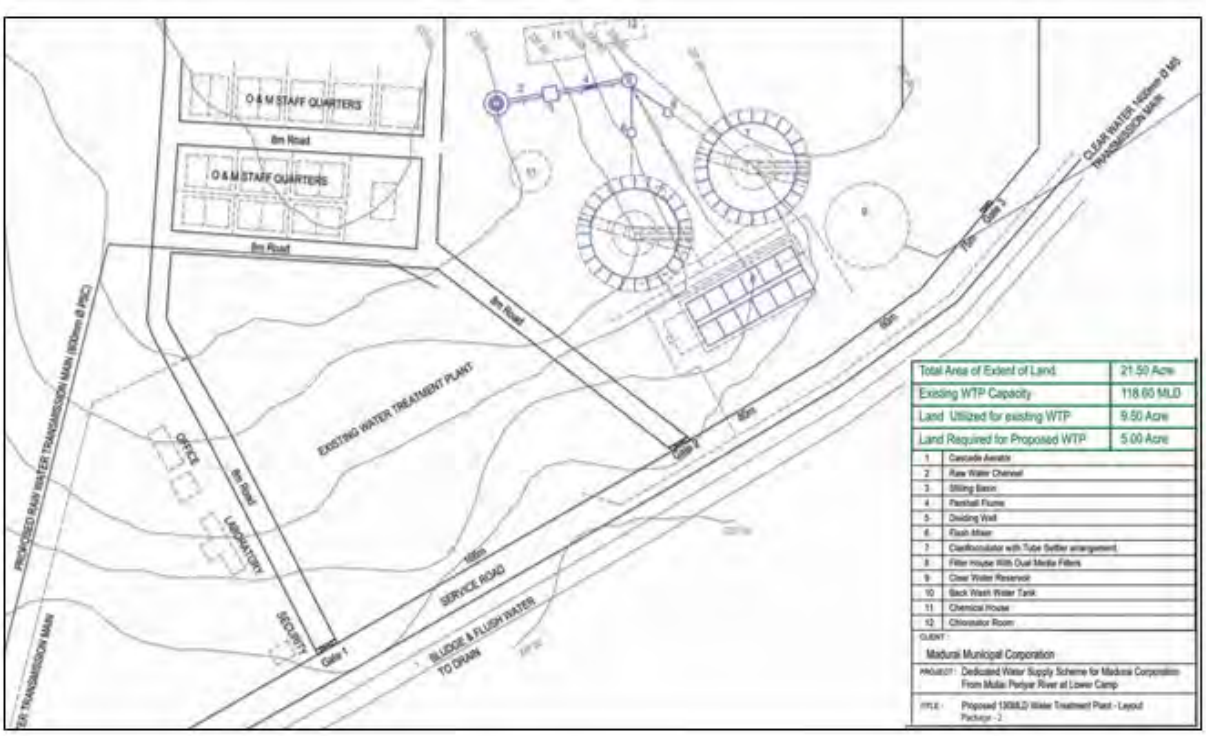
Table 14: Details of Railway Crossings

Description	Location	Chainage	Length in Meters
Railway Crossings	Near Karuppatti Railway Station	30,500 m	60
	Near Thachampatthu	36,500 m	60

Source: Madurai Municipal Corporation.

43. **125 MLD Full Scale Water Treatment Plant.** The proposed WTP will be constructed in 5-acre land proposed near the existing WTP at Pannaipatti Village, Nilakottai taluk, Dindigul District. The treatment plant layout has to be planned to treat 125 MLD of raw water (ultimate stage requirement). The land proposed for WTP is corporation own land. The proposed WTP will be based on conventional treatment process with full scale treatment involving coagulation, flocculation, sedimentation, filtration process, disinfection etc. The construction of WTP is proposed under design and build basis as per the process specified to suit the available site. Since the raw water is not suitable for the drinking purpose, the water treatment plant is proposed to treat raw water to meet the drinking water standards and supplied to consumers.

Figure 4: Proposed Water Supply Scheme Flow Diagram



4. Design Process

44. The design of the WTP shall be in compliance with the requirements of CPHEEO manual of water supply and treatment, third edition 1999 published by the expert committee of Central Public Health & Environmental Engineering Organisation, Government of India and relevant Bureau of Indian Standard (BIS) codes of practice. The source of water is from Mullai Periyar River at Lower camp through closed conduits.

45. The WTP will be constructed through DBOT basis, it shall be designed for continuous operation to produce net output of 125.00 MLD in 24 hrs. (considering raw water intake available is 125 MLD with 4 % losses in WTP) operation of treated water to specified quality standard. The treatment plant scheme shall broadly comprise of cascade aerator, parshall flume, flash mixer, clariflocculator, rapid gravity filters and chlorine mixing tank for delivering treated water of specified physical, chemical, and bacteriological quality. The sludge from clariflocculators shall be taken to the sludge balance tank and from there to discharge to drain nearby. Dirty backwash from the filters is routed to the used backwash recovery tank from which the supernatant is recycled back to the inlet chamber of WTP and the sludge generated is stored and disposed to ULB approved disposal/ processing facility. The design basis considered for the water treatment plant is as given below.

5. Design Capacity of the plant

(i) Net output capacity: 125 MLD over 24 hours operation (4.0% losses in WTP); and

(ii) All Channels / Pipes / Valves / Weirs: Designed for 20% overloading conditions.

6. Treatment Philosophy

46. The water treatment plant is designed for a treated water output of 125 MLD in 24 hours. The hydraulics of the treatment plant is designed in such a way that water flows by gravity from the cascade aerator to the existing clear water reservoir and the sludge generated from the clariflocculators flows by gravity to the sludge balance tank.

(i) Broadly, the flow scheme comprises the following process units:

- Stand post of Capacity 10 LL with 12 M Staging: 1
- Cascade Aerator: 1
- Parshall Flume: 1
- Flash Mixers: 2
- Clariflocculators: 2
- Rapid Gravity Sand Filter House: 1
- Chlorine Mixing Tank: 1
- Sludge Balancing Tank: 1 with 2 compartments
- Used Backwash Recovery Tank: 1 with 2 compartments
- Clear Water Sump: 1

7. Process Description

47. **Stand post** (of capacity 10 LL): The available residual head in raw water transmission main at Pannaipatti WTP site is 19.47 m. As per CPHEEO Manual on water supply and treatment, the head requirements over the tip of the aerator should be 0.5m to 3.0 m. To maintain the required residual head over the Aerator, a stand post of 10 LL capacity with 12 m staging height is proposed at WTP site to receive the 125 MLD of raw water from the raw gravity transmission main.

48. **Cascade Aerator cum Inlet Chamber.** The raw water is cascade aerator to release of odour and then received in the Inlet chamber of 1 minute's detention time for a design flow for 125.00 MLD at 24 hrs operations to achieve quiescent conditions.

49. **Parshall Flume/Inlet Flume.** The water from Inlet chamber then flows through channel installed with Parshall flume of standard design where flow measurement instrument is installed to monitor and record flow through the channel. Pre-chlorination is done by means of chlorine solution through diffusers installed to control organics.

50. **Flash Mixer.** Two flash mixers each designed to achieve an intimate mixing of raw water with alum dosed into the raw water. Each flash mixer is constructed in reinforced cement concrete (RCC) with 60 seconds retention time and provided with agitator.

51. **Clariflocculator.** The overflow from the flash mixer shall enter the pipe leading to flocculation of the clariflocculator for further flocculation and settling. Two numbers of clariflocculators, constructed in RCC is provided with flocculators clarifier raking mechanism. The clarifiers are provided for removal of turbidity, suspended matter, organic, etc. The coagulated water enters the reaction zone through a pipe to undergo reaction with the re-circulated sludge and chemicals. The flocculated water enters the clarifier zone to undergo the sedimentation process and the clarified water flows through launders plates and enters into a common clarified water channel, which leads to the filter inlet channel. The sludge collected at the bottom is scrapped slowly to the central sludge pocket by means of sludge scrapping mechanism from where it is withdrawn and led to sludge balancing tank.

52. **Rapid Gravity Sand Filters.** The clarified water from the clariflocculator clarifier enters into the common filter feed channel and routed to 6 nos. rapid gravity filters, each filter designed for a filtration rate of 6 $m^3/m^2/hr$. The filters shall be of the duplex type comprising two equal size beds separated by a central used wash water collection channel and operating at constant rate on the principle of influent flow division and constant water level.

53. The filters shall be arranged in two banks located on either side of a covered central gallery containing a walkway and freshwater consoles at high level and filter pipe gallery and filtered water channel complete with walkway at low level. The pipe gallery shall house the filter outlet chamber, common clear water channel and backwash water piping from the tank and air scour piping with valves. The gallery in the filter house is provided with adequate lighting and ventilation. The flow from the filter inlet channel enters each filter and undergoes filtration through sand media.

54. The filtered water is collected through the underdrain system comprising nozzles set in a plenum concrete floor and flows into an outlet chamber fitted with weir plate and overflows into the common filter water channel. When the filter head loss increases due to clogging of the bed, the filters shall be taken for backwashing using air and water.

55. **Back Wash Tank.** When the filter head loss increases due to clogging of the bed, the filters shall be taken on back washing using air and water. There shall be a backwash storage tank (rectangular tank on top of filter gallery) which will deliver the backwash water. The backwash storage tank shall be filled by pumps, which will take the water from the sump in the filtered water channel.

56. **Filter Annex Building.** Dedicated air scour blowers and backwash water pumps of adequate capacity to backwash one complete filter bed are provided. The backwash from the filters is routed by gravity to used wash water recovery tank from where the settled backwash sludge is stored and disposed to urban local body (ULB) approved disposal/ processing facility.

57. **Chlorine Mixing Tank.** The filtered water passes through a chlorine contact tank where post chlorination is done. Chamber is of RCC construction with baffles and covered**.**

58. **Treated Water Reservoir.** After filtration, the filtered water from filter house is taken to the existing Treated water reservoir**.**

59. **Sludge System.** The sludge generated from the clariflocculators is routed to the sludge-balancing tank from where the sludge is stored and disposed to ULB approved disposal/ processing.

60. **Chemical Dosing System.** The following chemical dosing systems of adequate capacity dosing tanks with agitators and dosing pumps:

(i) **Alum solution preparation & dosing system.** Alum is used as a coagulant in the removal of raw water turbidity;

(ii) **Hydrated Lime solution preparation & dosing system***.* Lime is used to maintain the alkalinity of water. The dosage of lime is decided depending upon the dosage of alum and alkalinity of raw water; and

(iii) **Pre & Post chlorination system.** Chlorinators for pre-chlorination and for post chlorination with all standard accessories as required to make the system complete.

61. A chemical storage house of RCC framed structure construction with brick walls, with rooms having proper corridor approach, with proper natural lighting & ventilation is provided.

There shall be access, to first floor and roof by means of stairs with filtered water connection in each floor for floor washing and for water required for preparing chemical solutions. The liquid chlorine cylinder (18-20 nos) will be stored in the room and other chemicals like alum & lime (15–20 T) will be stored for treatment system.

62. **Safety and/or Precaution.** When working with chlorine Wear glasses, masks, gloves, rubber boots, PVC aprons, use hood mask, airline mask and breathing apparatus. In case of chlorine leakage, the following instructions will be followed:

(i) If the leakage cannot be stopped, inform to the supplier. If not able to find the supplier, call the closest producers;

(ii) A capable, implemented staff having enough equipment must interfere the leakage. Move the other staff over a high place by taking the wind at backside. If the leakage is so thick, take all the staff away;

(iii) To find out the leakage pour ammonia into the suspicious area. A white smoke exists if there is a leakage. Control all the equipments at least once a day;

(iv) If the leakage is in the equipment or in pipes, close the chlorine input valve and transfer the pressured chlorine toan absorption system;

(v) If possible, decrease the pressure in container by transferring the gas to process or drainage system. Use an emergency bag. Inform to supplier. If not able to find the supplier, call the closest producer and ask for help. It is forbidden to transfer chlorine with leaking containers; and

(vi) Do not use water in chlorine leakages. Never put the chlorine cylinder or container to water or a liquid chemical mass. Prepare an absorption solution containing caustic soda and soda ash in a tank. For emergency reasons, keep these chemicals available for preparation of solution. Never put the leaked chlorine cylinder or container to absorption tank.

63. **Storage.** Chlorine cylinders, full or empty; should be stored in a dry and cool place and kept away from all kinds of sources of heat. Do not store beside elevators or ventilation systems. The places underground should not be preferred for storage.

(i) The storage temperature must not be over 55°C. These cylinders must be stored away from other compressed gas containers. Do not store near turpentine, ether, hydrocarbons, other flammable substances, ammonia and metal granules. Despite of oxidation risk keep the warehouse clean;

(ii) Should be stored where the daily controls and transportation of the full containers can be done with the least effort; and

(iii) Keep the full and empty containers in different places. Keep small cylinders vertical and bigger ones horizontally.

64. **Hydraulics**. Top water level of existing treated water reservoir is considered as 229.5 m, accordingly hydraulics shall be designed.

65. **Clear Water Gravity Transmission Main**. The treated water from the clear water reservoir will be conveyed by gravity to the proposed 36 OHTs (34 from Mullai Periyar, 2 from Cauvery CWSS and 1 sump) within the Madurai Municipal Corporation area. The total length of gravity clear water main and feeder mains from the WTP to the OHTs is around 54.5 km with a diameter of 1,422 mm. The clear water main is proposed to be laid along the PWD channel, SH, Rural Road and Vaigai River Bank upto the city limit. After crossing NH 7, the alignment will be in line with the state highways and local roads.

Table 15: Details of Clear Water Transmission Main

Chainage of Clear Water Main from Collection Sump (m)	Length (km)	Diameter (mm)	Pipe Thick (mm)	Pipe Material
LS 0 to 54,435	54.435	1422	12.50	MS

km = kilometer, m = meter, mm = millimeter.

8. Feeder Mains

66. **MS Feeder Main.** The 125 MLD of water received from the clear water transmission main is distributed to the Service Reservoirs through feeder mains of sizes varies from 150 mmΦ to 600 mmΦ DI pipes and mild steel pipes. In this proposal, mild steel pipe feeder mains are accounted as given below.

914 mm x 8 mm thick mild steel pipe : 6,845 m
711mm x 6.3 mm thick mild steel pipe : 1,840 m
813 mm x 7.1 mm thick mild steel pipe : 2,800 m

67. **DI Feeder Main.** The Madurai Municipal Corporation (MMC) has prepared two DPRs for water supply distribution system, one for added area and another one for Madurai Core City, which is under government approval. In these two DPRs there are 80 water supply distribution zones have been proposed for equitable distribution of water. In this 80 water supply distribution zones, 44 zones are proposed with existing service reservoirs and 36 zones and 1 sump are with newly proposed service reservoirs (covered under this proposal). In this project, it is proposed that 36 zones are covered by 125 MLD of water from Mullai Periyar River to feed 34 nos. of newly proposed service reservoirs and 3 zones covered by 8.97 MLD of water supply from Melur CWSS to feed 2 nos. of newly proposed service reservoirs and also 3.50 LL/day water is supplied to The Chennai High Court Branch, Madurai from 8.97 MLD water supply from Melur CWSS.

68. For the 914 mm x 8 mm, 813 mm x 7.1 mm and 711 mm x 6.3 mm thick mild steel feeder main Vaigai River Crossing at LS 54,435 m, pipe protection barrier wall has been provided across the Vaigai River for a length of 11,485 m.

69. **Storage reservoirs.** The entire MMC area is presently divided into hundred water distribution zones based on the elevation of the city. These zones will have OHT, which will directly receive water from existing and proposed water supply scheme. Totally 80 OHT are required as storage reservoirs (existing OHTs = 44, proposed OHTs = 36). Out of 36 OHT's, 34 OHT's are being constructed under the AMRUT scheme by MMC, balance 2 OHT's are being constructed under the Cauvery CWSS and 1 sump.

70. **Distribution Network.** Distribution system for 14 distribution zones of MMC is proposed to be provided in this project.

71. **Status of the water supply distribution system in Madurai Municipal Corporation.** The MMC encompasses 4 administrative zones consisting of 100 wards and 81 water distribution zones. Madurai Municipal Corporation proposes to provide distribution system to all the zones including added areas for which DPR is under finalization. Distribution system for 8 distribution zones are being implemented under Smart City funding. Of the remaining, distribution system for an estimate of ₹220 Crores will be covered under the proposed Madurai WSIS under TNUFIP and the balance distribution zones, will be taken up by Madurai Municipal Corporation subsequently.

D. Implementation Schedule

72. The bids for Package 1 (headworks & raw water main) and Package 3 (clear water main, feeder mains and construction of service reservoirs) will be invited in June 2019 and the contracts will be awarded by August 2019. Construction will take about 30 months to complete. For package 2 (construction of WTP & Supervisory Control and Data Acquisition [SCADA] arrangements), works will be awarded in June 2019. Construction period for WTP is 24 months. The distribution system proposed under TNUFIP will be taken up under Package 4.

Figure 5: Proposed Water Supply Scheme Flow Diagram

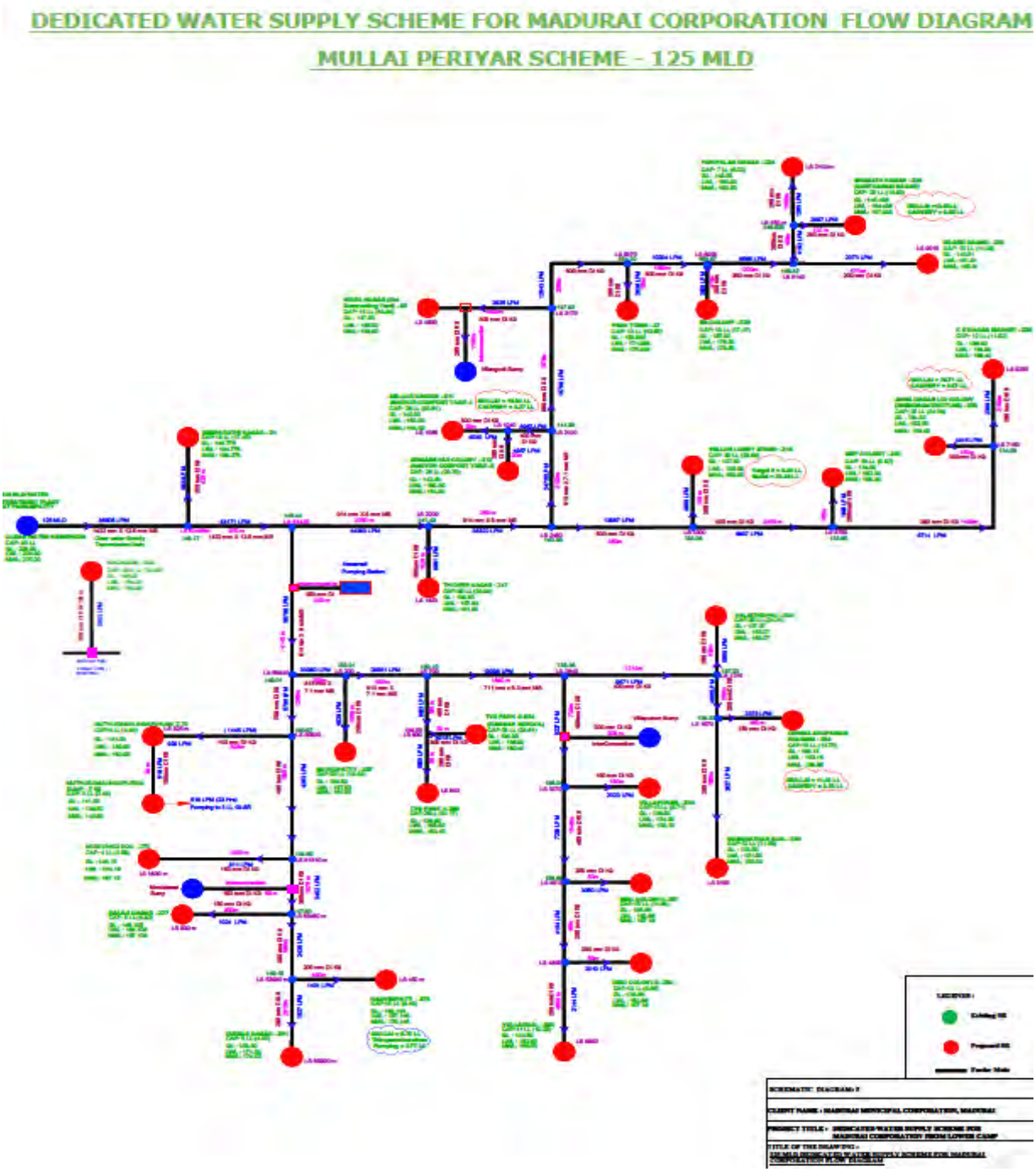
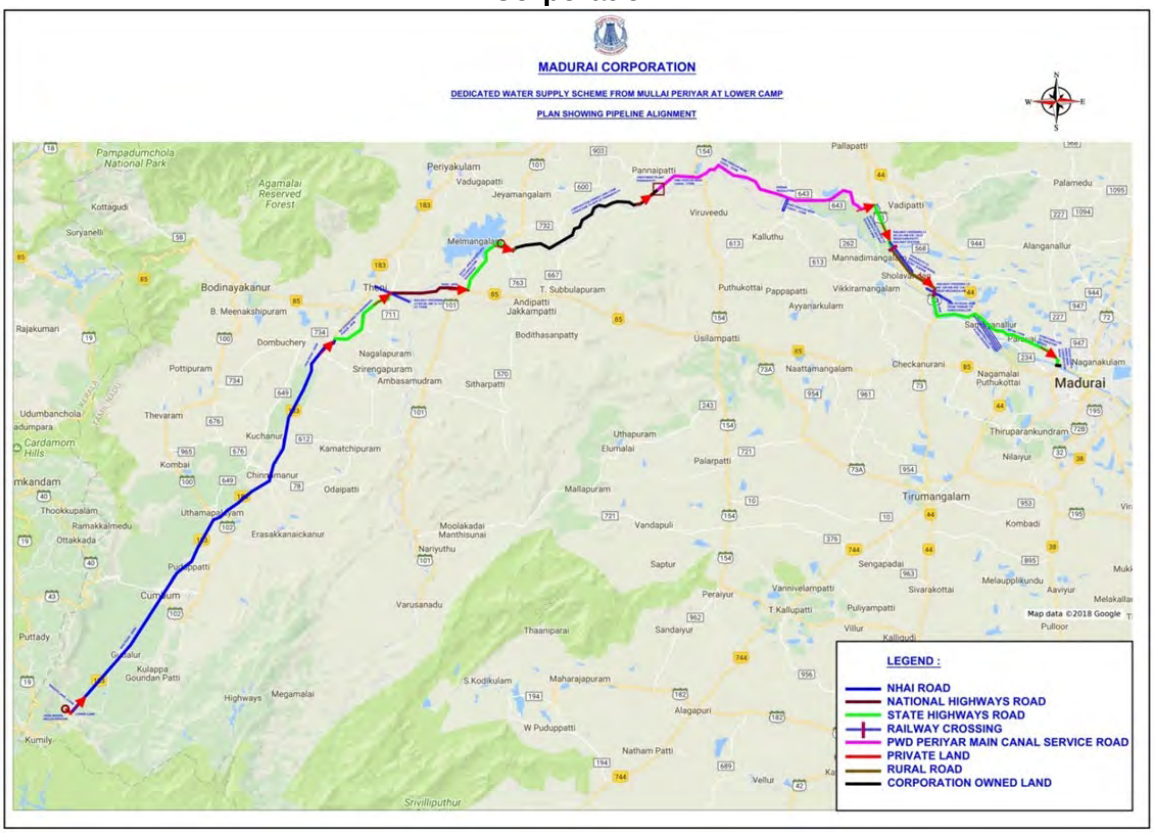


Figure 6: Map Showing Pipeline Drawing for Water Supply to Madurai Municipal Corporation



III. POLICY, LEGAL AND ADMINISTRATIVE FRAMEWORK

A. ADB Policy

73. ADB requires the consideration of environmental issues in all aspects of ADB's operations, and the requirements for environmental assessment are described in ADB SPS, 2009. This states that ADB requires environmental assessment of all ADB investments.

74. **Screening and categorization.** The nature of the environmental assessment required for a project depends on the significance of its environmental impacts, which related to the type and location of the project: the sensitivity, scale, nature, magnitude of its potential impacts, and the availability of cost-effective mitigation measures. Projects are screened for their expected environmental impacts, and are assigned to one of the following four categories:

(i) **Category A**. A proposed project is classified as category 'A' if it is likely to have significant adverse environmental impacts that are irreversible, diverse, or unprecedented. These impacts may affect an area larger than the sites or facilities subject to physical works. An EIA is required;

(ii) **Category B.** A proposed project is classified as category 'B' if its potential adverse environmental impacts are less adverse than those of category 'A' projects. These impacts are site-specific, few if any of them are irreversible, and in most cases mitigation measures can be designed more readily than for category 'A' projects. An IEE is required;

(iii) **Category C.** A proposed project is classified as category 'C' if it is likely to have minimal or no adverse environmental impacts. No environmental assessment is required although environmental implications need to be reviewed; and

(iv) **Category FI.** A proposed project is classified as category 'FI' if it involves investment of bank funds to or through a Financial Intermediary.

75. **Environmental Management Plan.** An EMP, which addresses the potential impacts and risks identified by the environmental assessment, shall be prepared. The level of detail and complexity of the EMP and the priority of the identified measures and actions will be commensurate with the project's impact and risks.

76. **Public disclosure.** ADB will post the safeguard documents on its website as well as disclose relevant information in accessible manner in local communities:

(i) for environmental category A projects, draft EIA report at least 120 days before Board consideration;

(ii) final or updated IEE upon receipt; and

(iii) environmental monitoring reports submitted by the implementing agency during project implementation upon receipt.

B. National Environmental Laws

77. **Environmental Assessment.** The Government of India EIA Notification of 2006 (replacing the EIA Notification of 1994), set out the requirements for Environmental Assessment in India. This states that environmental clearance is required for specified activities/projects, and this must be obtain before any construction work or land preparation (except land acquisition) may commence. Projects are categorized as A or B depending on the scale of the project and the nature of its impacts.

78. **Category A** projects requires environmental clearance from the central Ministry of Environment, Forests and Climate Change (MoEFCC). The proponent is required to provide preliminary details of the project in the prescribed manner with all requisite details, after which an Expert Appraisal Committee (EAC) of the MoEFCC prepares comprehensive terms of reference (TOR) for the EIA study. On completion of the study and review of the report by the EAC, MoEF&CC considers the recommendation of the EAC and provides the environmental clearance if appropriate.

79. **Category B** projects require environmental clearance from the State Environment Impact Assessment Authority (SEIAA). The State level EAC categorizes the project as either B1 (requiring EIA study) or B2 (no EIA study) and prepares TOR for B1 projects within 60 days. On completion of the study and review of the report by the EAC, the SEIAA issues the environmental clearance based on the EAC recommendation. The Notification also provides that any project or activity classified as category B will be treated as category A if it is located in whole or in part within 10 km from the boundary of protected areas, notified areas or inter-state or international boundaries.

80. None of the components of this water supply scheme subproject falls under the ambit of the EIA Notification 2006, and, therefore EIA Study or environmental clearance is not required for the subproject.

81. **Applicable environmental regulations**. Besides EIA Notification 2006, there are various other acts, rules, policies and regulations currently in force in India that deal with environmental issues that could apply to infrastructure development. The specific regulatory compliance requirements of the subproject are shown in Table 16.

Table 16: Applicable Environmental Regulations

Law	Description	Requirement
Water (Prevention and Control of Pollution) Act of 1974, Rules of 1975, and amendments	An Act enacted to provide for the prevention and control of water pollution and the maintaining or restoring of wholesomeness of water. Control of water pollution is achieved through administering conditions imposed in consent issued under to this Act. All pollution potential activities will require Consent to Establish (CTE) from Tamil Nadu Pollution Control Board (TNPCB) before starting implementation and Consent to Operate (CTO) before commissioning.	Construction of proposed wate-to-energy (WTP) (125 MLD) requires CTE and CTO from TNPCB before starting construction and before commissioning of WTP respectively. Application has to be submitted online at http://tnocmms.nic.in/OCMMS/
Environment (Protection) Act, 1986 and CPCB Environmental Standards.	Emissions and discharges from the facilities to be created or refurbished or augmented shall comply with the notified standards	To comply with applicable notified standards
Noise Pollution (Regulation and Control) Rules, 2000 amended up to 2010.	Rule 3 of the Act specifies ambient air quality standards in respect of noise for different areas/zones.	To comply with the noise standards.
Air (Prevention and Control of Pollution)	Applicable for equipment and machinery's potential to emit air pollution (including but	Generators will require CTE and CTO from TNPCB and has to

Law	Description	Requirement
Act, 1981, amended 1987 and its Rules, 1982.	not limited to diesel generators and vehicles); • CTE and CTO from TNPCB; • Compliance to conditions and emissions standards stipulated in the CTE and CTO.	comply with applicable emission standards as well
Solid Wastes Management Rules, 2016	Rules to manage municipal solid waste generated; provides rules for segregation, storage, collection, processing and disposal.	Solid waste generated at proposed facilities shall be managed and disposed in accordance with the Solid Wastes Management (SWM) Rules
Construction and Demolition Waste Management Rules, 2016	Rules to manage construction and to waste resulting from construction, remodeling, repair and demolition of any civil structure. Rules define C and D waste as waste comprising of building materials, debris resulting from construction, re-modeling, repair and demolition of any civil structure.	Construction and demolition waste generated from the project construction shall be managed and disposed as per the rules
Labor Laws	The contractor shall not make employment decisions based upon personal characteristics unrelated to job requirements. The contractor shall base the employment relationship upon equal opportunity and fair treatment and shall not discriminate with respect to aspects of the employment relationship, including recruitment and hiring, compensation (including wages and benefits), working conditions and terms of employment or retirement, and discipline. The contractor shall provide equal wages and benefits to men and women for work of equal value or type.	Appendix 2 provides applicable labor laws including amendments issued from time to time applicable to establishments engaged in construction of civil works, which will need to be followed by the project.
Manufacture, Storage and Import of Hazardous Chemicals Rules, 1989 (MSIHC Rules, 1989)	Never expose cylinders to heat, always keep the valve protection cap in place, except when the cylinder is being used, never lift a cylinder by its valve protection cap, Cylinders must be kept upright at all times when moved or stored. Secure chlorine containers with chains, chocks or appropriate equipment.	To comply with the storage and import of hazardous chemicals rules.

82. **Clearances / permissions to be obtain by contractor.** Following table shows the list of clearances/permissions required for project construction. This list indicative and the contractor should ascertain the requirements prior to start of the construction and obtain all necessary clearances/permission prior to start of construction.

Table 17: Clearances and Permissions Required for Construction

S. No	Construction Activity	Statutory Authority	Statute under which Clearanceis Required	Implementation	Supervision
1	Tree Cutting	Department of Forest and District Collector/ DRO	Clearances from the authorities as per the Tamil Nadu Timber Transit Rules, 1968 or latest.	PIU	PMU
2.	Construction of WTP	TNPCB	Consent to establish and consent to operate under Water Act, 1974 and Air act 1981	Contractor & PIU	PIU
3	Hot mix plants, Crushers and Batching plants	TNPCB	Consent to establish and consent to operate under Air Act, 1981	Contractor	PIU
4	Discharges from construction activities	TNPCB	Consent to establish and consent to operate under Water Act, 1974	Contractor	PIU
5	Storage, handling and transport of hazardous materials	TNPCB	Hazardous Wastes (Management and Handling) Rules, 1989 Manufacturing, Storage and Import of Hazardous Chemicals Rules, 1989	Contractor	PIU
6	Sand mining, quarries and borrow areas	Department of Geology and mining, GOTN	Tamil Nadu Minor Mineral Concession Rules, 1959 (corrected up to 31 March 2001)	Contractor	PIU
7	New quarries and borrow areas	MOEF&CC	Environmental clearance under EIA Notification 2006	Contractor	PIU
8	Groundwater extraction	Public Works Department	(Groundwater) Tamil Nadu Groundwater Development and Management Act 2000	Contractor	PIU
9	Disposal of bituminous wastes	Tamil Nadu State Pollution Control Board	Hazardous Wastes (Management and Handling) Rules. 1989	Contractor	PIU
7	Temporary traffic diversion measures	-	MoRTH 112 SP 55of IRC codes	Contractor	PIU
8	Water source (With drawl)	PWD	Permission obtained attached as Appendix 9	PIU	PIU
9	Pipe carrying bridge	PWD	Permission Obtained	PIU	PIU

DRO - District Revenue Office, EIA = environmental impact assessment, PIU = program implementation unit, PMU = program management unit, PWD = Public Works Department, TNPCB = Tamil Nadu Pollution Control Board.

83. **ADB SPS Requirements.** During the design, construction, and operation of the project the program management unit (PMU) and program implementation units (PIUs) will apply

pollution prevention and control technologies and practices consistent with international good practice, as reflected in internationally recognized standards such as the World Bank Group's Environment, Health and Safety Guidelines.These standards contain performance levels and measures that are normally acceptable and applicable to projects. When Government of India regulations differ from these levels and measures, the PMU and PIU in Madurai Municipal Corporation will achieve whichever is more stringent. If less stringent levels or measures are appropriate in view of specific project circumstances, the PMU and PIU Madurai Municipal Corporation will provide full and detailed justification for any proposed alternatives that are consistent with the requirements presented in ADB SPS, 2009.

Table 18: Applicable Ambient Air Quality Standards for India Projects

Parameter	Location[a]	National Ambient Air Quality Standards[b]	WHO Air Quality Guidelines (µg/m³)		Applicable Per ADB SPS[c] (µg/m³)
			Global Update[d] 2005	Second Edition[e] 2000	
Particulate Matter PM_{10} (µg/m³)	Industrial Residential, Rural and Other Areas	60 (Annual) 100 (24-hr)	20 (Annual) 50 (24-hr)	-	20 (Annual) 50 (24-hr)
	Sensitive Area	60 (Annual) 100 (24-hr)	20 (Annual) 50 (24-hr)	-	20 (Annual) 50 (24-hr)
Particulate Matter PM_{25} (µg/m³)	Industrial Residential, Rural and Other Areas	40 (Annual) 60 (24-hr)	10 (Annual) 25 (24-hr)	-	10 (Annual) 25 (24-hr)
	Sensitive Area	40 (Annual) 60 (24-hr)	10 (Annual) 25 (24-hr)		10 (Annual) 25 (24-hr)
Sulfur Dioxide SO_2 (µg/m³)	Industrial Residential, Rural and Other Areas	50 (Annual) 80 (24-hr)	20 (24-hr) 500 (10-min)	-	20 (Annual) 800 (24-hr) 500 (10-min)
	Sensitive Area	20 (Annual) 80 (24-hr)	20 (24-hr) 500 (10-min)	-	20 (Annual) 20 (24-hr) 500 (10-min)
Nitrogen Dioxide NO_2 (µg/m³)	Industrial Residential, Rural and Other Areas	40 (Annual) 80 (24-hr)	40 (Annual) 200 (1-hr)	-	40 (Annual) 80 (24-hr) 200 (1-hr)
	Sensitive Area	30 (Annual) 80 (24-hr)	40 (Annual) 200 (1-hr)	-	30 (Annual) 80 (24-hr) 200 (1-hr)
Carbon Monoxide CO (µg/m³)	Industrial Residential, Rural and Other Areas	2,000 (8-hr) 4,000 (1-hr)	-	10,000 (8-hr) 100,000 (15-min)	2,000 (8-hr) 4,000 (1-hr) 100,000 (15-min)
	Sensitive Area	2,000 (8-hr) 4,000 (1-hr)	-	10,000 (8-hr) 100,000 (15-min)	2,000 (8-hr) 4,000 (1-hr) 100,000 (15-min)
Ozone (O_3) (µg/m³)	Industrial Residential, Rural and Other Areas	100 (8-hr) 180 (1-hr)	100 (8-hr)	-	100 (8-hr) 180 (1-hr)
	Sensitive Area	100 (8-hr) 180 (1-hr)	100 (8-hr)	-	100 (8-hr) 180 (1-hr)
Lead (Pb) (µg/m³)	Industrial, Residential, Rural and Other Areas	0.5 (Annual) 1.0 (24-hr)	-	0.5 (Annual)	0.5 (Annual) 1.0 (24-hr)
	Sensitive Area	0.5 (Annual) 1.0 (24-hr)	-	0.5 (Annual)	0.5 (Annual) 1.0 (24-hr)

Parameter	Location[a]	National Ambient Air Quality Standards[b]	WHO Air Quality Guidelines (µg/m³)		Applicable Per ADB SPS[c] (µg/m³)
			Global Update[d] 2005	Second Edition[e] 2000	
Ammonia (NH_3) (µg/m³)	Industrial Residential, Rural and Other Areas	100 (Annual) 400 (24-hr)	-		100 (Annual) 400 (24-hr)
	Sensitive Area	100 (Annual) 400 (24-hr)	-	-	100 (Annual) 400 (24-hr)
Benzene (C_6H_6) (µg/m³)	Industrial Residential, Rural and Other Areas	5 (Annual)	-	-	5 (Annual)
	Sensitive Area	5 (Annual)	-	-	5 (Annual)
Benzo(o) pyrene (BaP) (ng/m³)	Industrial Residential, Rural and Other Areas	1 (Annual)	-	-	1 (Annual)
	Sensitive Area	1 (Annual)	-	-	1 (Annual)
Arsenic (As) (ng/m³)	Industrial Residential, Rural and Other Areas	6 (Annual)	-	-	6 (Annual)
	Sensitive Area	6 (Annual)	-	-	6 (Annual)
Nickel (Ni) (ng/m³)	Industrial Residential, Rural and Other Areas	20 (Annual)	-	-	20 (Annual)
	Sensitive Area	20 (Annual)	-	-	20 (Annual)

[a] Sensitive area refers to such areas notified by the India Central Government.
[b] http://cpcb.nic.in/uploads/National_Ambient_Air_Quality_Standards.pdf
[c] As per ADB SPS, the government shall achieve whichever of the ambient air quality standards is more stringent. If less stringent levels or measures are appropriate in view of specific project circumstances, the executing agency of the government will provide full and detailed justification for any proposed alternatives that are consistent with the requirements presented in ADB SPS.
[d] World Health Organization. 2006. Air quality guidelines for particulate matter, ozone, nitrogen dioxide and sulfur dioxide. *Global update 2005*.
[e] World Health Organization. 2000. Air Quality Guidelines for Europe Second Edition.

Table 19: Applicable Ambient Noise Level Standards for India Projects

Receptor/ Source	Noise Level Standards[a] (dBA)		WHO Guidelines Value For Noise Levels Measured Out of Doors[b] (One Hour LA_{eq} in dBA)		Applicable Per ADB SPS[c] (dBA)	
	Day	Night	07:00 – 22:00	22:00 – 07:00	Day time	Night time
Industrial area	75	70	70	70	70	70
Commercial area	65	55			65	55
Residential Area	55	45	55	45	55	45
Silent Zone	50	40			50	40

[a] Noise Pollution (Regulation and Control) Rules, 2002 as amended up to 2010 (http://cpcb.nic.in/displaypdf.php?id=Tm9pc2UtU3RhbmRhcmRzL25vaXNlX3J1bGVzXzIwMDAucGRm)
[b] World Health Organization. 1999. Guidelines for Community Noise.
[c] As per ADB SPS, the Executing Agency shall achieve whichever of the ambient air quality standards is more stringent. If less stringent levels or measures are appropriate in view of specific project circumstances, the executing agency of the government will provide full and detailed justification for any proposed alternatives that are consistent with the requirements presented in ADB SPS, 2009.

Table 20: Applicable Drinking Water Quality Standards[a] for India Projects

Group	National Standards for Drinking Water[b]			WHO Guidelines for Drinking-Water Quality, 4th Edition, 2011[c]	Applicable Per ADB SPS[d,e]
	Parameter	Unit	Max. Concentration Limit		
Physical	Turbidity	NTU	1 (5)	-	1 (5)
	pH		6.5 – 8.5	none	6.5 – 8.5
	Color	Hazen units	5 (15)	none	5 (15)
	Taste and Odor		Agreeable	-	Agreeable
	TDS	mg/l	500 (2,000)	-	500 (2,000)
	Iron	mg/l	0.3	-	0.3
	Manganese	mg/l	0.1 (0.3)	-	0.1 (0.3)
	Arsenic	mg/l	0.01 (0.05)	0.01	0.01
	Cadmium	mg/l	0.003	0.003	0.003
	Chromium	mg/l	0.05	0.05	0.05
	Cyanide	mg/l	0.05	none	0.05
	Fluoride	mg/l	1 (1.5)	1.5	1 (1.5)
	Lead	mg/l	0.01	0.01	0.01
	Ammonia	mg/l	0.5	none established	0.5
Chemical	Chloride	mg/l	250 (1,000)	none established	250 (1,000)
	Barium	mg/l	0.7	none	0.7
	Sulphate	mg/l	200 (400)	none	200 (400)
	Nitrate	mg/l	45	50	45
	Copper	mg/l	0.05 (1.5)	2	0.05 (1.5)
	Total Hardness	mg/l	200 (600)	-	200 (600)
	Calcium	mg/l	75 (200)	-	75 (200)
	Zinc	mg/l	5 (15)	none established	5 (15)
	Mercury	mg/l	0.001	0.006	0.001
	Aluminum	mg/l	0.1 (0.3)	none established	0.1 (0.3)
	Anionic detergents	mg/l	0.2 (1.0)	none	0.2 (1.0)
	Phenolic compounds	mg/l	0.001(0.002)	none	0.001(0.002)
	Residual Chlorine	mg/l	0.2	5	0.2
Microbial indicator	E-coli	MPN/100ml	Must not be detectable in any 100 ml sample	Must not be detectable in any 100 ml sample	Must not be detectable in any 100 ml sample
	Total Coliform	MPN/100ml			

[a] http://cgwb.gov.in/Documents/WQ-standards.pdf

[b] Bureau of India Standard 10500: 2012 (Indian Standard, Drinking Water — Specification (Second Revision).

[c] Health-based guideline values

[d] As per ADB SPS, the government shall achieve whichever of the drinking quality standards is more stringent. If less stringent levels or measures are appropriate in view of specific project circumstances, the executing agency of the government will provide full and detailed justification for any proposed alternatives that are consistent with the requirements presented in ADB SPS, 2009.

[e] Figures in parenthesis are maximum limits allowed in the absence of alternate source.

Table 21: General Standards for Discharge of Environmental Pollutants[a]
Part- A: Effluents (SCHEDULE–V)

Sl. no	Parameter	Inland surface water	Public sewers	Land for irrigation	Marine/ coastal areas
1	Suspended solids mg/l, max.	100	600	200	(a) For process waste water (b) For cooling water effluent 10 per cent above total suspended matter of influent
2	Particle size of suspended solids	shall pass 850 micron IS Sieve	-	-	(a) Floatable solids, solid s max. 3 mm (b) Settleable s olids, max 856 microns
3	pH value	5.5 to 9.0	5.5 to 9.0	5.5 to 9.0	5.5 to 9.0
4	Temperature	shall not exceed 5ºC above the receiving water temperature	-	-	shall not exceed 5ºC above the receiving water temperature
5	Oil and grease, mg/l max	10	20	10	20
6	Total residual chlorine, mg/l max	1	-	-	1
7	Ammonical nitrogen (N), mg/l, max	50	50	-	50
8	Total kjeldahl nitrogen (N) mg/l, max	100	-	-	100
9	Free ammonia (NH_3), mg/l, max.	5	-	-	5
10	Biochemical Oxygen Demand (3 days at 27ºC), mg/l, max	30	350	100	100
11	Chemical Oxygen Demand, mg/l, max	250	-	-	250
12	Arsenic (As) mg/l, max.	0.2	0.2	0.2	0.2
13	Mercury (Hg), mg/l, max.	0.01	0.01	-	0.01
14	Lead (Pb) mg/l, max	0.1	1	-	2
15	Cadmium (Cd) mg/l, max	2	1	-	2
16	Hexavalent chromium (Cr +6), mg/l, max.	0.1	2	-	1
17	Total Chromium (Cr) mg/l, max.	2	2	-	2
18	Copper (Cu) mg/l, max.	3	3	-	3
19	Zinc (Zn) mg/l, max	5	15	-	15

Sl. no	Parameter	Inland surface water	Public sewers	Land for irrigation	Marine/ coastal areas
20	Selenium (Se) mg/l, max	0.05	0.05	-	0.05
21	Nickel (Ni) mg/l, max.	3	3	-	5
22	Cyanide (CN) mg/l, max	0.2	2	0.2	0.2
23	Fluoride (F) mg/l, max.	2	15	-	15
24	Dissolved phosphates (P), mg/l, max	5	-	-	-
25	Sulphide (S) mg/l, max.	2	-	-	5
26	Phenolic compounds (C_6H_50H) mg/l, max.	1	5	-	5
27	Radioactive materials:				
	(a) Alpha emitters micro curie mg/l, max.	10^{-7}	10^{-7}	10^{-8}	10^{-7}
	(b)Beta emitters micro curie mg/l	10^{-6}	10^{-6}	10^{-7}	10^{-6}
28	Bio-assay test	90% survival of fish after 96 hours in 100% effluent	90% survival o f fish after 96 hours in 100% effluent	90% survival of fish after 96 hours in 100% effluent	90% survival of fish after 96 hours in 100% effluent
29	Manganese	2 mg/l	2 mg/l	-	2 mg/l
30	Iron (Fe)	3mg/l	3mg/l	-	3mg/l
31	Vanadium (V)	0.2mg/l	0.2mg/l	-	0.2mg/l
32	Nitrate Nitrogen	10 mg/l	-	-	20 mg/l

[a] http://cpcb.nic.in/industry-effluent-standards/

IV. DESCRIPTION OF THE ENVIRONMENT

A. Methodology used for Baseline Study

84. **Data collection and stakeholder consultations.** Data for this study has been primarily collected through comprehensive literature survey, discussion with stakeholder agencies and field visits to the proposed subproject sites.

85. The literature survey broadly covered the following:

(i) Project details, reports, maps, and other documents prepared by Madurai Municipal Corporation;
(ii) Discussions with technical experts, publics and other relevant government agency.
(iii) Secondary data from previous project reports and published articles; and
(iv) Literature on land use, soil, geology, hydrology, climate, socioeconomic profiles, and other planning documents collected from Government agencies and websites.

86. In order to predict the anticipated impacts due to an infrastructure project implementation/ construction, it is necessary to obtain baseline information of the environment, as it exists, which would serve as a datum. The interaction of baseline environment and the anticipated impacts are the basis for the preparation of the EMP. This chapter includes existing scenario for various environmental components of the study area. The baseline environmental quality status is assessed through field studies in the study area for various components of environment, viz, air,

noise, water, land, biological and socio-economic. Baseline data collection for each of the environmental components is based on the location of proposed project and anticipated distance of the significant impact. The study area is defined for each of the environmental components independently taking into consideration the vulnerability of the environmental component with respect to the activity of the proposed project. Majority of data on water quality, vegetation, air and noise quality was collected during field studies.

87. **Ocular inspection.** Several visits to the project sites were made during IEE preparation period in 2018 to assess the existing environment (physical, biological, and socio-economic) and gather information with regard to the proposed sites and scale of the proposed project. A separate socioeconomic study was conducted to determine the demographic information, existing service levels, stakeholder needs and priorities.

B. Physical Environmental Component

88. Considering the environmental setting of the project, project activities and their interaction, environmental regulations and standards, the following Environmental attributes have been included for the IEE. The study was conducted at 8 locations in project alignment area.

(i) Site-specific micrometeorological data for the parameters of Windspeed & direction, Temperature, Humidity, Cloud Cover and Rainfall;
(ii) Ambient Air Quality at 8 locations for the parameters: PM_{10}, $PM_{2.5}$, SO_2, NO_2;
(iii) Noise Level Measurements at 8 Locations for both Leq-Day and Leq-Night values.
(iv) Water Quality: Surface Water at 2 Locations and Groundwater at 6 Locations for IS: 10500 Norms;
(v) Soil Quality at 8 Locations for Textural & Physical Parameters, Nutrients, etc.;
(vi) Present & Post-project Land Use Pattern based on Satellite Imagery;
(vii) Biotic Attributes: Flora & Fauna -Core zone & Buffer zone-Diversity Index; and
(viii) Socio-Economic Profile (2011 Census): Total Population, Household Size, Age, Gender Composition, SC/ST, Literacy Level, Occupational Structure, etc.

89. **Micrometeorology.** As a part of the study, the micrometeorology and microclimatic parameters were recorded by using a weather monitoring station. Information related to wind velocity; wind direction, ambient temperature and relative humidity were recorded. From the observation, the maximum temperature of 36.5^{o}C was recorded for the month of April 2017 and minimum temperature of 25.7^{o}C was recorded for the month of June 2017. The predominant wind direction was towards South West Direction during the study period. Using the data, suitable wind rose diagram are also prepared and depicted in the Figures 6, 7 and 8 respectively. The maximum wind velocity was observed 13 m/s during the period of June 2017, and the minimum wind velocity was observed 1 m/s during the period of April and May 2017. Relative Humidity ranges from 60 % to 96 %. The maximum humidity was observed during the month of June 2017 and the minimum humidity was observed in April 2017. The outcome of the monitoring is given in the Table 22, 23 and 24 respectively.

Table 22: Meteorological Data for the Month of April 2017

Date	Temperature (^{o}C)	Wind Direction	Wind Velocity (m/s)	Relative Humidity
01 April 2017	33	130	2	72
02 April 2017	33.4	135	3	79
03 April 2017	35	140	4	78
04 April 2017	34.8	145	3	67

Date	Temperature (ºC)	Wind Direction	Wind Velocity (m/s)	Relative Humidity
05 April 2017	36.1	150	2	61
06 April 2017	36.5	135	3	60
07 April 2017	35.4	130	4	74
08 April 2017	35.5	125	3	70
09 April 2017	34.3	55	3	72
10 April 2017	35	60	3	71
11 April 2017	35	130	3	64
12 April 2017	34.4	135	2	73
13 April 2017	29	145	3	75
14 April 2017	28.3	150	2	79
15 April 2017	30.5	140	2	91
16 April 2017	29.3	130	1	88
17 April 2017	30.5	145	2	78
18 April 2017	30.5	130	2	71
19 April 2017	31.3	135	1	70
20 April 2017	32.3	125	2	76
21 April 2017	31.7	130	2	69
22 April 2017	32.3	135	3	71
23 April 2017	33.5	145	3	79
24 April 2017	31.9	140	3	71
25 April 2017	33.4	65	2	83
26 April 2017	31.3	60	2	74
27 April 2017	30.8	55	1	87
28 April 2017	31.1	60	3	84
29 April 2017	32.6	50	3	84
30 April 2017	33	55	3	71

Source: Primary Data.

Table 23: Meteorological data for the Month of May 2017

Date	Temperature (ºC)	Wind Direction	Wind Velocity (m/s)	Relative Humidity
01 May 2017	33.4	130	3	70
02 May 2017	33.8	135	3	79
03 May 2017	33.3	140	4	77
04 May 2017	32	135	2	84
05 May 2017	31.1	125	2	74
06 May 2017	31.5	145	2	78
07 May 2017	30.7	140	2	75
08 May 2017	31.7	290	3	75

Date	Temperature (°C)	Wind Direction	Wind Velocity (m/s)	Relative Humidity
09 May 2017	33.4	310	3	75
10 May 2017	33.1	320	3	77
11 May 2017	31.2	300	2	76
12 May 2017	31.5	305	3	76
13 May 2017	32	315	1	83
14 May 2017	28.5	310	1	80
15 May 2017	29.6	325	2	82
16 May 2017	31.2	295	2	78
17 May 2017	30.1	300	2	89
18 May 2017	29.6	305	4	90
19 May 2017	31.2	320	2	76
20 May 2017	32	310	4	85
21 May 2017	33	325	6	81
22 May 2017	32	315	5	84
23 May 2017	32	310	5	79
24 May 2017	31.1	325	6	82
25 May 2017	33.3	320	6	80
26 May 2017	33	295	6	77
27 May 2017	32.2	295	6	79
28 May 2017	29.8	300	5	88
29 May 2017	28.2	295	3	84
30 May 2017	32.4	300	5	71
31 May 2017	32.2	310	4	81

Source: Primary Data.

Table 24: Meteorological Data for the Month of June 2017

Date	Temperature (°C)	Wind Direction	Wind Velocity (m/s)	Relative Humidity
01 June 2017	32.5	225	5	86
02 June 2017	31	220	4	82
03 June 2017	28.6	250	3	79
04 June 2017	30.5	245	3	78
05 June 2017	29.4	230	2	96
06 June 2017	30.6	235	4	81
07 June 2017	32	220	5	68

Date	Temperature (°C)	Wind Direction	Wind Velocity (m/s)	Relative Humidity
08 June 2017	31.2	235	7	79
09 June 2017	31.2	250	6	80
10 June 2017	30.7	245	6	85
11 June 2017	32	230	5	88
12 June 2017	31.4	215	6	86
13 June 2017	28.9	230	5	86
14 June 2017	29.7	250	6	91
15 June 2017	27.2	225	13	83
16 June 2017	29	235	6	88
17 June 2017	28.3	230	6	81
18 June 2017	27.2	250	7	84
19 June 2017	27.4	215	7	86
20 June 2017	26.4	230	7	91
21 June 2017	28.3	205	8	93
22 June 2017	25.7	220	8	85
23 June 2017	28.7	240	9	86
24 June 2017	28.2	225	10	86
25 June 2017	30.3	225	9	83
26 June 2017	30.6	220	9	86
27 June 2017	27.4	225	8	83
28 June 2017	29	220	8	83
29 June 2017	30.4	235	7	83
30 June 2017	32	225	5	88

Source: Primary Data.

Figure 7: Wind Rose diagram for April 2017

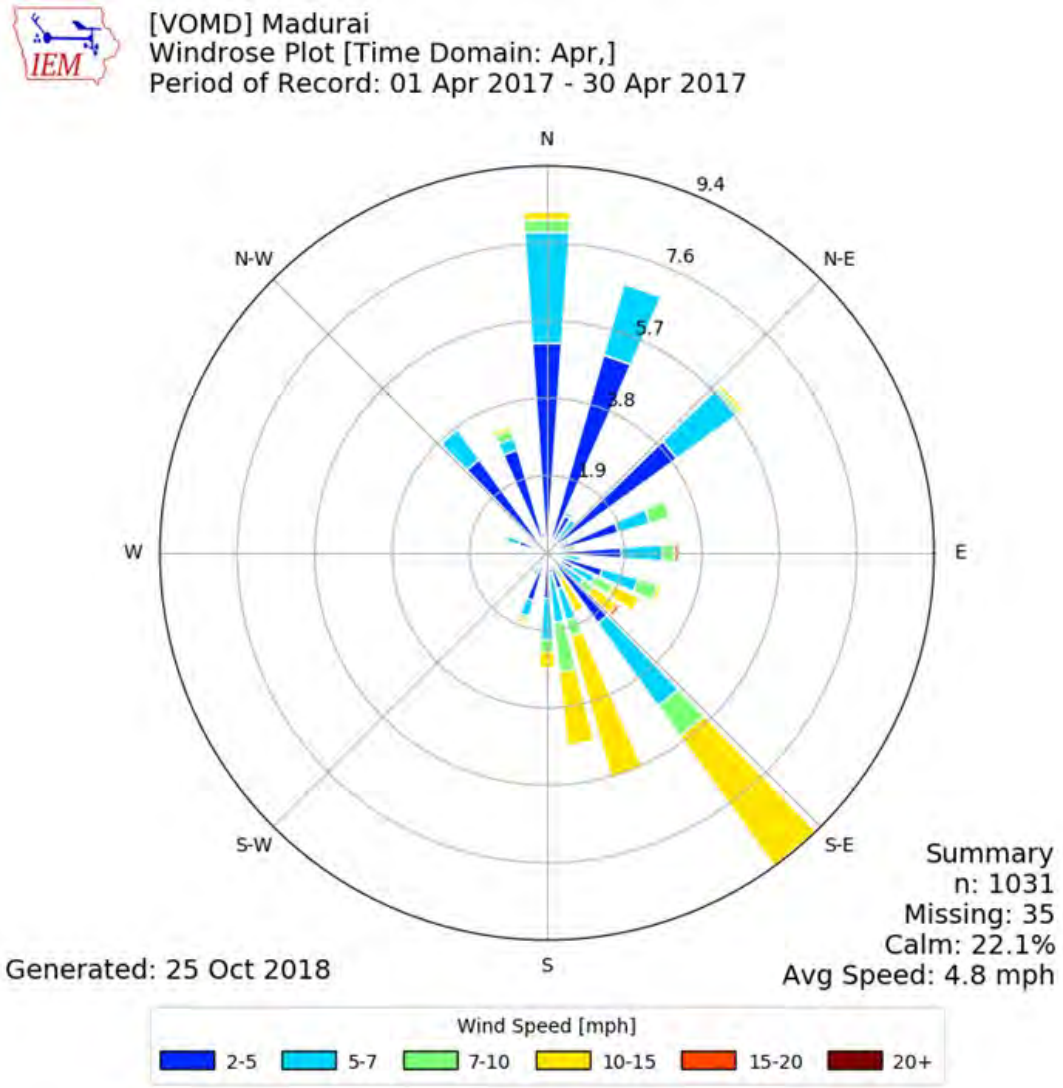


Figure 8: Wind Rose diagram for May 2017

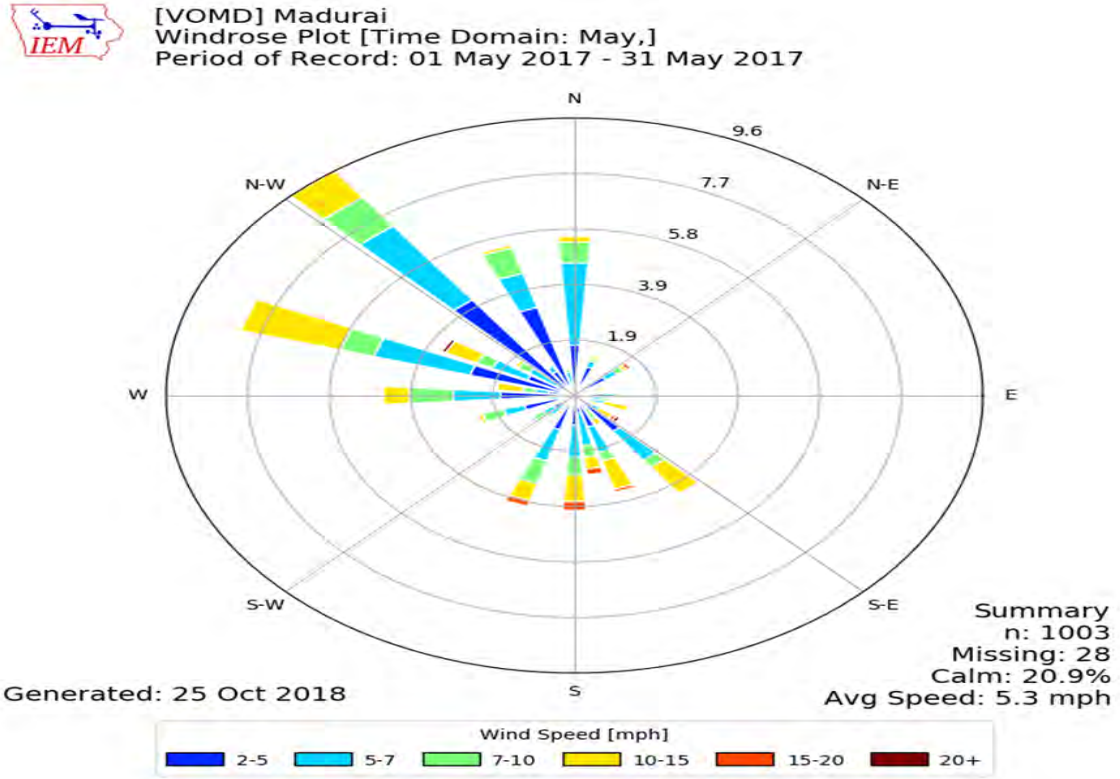
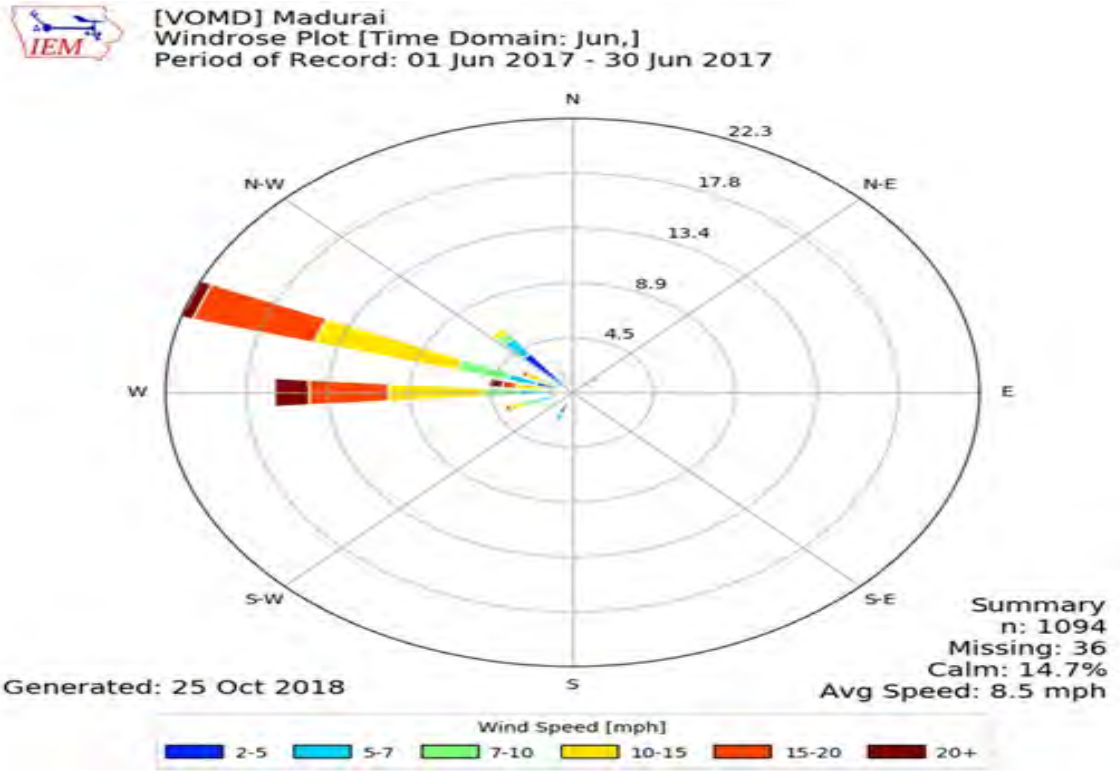


Figure 9: Wind Rose diagram for June 2017



90. The secondary data collected from IMD includes temperature, relative humidity, rainfall and wind speed. The monthly maximum, minimum and average values are presented in Table 22. All these parameters are recorded twice a day viz at 8:30 a.m. and 5:30 p.m.

91. **Temperature.**The winter season starts from December and continues until the end of February. December and January are the coolest month with the mean daily maximum temperature in winter season around 40.2ºC (in the month of May 2013) and the mean daily minimum temperature at 18.7ºC (in the month of January 2009). Both the night and day temperatures increase rapidly during the onset of the pre-monsoon season from March to May.

92. **Relative humidity.** The air is generally humid in this region during the post monsoon season. The relative humidity at 0830 hr was observed to be 98%. Similarly, at 1730 hr, the relative humidity was observed to be of 100%. In general, the weather during other seasons was observed to be dry.

93. **Rainfall.** The monsoon sets in the month of June and continues up to September and sometime extends up to mid-October. The maximum amount of rainfall (256.3 mm) occurs in the month of November.

Table 25: Meteorological Data (Madurai Station, 2009–2013)

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
I.ELEMENT: Monthly Mean Maximum Temperature (DEG C)												
2009	30.2	33.4	35.2	36.1	34.5	32.5	30.3	32	31.9	32.2	29.9	29.2
2010	30.6	33.3	36.2	37.3	35.3	32.9	31.5	30.9	31.9	31.7	29.1	28.9
2011	30.8	32.3	35.3	36.2	37.7	37.6	36.7	36.0	36.1	33.7	30.4	30.3
2012	30.9	33.1	36.7	37.8	38.6	39.2	39.1	38.0	37.5	33.7	32.7	32.8
2013	33.4	33.7	36.3	40.0	40.2	37.5	38.1	36.9	35.9	36.2	32.7	31.4
II. ELEMENT: Monthly Highest Maximum Temperature (DEG C)												
2009	32.5	37	37.7	38	37.4	37.2	35.6	33.9	35.1	34.2	33.1	32
2010	32.2	36	37.7	39.5	37.8	37	35	33.8	34.2	33.8	32.6	31.6
2011	32.0	35.0	36.8	38.4	39.4	40.0	40.0	38.4	37.0	36.4	32.8	31.6
2012	32.2	35.4	38.8	40.5	41.1	42.0	41.5	40.5	40.1	38.6	35.6	34.2
2013	34.6	36.5	39.3	41.9	42.0	40.2	40.8	39.0	38.6	39.2	34.6	34.4
III. ELEMENT: Monthly Mean Minimum Temperature (DEG C)												
2009	18.7	19.9	22.3	24.3	23.8	23.4	22.3	22.7	22.9	22.3	22.1	20.9
2010	20.3	20.8	23	25.1	25	23.5	22.6	22.4	22.6	22.5	21.7	20
2011	21.1	21.4	22.9	25.2	25.7	26.0	25.6	25.2	25.0	24.0	22.5	21.5
2012	20.3	21.5	24.5	25.7	26.4	26.4	26.2	25.4	25.3	23.9	23.0	22.4
2013	21.5	22.0	23.7	26.3	26.6	27.0	27.0	25.4	25.3	24.5	23.8	21.9
IV. ELEMENT: Monthly Lowest Minimum Temperature (DEG C)												
2009	16.1	17.8	19.7	22.6	21.4	21.2	21	21.6	21.6	20.2	19	17.8
2010	17.4	17.4	19.8	23	22	21.6	21.3	21.2	20.4	20.8	19	16.6
2011	16.6	16.0	20.2	23.0	22.0	23.8	22.0	23.7	23.0	22.2	18.5	17.0

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
2012	16.4	18.5	20.3	22.0	22.0	24.7	24.5	23.5	23.5	22.7	20.4	19.7
2013	19.0	17.0	19.1	24.0	25.1	25.2	26.0	22.6	23.6	22.0	21.6	19.4
V. ELEMENT: Monthly Mean R.H. at 0830 HRS IST (%)												
2009	78	68	71	73	79	77	82	82	81	75	86	81
2010	80	77	71	73	78	80	81	83	80	82	89	86
2011	75	72	70	71	65	61	61	64	62	76	78	77
2012	75	69	68	71	64	56	58	63	63	74	73	70
2013	70	72	69	65	57	59	54	63	67	66	74	74
VI. ELEMENT: Monthly Highest R.H. at 0830 HRS IST (%)												
2009	88	88	87	85	88	93	92	96	92	94	96	93
2010	91	86	88	81	91	95	91	98	95	96	98	96
2011	85	88	87	92	83	87	70	87	75	96	96	91
2012	85	82	77	87	73	66	77	79	80	91	87	86
2013	77	95	87	75	70	68	62	80	90	93	90	91
VII. ELEMENT: Monthly Lowest R.H. at 0830 HRS IST (%)												
2009	68	50	48	61	59	64	69	75	66	49	64	72
2010	67	60	53	58	64	66	65	74	64	66	68	75
2011	64	54	59	57	51	49	52	52	54	61	58	64
2012	60	44	56	60	54	44	49	48	50	58	62	58
2013	62	51	51	52	49	49	45	45	49	49	61	62
VIII. ELEMENT: Monthly Mean R.H. at 1730 HRS IST (%)												
2009	35	23	27	37	55	61	67	63	67	51	68	57
2010	30	29	25	40	58	65	66	67	63	71	73	60
2011	56	48	37	49	45	45	49	52	52	66	69	64
2012	50	42	37	49	52	47	44	54	51	67	60	57
2013	47	46	43	41	44	50	46	55	54	54	61	54
IX. ELEMENT: Monthly Highest R.H. at 1730 HRS IST (%)												
2009	52	37	70	60	90	91	93	83	76	91	92	97
2010	71	40	45	65	85	90	95	85	74	96	95	98
2011	77	82	47	95	88	80	84	87	93	90	96	95
2012	88	63	45	100	92	95	76	95	80	95	74	92
2013	87	72	92	75	65	63	62	95	88	92	89	80
X. ELEMENT: Monthly Lowest R.H. at 1730 HRS IST (%)												
2009	16	14	11	13	37	41	48	42	45	42	48	33
2010	26	15	10	21	44	47	51	46	49	45	52	37
2011	46	36	23	30	34	33	40	38	35	46	49	31

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
2012	33	19	24	36	40	35	33	33	38	38	47	42
2013	38	27	26	33	32	40	38	38	40	31	50	39
XI. ELEMENT: Monthly Total Rainfall (MM)												
2009	0	0	5.8	3.1	91	8.7	42.8	55.9	68.7	51.3	227	1.3
2010	0.1	0	0	17.7	57.8	31.9	14.8	60.1	30.8	132.2	256.3	34.7
2011	7.4	42.9	0.4	52.5	68.9	28.2	70.4	65.2	74.0	219.1	189.1	15.5
2012	13.9	Trace	0.4	111.1	61.8	18.3	15.8	91.2	57.1	187.9	9.6	3.5
2013	3.9	23.1	18.2	12.8	25.2	6.9	0.1	195.5	44.3	182.2	33.7	80.5
XII. ELEMENT: Monthly Mean Windspeed (KMPH)												
2009	3	4	4	6	9	10	11	9	9	5	3	4
2010	5	4	6	7	9	11	12	12	9	8	3	4
2011	5	6	5	4	4	4	4	4	4	3	5	5
2012	5	6	5	4	3	5	5	4	4	4	4	7
2013	12	6	6	5	4	6	6	4	4	3	4	5

Source: IMD.

94. **Ambient air quality.** The prime objective of the baseline air quality study was to assess the existing air quality of the project area. This will also be useful for assessing the conformity to standards of the ambient air quality during the construction and operation of the subproject. The study area represents mostly vacant/ barren land, agricultural and commercial cum residential landuse. This section describes the selection of sampling locations, methodology adopted for sampling, analytical techniques and frequency of sampling. The results of monitoring carried out for study period of April to June 2017 is presented in the following sections.

1. Selection of Sampling Locations

95. The ambient air quality has been assessed through a scientifically designed ambient air quality monitoring network based on the following considerations:

(i) Meteorological conditions;
(ii) Topography of the study area;
(iii) Representative of regional background air quality for obtaining baseline status; and
(iv) Representatives of likely impact areas.

96. Ambient Air Quality Monitoring (AAQM) stations were set up at eight locations with due consideration to the above-mentioned points. The AAQM locations are depicted in Figure 11.

2. Particulate Matter (PM_{10} & $PM_{2.5}$)

97. Based on the outcome of the analysis, the PM_{10} and $PM_{2.5}$ varied from 31 to 58 µg/m^3 and 14 to 26 µg/m^3 respectively. The observed values are below than the stipulated limits of AAQ standards. The results are presented in Tables 26 and 27 respectively.

Table 26: Ambient Air Quality Status (PM_{10}) – (April – June 2017)

Averaging Time: 24 hrs Unit: µg/m^3

Sl. No.	Sampling Station	Max	Min	Arithmetic Mean	Standard Deviation	98th Percentile
AAQ1	Lower Camp	53	41	50	3.6	53
AAQ2	Gudalur	53	46	50	2.8	53
AAQ3	Cumbum	58	43	48	3.8	58
AAQ4	Chinnamanur	51	40	47	3.6	51
AAQ5	Theni	49	38	43	2.7	49
AAQ6	Pannaipatti	41	34	38	2.3	41
AAQ7	Samayanallur	43	31	39	3.7	43
AAQ8	Madurai	47	38	43	3.4	47

Note: PM_{10} Permissible limit for industrial, Residential, Rural and other area is 100 µg/m^3.

Table 27: Table 27: Ambient Air Quality Status ($PM_{2.5}$) – (April – June 2017)

Averaging Time: 24 hrs Unit: µg/m^3

Sl. No.	Sampling Station	Max	Min	Arithmetic Mean	Standard Deviation	98th Percentile
AAQ1	Lower Camp	26	21	24	1.6	26
AAQ2	Gudalur	25	18	23	1.8	25
AAQ3	Cumbum	23	18	22	1.5	23
AAQ4	Chinnamanur	25	18	21	1.8	25
AAQ5	Theni	21	16	19	1.2	21
AAQ6	Pannaipatti	20	15	17	1.4	20
AAQ7	Samayanallur	21	14	18	2.0	21
AAQ8	Madurai	22	16	19	1.8	22

Note: $PM_{2.5}$ Permissible limit for industrial, Residential, Rural and other area is 60 µg/m^3.

3. Sulphur Dioxide (SO_2)

98. From the observation, the recorded SO_2 concentration was in the range between 07 to 19 µg/m^3. Maximum concentration was recorded in Chinnamanur (19 µg/m^3) and minimum concentration was recorded in Pannaipatti (7 µg/m^3). The results are shown in theTable 28.

Table 28: Ambient Air Quality Status (SO_2) - (April – June 2017)

Averaging time: 24 hrs. Unit: µg/m^3

Sl. No.	Sampling Station	Max	Min	Arithmetic Mean	Standard Deviation	98th Percentile
AAQ1	Lower Camp	18	13	15	1.6	18
AAQ2	Gudalur	13	08	11	1.6	13

Sl. No.	Sampling Station	Max	Min	Arithmetic Mean	Standard Deviation	98th Percentile
AAQ3	Cumbum	10	07	9.0	1.0	10
AAQ4	Chinnamanur	19	09	12	2.3	19
AAQ5	Theni	15	11	13	1.4	15
AAQ6	Pannaipatti	12	07	10	1.6	12
AAQ7	Samayanallur	17	12	14	1.7	17
AAQ8	Madurai	16	10	13	1.6	16

Note: Permissible limit of SO_2 for Industrial, Residential, Rural and other area is 80 µg/m^3.

4. Oxides of Nitrogen (NO_2)

99. The Nitrogen dioxide concentration in the subproject area was in the range of 13 to 34 µg/ m^3. The maximum concentration was recorded in Lower camp (30 µg/ m^3) and minuimum concentration was recorded in Cumbum (13 µg/ m^3) presented in Table 29.

Table 29: Ambient Air Quality Status (NO_2) (April – June 2017)

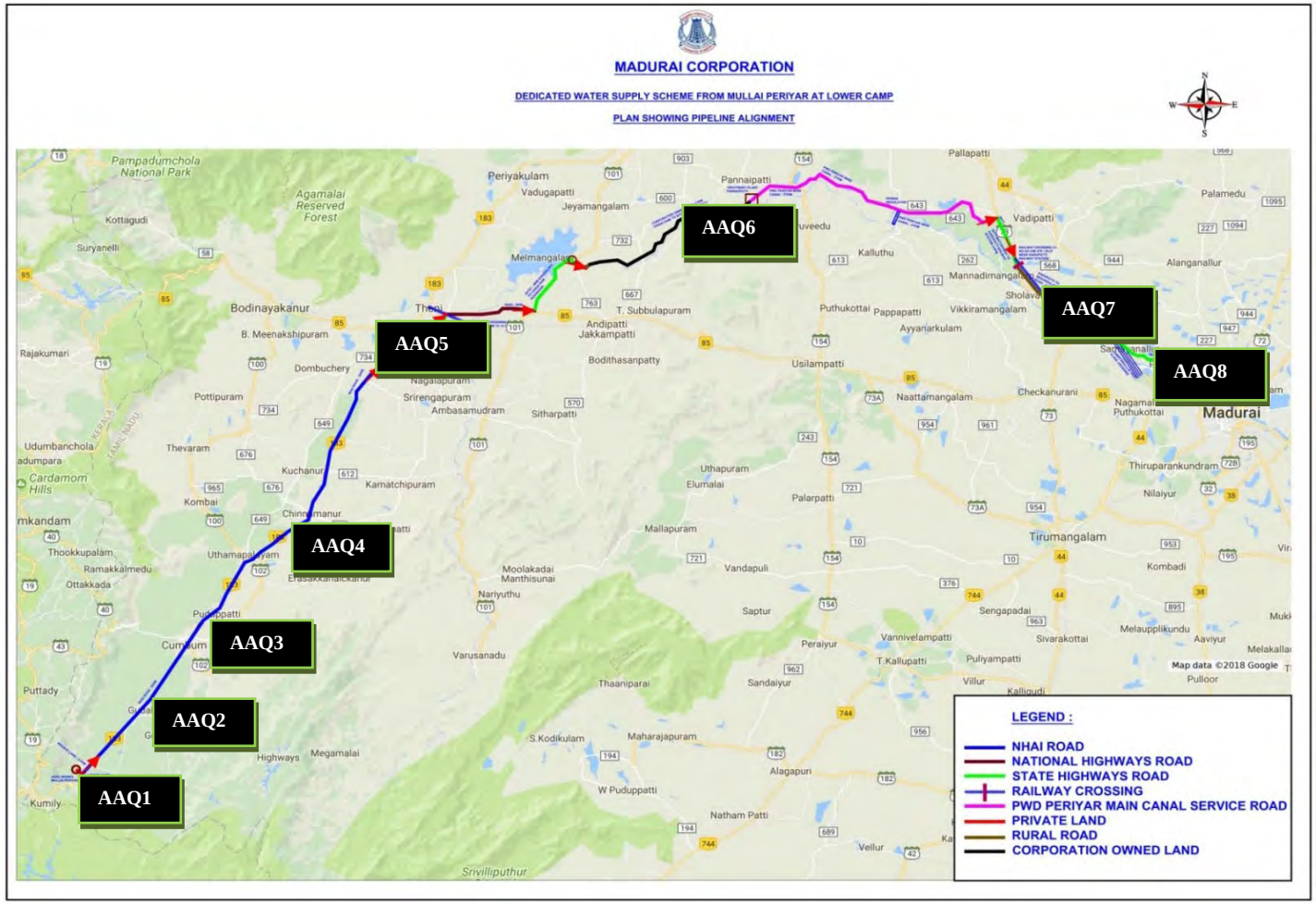
Averaging Time: 24 hrs. Unit: µg/m^3

Sl. No.	Sampling Station	Max	Min	Arithmetic Mean	Standard Deviation	98th Percentile
AAQ1	Lower Camp	34	24	27	2.8	34
AAQ2	Gudalur	20	17	19	1.1	20
AAQ3	Cumbum	16	13	15	1.0	16
AAQ4	Chinnamanur	21	15	19	1.6	21
AAQ5	Theni	24	18	22	2.9	24
AAQ6	Pannaipatti	18	14	17	1.4	18
AAQ7	Samayanallur	30	21	26	2.6	30
AAQ8	Madurai	27	18	24	3.2	27

Note: Permissible limit of NO_2 for Industrial, Residential, Rural and other area is 80 µg/m^3.

Figure 10: Ambient Air Quality Sampling Photos

Figure 11: Ambient Air Quality Sampling Location Map



Station	Ground Water Sampling Location
AAQ 1	Lower Camp
AAQ 2	Gudalur
AAQ 3	Cumbum
AAQ 4	Chinnamanur
AAQ 5	Theni
AAQ 6	Pannaipatti
AAQ 7	Samayanallur
AAQ 8	Madurai

100. **Noise Environment**. The main objective of noise monitoring in the study area is to establish the baseline noise levels and assess the impact of the total noise expected to be generated by the construction and operation of the proposed activity.

1. Identification of Sampling Locations

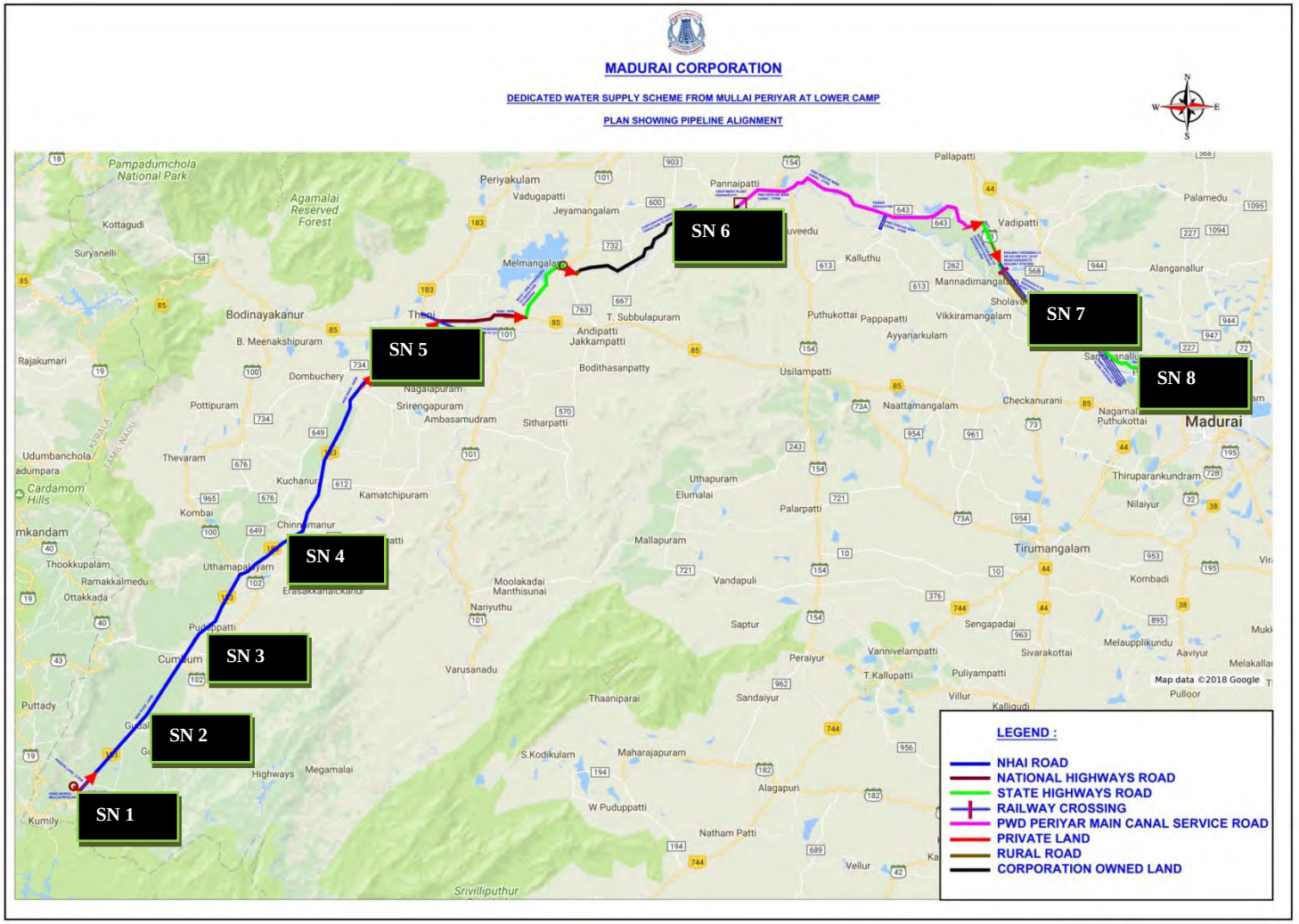
101. A preliminary reconnaissance survey has been undertaken at 8 locations to identify the major noise generating sources in the area and accordingly sampling locations are fixed (refer Figure 12). The noise levels at each location were recorded for 24 hours. The outcome of the monitoring is given in the Table 30**.**

Table 30: Equivalent Day-Night Noise Level Details

Station No.	Sampling Stations	Equivalent Levels dB(A)			
		Day Time		Night Time	
		Min	Max	Min	Max
SN1	Lower Camp	63.5	71.8	57.2	67.9
SN2	Gudalur	61.9	72.5	59.8	69.1
SN3	Cumbum	62.9	72.3	55.8	68.9
SN4	Chinnamanur	65.1	71.9	57.2	64.5
SN5	Theni	66.1	73.9	56.8	64.5
SN6	Pannaipatti	61.9	72.9	51.8	61.8
SN7	Samayanallur	59.9	73.9	57.9	63.9
SN8	Madurai	61.8	73.1	56.8	63.8

102. The daytime noise levels range between 61.8 dB(A) and 73.9 dB(A). The maximum value 73.9 dB (A) was recorded at Theni and the minimum value (61.8 dB [A]) was recorded at Madurai.The nighttime noise levels ranges between 51.8 dB (A) and 69.1 dB (A). The maximum value (69.1dB [A]) was recorded at Gudalur and the minimum value (51.8 dB [A]) was recorded at Pannaipatti.

Figure 12: Noise Sampling Location Map



Stations	Ground Water Sampling Location
SN1	Lower Camp
SN 2	Gudalur
SN 3	Cumbum
SN 4	Chinnamanur
SN 5	Theni
SN 6	Pannaipatti
SN 7	Samayanallur
SN 8	Madurai

103. **Water Quality Monitoring.** The purpose of this study is to assess the water quality characteristics in the subproject area. Understanding the water quality is essential in preparation of report and to identify critical issues with a view to suggest appropriate mitigation measures for implementation. The information required has been collected through primary surveys and secondary sources.

104. **Ground Water Quality**. Water samples were collected from eight locations. These samples were taken as grab samples and were analyzed for physico-chemical parameters to compare with the standards for drinking water (IS:10500).

(i) The analysis results indicate that the pH ranges in between 7.0 to 7.8, which is well within the specified standard (6.5 to 8.5). The maximum pH of 7.8 was observed at Gudalur and the minimum pH of 7.0 was observed at Chinnamanur and Samayanallur;

(ii) Total hardness was observed to be ranging from 44 to 1222 mg/l. The maximum hardness was recorded at Pannaipatti and the minimum was recorded at Samayanallur;

(iii) Chlorides were found to be in the range of 179 mg/l to 975 mg/l, the maximum concentration of chlorides was observed at Pannaipatti and whereas the minimum value was observed at Cumbum;

(iv) Sulphates were found to be in the range of 12 mg/l to 244 mg/l. The maximum value observed at Pannaipatti whereas the minimum value observed at Samayanallur; and

(v) The Total Dissolved Solids (TDS) concentrations were found to be ranging in between 89 to 3680 mg/l, the maximum TDS observed at Pannaipatti and minimum concentration of TDS observed at Samayanallur.

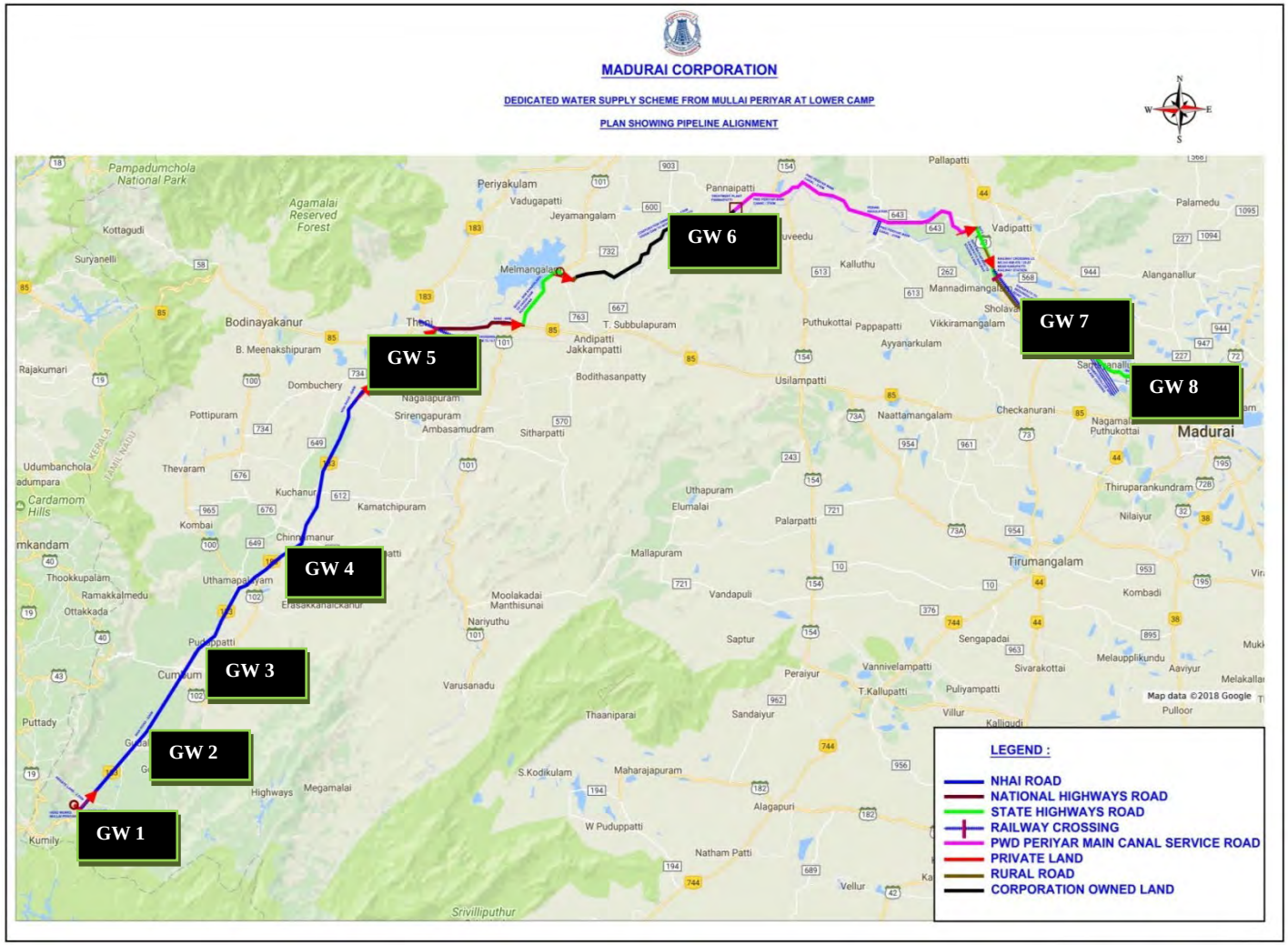
105. The locations of ground water samples are shown in Figure 14 and the results of ground water samples are given in Table 31.

Table 31: Results of Water Quality Parameters

Parameters	Units	GW1	GW2	GW3	GW4	GW5	GW6	GW7	GW8
Calcium as Ca	mg/l	182	90	182	339	151	306	50	154
Chlorides as Cl	mg/l	188	487	179	901	272	975	220	247
Color	Hazen	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<0.1
Electrical Conductivity	µmhos/cm	1535	1431	1372	2410	1798	5661	1337	1498
Fluoride as F	mg/l	0.4	0.4	0.2	0.4	1.2	0.6	<0.1	0.4
Iron as Fe	mg/l	0.16	0.12	0.09	0.18	0.11	0.51	<0.01	0.14
Magnesium as Mg	mg/l	67	34	45	85	58	112	23	37
Nitrate Nitrogen as NO_3	mg/l	2.2	1.6	1.8	3.2	2.2	4.8	<1.0	2.0
pH	-	7.3	7.8	7.6	7.0	7.2	7.1	7.0	7.1
Sulphates	mg/l	18	106	26	114	114	244	12	28
Total Alkalinity as CaCO3	mg/l	460	332	277	138	449	510	55	389
Total Dissolved Solids	mg/l	998	930	892	1564	1169	3680	89	973
Total Hardness	mg/l	619	365	640	1191	613	1222	44	675
Turbidity	NTU	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5

Figure 13: Water Quality Sampling Photos

Figure 14: Water Sampling Locations



Stations	Ground Water Sampling Location
GW1	Lower Camp
GW 2	Gudalur
GW 3	Cumbum
GW 4	Chinnamanur
GW 5	Theni
GW 6	Pannaipatti
GW 7	Samayanallur
GW 8	Madurai

106. **Soil Quality**. The study on the soil profile establishes the baseline characteristics and identifies the incremental concentrations. The sampling locations have been identified with the following objectives:

(i) to determine the baseline soil characteristics of the study area; and
(ii) to determine the impact on soil more importantly from agricultural productivity point of view.

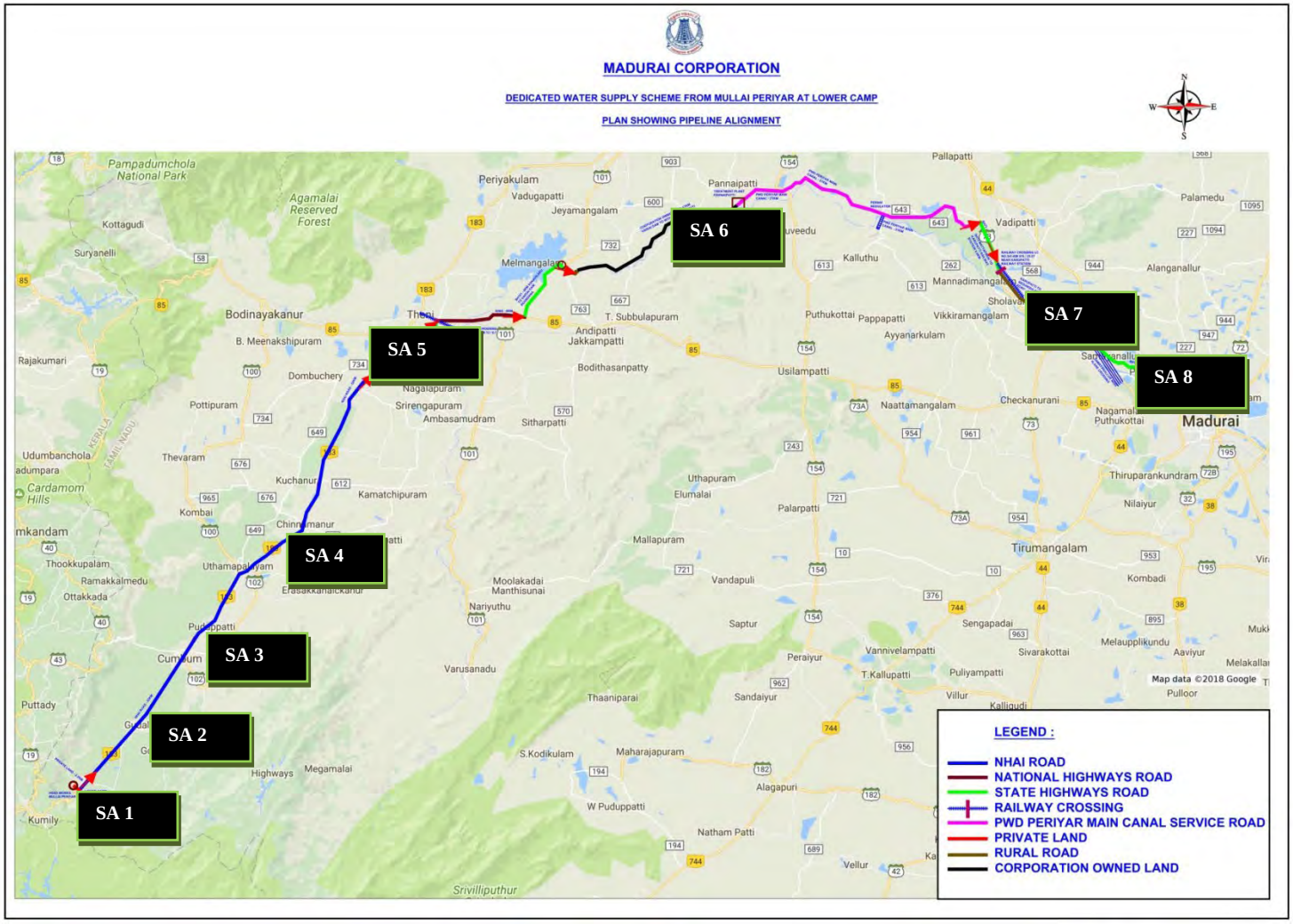
107. Eight locations in the study area were selected for soil sampling. At each location, soil samples were collected from three different depths viz. 30 cm, 60 cm and 90 cm below the surface and homogenized. The homogenized samples were taken to identify soil conditions. The samples were collected by ramming a core-cutter into the soil up to a depth of 90 cm. Simultaneously, in-situ infiltration test using double ring infiltrometer was carried out at all location to determine the permeability. The details of the sampling location is shown in Figure 15 and outcome of the results are given in Table 32.

(i) It has been observed that the pH of the soil in the study area ranged from 6.8 to 8.4 the maximum pH value of 8.4 was observed at Samayanallur, whereas the minimum value of 6.0 was observed at Gudalur & Cumbum;
(ii) The electrical conductivity was observed to be in the range of 95 mmhos/cm to 425 mmhos/cm, with the maximum observed at Lower camp with the minimum observed at Gudalur & Cumbum;
(iii) The nitrogen values range between 1.0 to 3.4%, with the maximum observed at Lower camp with the minimum observed at Madurai;
(iv) The phosphorus values < 0.1 kg/ha, indicating that the phosphorus content in the study area falls in average sufficient to more than Sufficient; and
(v) The potassium values range between 18–108 kg/acre, with the maximum observed at Madurai with the minimum observed at Gudalur.

Table 32: Results of Soil Quality Parameters

S. no	Parameters	Units	Results							
			SA-1	SA-2	SA- 3	SA- 4	SA- 5	SA - 6	SA-7	SA-8
1	pH	No.	8.0	6.8	6.8	6.9	8.3	7.4	8.4	7.2
2	EC	mmhos/cm	425	95	95	97	178	134	216	160
3	Texture	---	Sandy Loam	Sandy Loam	Sandy Loam	Sandy Loam	Sandy Loam	Sandy Loam	Sandy Loam	Sandy Loam
Macro Nutrients:										
4	Nitrogen	%	3.4	1.2	1.4	0.8	0.4	1.4	1.2	1.0
5	Phosphorus	%	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
6	Potassium	kg/Acre	38	18	58	12	64	92	26	108
Micro Nutrients:										
7	Iron	mg/kg	14164	8868	9344	9144	11615	11618	10144	9654
8	Manganese	mg/kg	165	121	166	116	194	208	158	156
9	Zinc	mg/kg	1.6	5.4	14	1.4	10	12	1.0	1.0
10	Copper	mg/kg	1.9	1.0	6.9	1.0	1.4	1.4	1.2	4.4

Figure 15: Soil Sampling Locations



Stations	Soil Sampling Locations
SA 1	Lower Camp
SA 2	Gudalur
SA 3	Cumbum
SA 4	Chinnamanur
SA 5	Theni
SA 6	Pannaipatti
SA 7	Samayanallur
SA 8	Madurai

1. Land environment

108. **Land Use Pattern.** Land use pattern for Madurai City as existed in1994, 2001 and in 2021 is as given in the following Table 33.

Table 33: Details of Land Use Pattern

Sl. No	Type of Land Use	Area in km²			% to the Developed Area		
		1994	2001	2021	1994	2001	2021
1	Residential	21.45	21.79	24.75	57.49	57.49	50.36
2	Commercial	1.94	4.14	4.7	5.32	5.32	9.57
3	Industrial	2.1	3.12	3.12	5.63	5.63	6.35
4	Education	1.72	3.62	3.62	4.61	4.61	7.36
5	Public & Semi-Public	2.65	4.66	4.66	7.1	7.1	9.49
6	Transportation / Circulation	7.41	8.29	16.86	19.85	19.85	8.29
7	Sub-Total (Developed Area)	37.32	45.61	49.14	100	100	100
8	WaterBodies	5.03	2.07	2.07	--	--	--
9	Agriculture	9.48	4.14	0.61	--	--	--
10	Sub-Total (Un-DevelopedArea)	14.06	6.21	2.68	--	--	--
	Total	**51.82**	**51.96**	**51.96**	--	--	--

km = kilometer.

109. **Topography**. In general, the topography of the MMC is gently sloped towards Vaigai River. There are small hillockswithin the Madurai District, but not within the city limit (MMC). These are located at Anaimalai, Nagamalai, Pasumalai and Sikandamalai and the distant ranges of Sirumalai, Karandamalai, Alagar Malai and Aaliur Hill, which form the panoramic landscape features.

Figure 16: Topographic map of Madurai City

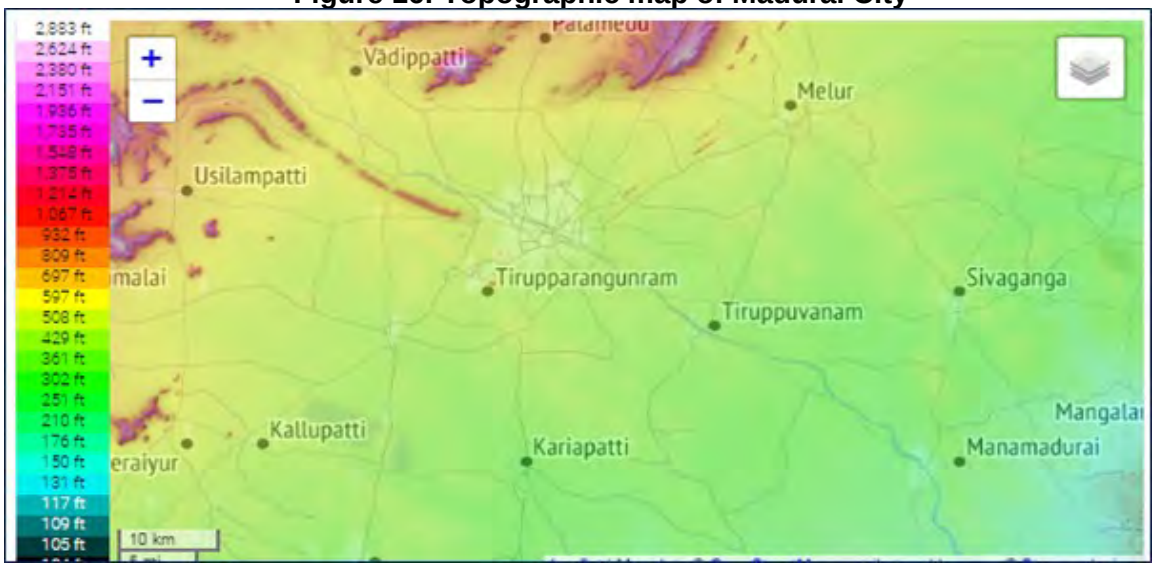
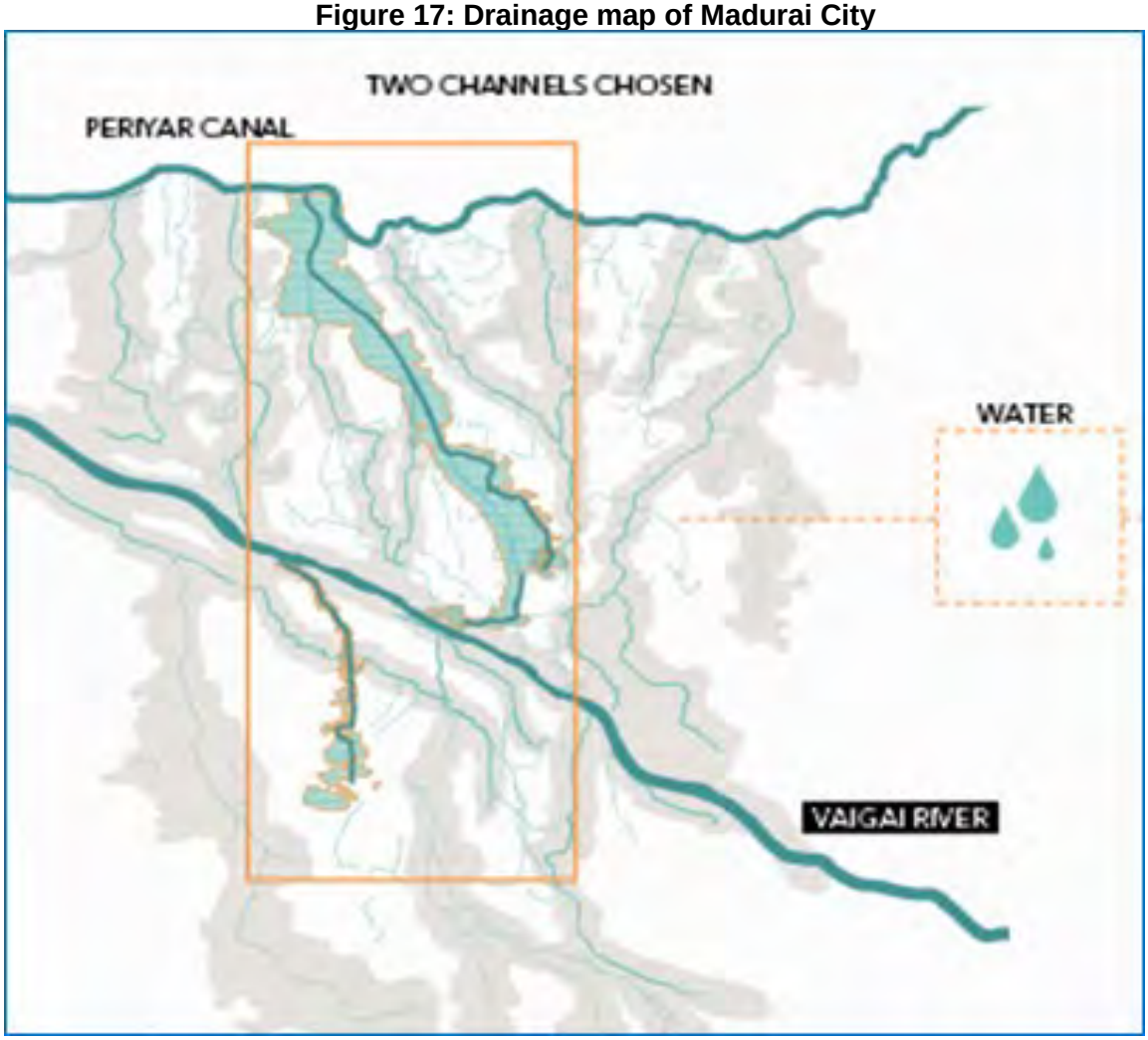


Figure 17: Drainage map of Madurai City



110. **Drainage**. Vaigai, a major ephemeral river originates in Western Ghats of Theni District flow in NW-SE direction, in the central part of the district. In addition, tributaries of Vaipar and Gundar drain in south-western part of the district, while the tributaries of Pambar drained in northeastern part. The general flow direction of the drainage is NW-SE.

C. Biological Environment

111. The main objective of the study is to provide necessary information on floristic structure of the study area. The climatic and biotic variations and composition of species, which are adapted to these variations, have resulted in different vegetation covers. The tree species, shrubs, herbs, climbers and grasses were documented during the study period. The tree species observed in the study area are listed in Table 31; the shrubs observed in the study area are documented in Table 32; the herbs & grasses in Table 33 and climbers in Table 34.

112. **Tree species**. Fifty-two tree species belonging to 24 families were observed in the study area (Table 34). The dominant tree species in the study area are *Anacardium occidentale*, *Coccus nucifer*, *Albizia lebbeck*, *Delonix regia, Casuarina equisetifolia, Musa paradisiaca. Ficus benghalensis, Anacardium occidentale, Phoenix sylvestris*and *Erythrina indica.*

Table 34: List of Tree Species

S. No	Family Name	Botanical Name	Vernacular name
1	*Anacardiaceae*	*Mangifera indica*	Mamaram
		Lannea coromandelica	Otti
2	*Annonaceae*	*Polyalthia longifolia*	Nettilingam
3	*Arecaceae*	*Borassus flabellifer*	Panai
		Caryota urens	Kuntharpanai
		Coccus nucifera	Thennai
		Roystonea regia	Arasapanai
		Spathodea campanulata	Patadi
4	*Apocynaceae*	*Alstonia scholaris*	Yelilai pillai
		Plumeria alba	Perunkalli
		Plumeria rubra	Perunkalli
5	*Caesalpiniaceae*	*Cassia fistula*	Sarakondrai
		Cassia siamea	Manjalkondrai
		Peltophorum pterocarpum	Perunkondrai
		Tamarindus indica	Puliyamaram
6	*Cannabaceae*	*Trema orientalis*	Yeralai
7	*Caricaceae*	*Carica papaya*	Pappali
8	*Casuarinaceae*	*Casuarina equisetifolia*	Savukku
9	*Combretaceae*	*Terminalia catapa*	Patham
10	*Euphorbiaceae*	*Euphorbia tirucalli*	Kalli
11	*Fabaceae*	*Acacia auriculiformis*	Kathi savukku
		Bauhinia purpurea	Mantharai
		Delonix regia	Semmayir kondrai
		Gliricidia sepium	Seemai agathi
		Leucaena leucocephala	Periyathagarai
		Pongamia glabra	Pungan
		Pongamia pinnata	Pungan
12	*Lamiaceae*	*Gmelina arborea*	Kumalamaram
		Tectona grandis	Thekku
13	*Lecythidaceae*	*Barringtonia acutangula*	senkadampu
14	*Malvaceae*	*Thespesia populnea*	Poovarasu

S. No	Family Name	Botanical Name	Vernacular name
15	*Meliaceae*	*Azadiracta indica*	Vembu
16	*Mimosaceae*	*Acacia nilotica*	Karuvelai
		Albizia lebbeck	Vagai
		Pithecellobium dulce	Kodikai
		Samanea saman	Thungumunji maram
17	*Moraceae*	*Ficus bengalensis*	Aalamaram
		Ficus hispita	Peiaththi
		Ficus racemosa	Anai athi
		Ficus regiosa	Arasamaram
18	*Moringaceae*	*Moringa oleifera*	Murungai
		Morinda tinctoria	Manjanethi
19	*Musaceae*	*Musa paradisiacal*	Valai
20	*Myristicaceae*	*Myristica fragrans*	Sathikai
21	*Myrtaceae*	*Callistemon lanceolatus*	*Bottle brush*
		Eucalyptus	Thailamaram
		Syzygium cumini	Naval
22	*Rubiaceae*	*Neolamarckia cadamba*	Cadampam
23	*Rutaceae*	*Aegle marmelos*	Vilvam
		Murraya exotica	-
		Murraya koenigii	Karuvepillai
24	*Sapotaceae*	*Manilkara zapota*	Sapotta

113. **Shrub Species.** During the survey a total of 26 shrub species belonging to 17 families from the study area were observed. The dominant shrubs in the study area were *Calotropis gigantea*, *Calotropis procera*, *Tecoma stans*, *Jatropha curcas*, *Ricinus communis, Ipomoea carnea*, *Ziziphus jujube*, *Solanum torvum* and *Ricinus communis*. The shrubs observed in the study area are given in the Table 35.

Table 35: List of Shrub Species

S. No	Family Name	Botanical Name	Vernacular name
1	Apocynaceae	*Nerium indicum*	Arali
		Nerium oleander	Sevvarali
		Tabernaemontana divaricata	Nanthiyavattai
2	Asclepidaceae	*Calotropis Gigantea*	Vellerukku
		Calotropis procera	Erukku
	Bignoniaceae	*Tecoma stans*	Nagasambagam
3	Convolvulaceae	*Ipomoea carnea*	Kulai kuchi
	Euphorbiaceae	*Jatropha curcas*	Kattamanakku
4		*Ricinus communis*	Amanakku
5	Leguminaceae	*Bauhinia racemosa*	kattathi
6	Lythraceae	*Lawsonia innemis*	Maruthani
	Malvaceae	*Hibiscus rosa-sinensis*	Semparuthi
7	Mimosaceae	*Projopis juliflora*	Seemai karuvelam
8	Nyctaginaceae	*Bougainvilla spectabilis*	Kakitha poo
9	Pandanaceae	*Pandanus parkinson*	Thazhai
10	Rhamnaceae	*Ziziphus rugosa*	Ilanthai
11	Rosaceae	*Rosa indica*	Rose
12	Rubiaceae	*Ixora coccinia*	Idly poo
13	Rutaceae	*Citrus medica*	Elumichai
14	Solanaceae	*Datura stramonium*	Umaththai
15	Solanaceae	*Xanthium strumarium*	Marulumaththai

16	Verbinaceae	*Clerodendrum inerme*	Sangam
		Duranta erecta	
		Lantana camara	Unni sedi
		Vitex negundo	Notchi

114. **Herb Species**. At the time of survey, the herb and grasses are observed to be dried (during summer season); however, few herbs and grass are observed in the surroundings of the riverbank and ponds/ tanks. As per the inventory, there are a total 42 herb and grass species belonging to 23 families were recorded (Table 36). Some of the common species identified are *Nymphaea* sp, *Ruellia tuberosa*, *Typha angustifolia*, *Aerva lanata* and *Nymphaea sp.*

Table 36: List of Herbs and Grasses in the Study Area

S. No	Family Name	Botanical Name	Vernacular name
1	Acanthaceae	*Asteracantha longifolia*	Neermulli
2	Amaranthaceae	*Achyranthes aspera*	Nayuruvi
		Celosia argentea	Kozhi poo
3	Apocynaceae	*Catharanthus roseus*	Nithya kalyani
4	Araceae	*Colocasia esculenta*	Samai kilangu
5	Asteraceae	*Ageratum conyzoides*	Appakkoti
		Eclipta alba	Karisalan kanni
		Tridax procumbens	Thatha poochedi
		Wedelia trilobata	Manjal karisalankanni
6	Brassicaceae	*Rapanus sativus*	Mullangi
7	Caesalpiniaceae	*Cassia tora*	Sirukondrai
		Cassia alata	Seemai agathi
8	Convolvulaceae	*Merremia emarginata*	Elikkadhu-keerai
9	Cyperaceae	*Cyperus rotundus*	Korai
10	Euphorbiaceae	*Acalypha indica*	kuppaimeni
		Euphorbia hirta	Amman pacharisi
11	Fabaceae	*Tephrosia purpurea*	Kolinchi
12	Lamiaceae	*Hyptis suaveolens*	Nattapoochedi
		Leucas aspera	Thumbai
13	Nelumbonaceae	*Nelumbo nucifera*	Thamarai
14	Nyctaginaceae	*Boerhavia diffusa*	Mukkuruttai kodi
15	Nymphaeaceae	*Nymphaea odorata*	Alli
16	Pedaliaceae	*Pedalium Murex*	Yanai nerunchi
17	Poaceae	*Bambusa bambos*	Moongil
		Cynodon dactylon	Arugam pul
		Heteropogon contortus	-
		Oriza sativa	Nel
		Panicum miliare	samai
		Paspalum scrobiculatum	Varagu
		Saccharum arundinaceum	Nanal
		Saccharum officinarum	Karumpu
18	Polygonaceae	*Polygonum glabrum*	Sivappu Kumbakodaali
19	Ponterderiaceae	*Eichhornia crassipes*	Agaya thamarai
20	Portulacaceae	*Portulaca oleracea*	Siru pasalai
21	Solanaceae	*Lycopersicon esculentum*	Thakkali
		Physalis minima	Sodakku thakkali
		Solanum melongena	kaththari
		Solanum trilobatum	Thuthuvalai
		Solanum virginianum	Kandankathiri
		Solanum xanthocarpum	Sundai kai

S. No	Family Name	Botanical Name	Vernacular name
22	Typhaceae	*Typha angustifolia*	Sambu
23	Zygophylacaeae	*Tribulus terrestris*	Nerunchi

115. **Climbers.** The climbers were observedin the riverside and ponds/ tanks of the study area. Totally 9 climber species belonging to 7 families were noted from the study area Table 37. Some of the common species identified in the project area are *Ipomoea sp, Solanum trilobatum, Clitoria ternatea* and *Luffa acutangular.*

Table 37: List of Climbers in the Study Area

S. No	Family Name	Botanical Name	Vernacular name
1	Asclepidaceae	*Pergularia daemia*	Veliparuthi
2	Convolvulaceae	*Ipomoea aquatica*	vallai
		Ipomoea digitata	Nilapoosani
		Ipomoea pes-caprae	Aatukkal
3	*Cucurbitaceae*	*Citrullus lanatus*	peikumatti
4	Fabaceae	*Luffa acutangula*	Aagasaveni
5	Menispermaceae	*Clitoriat ernatea*	Sangu poo
6	Polygonaceae	*Cocculus hirsutus*	Kattu kodi
7	Sapindaceae	*Antigonon leptopus*	Kodi rose

116. **Fauna.** Faunal survey covers the terrestrial fauna, avian fauna and aquatic fauna. The survey was based on visual observation, enquiry with local population and records available. This survey will include identification of endangered and rare species as per Red Book. Both direct and indirect observation methods were used to survey the fauna. Visual encounter (search) method was employed to record vertebrate species. Additionally, survey of relevant literature was also done to consolidate the list of vertebrate fauna distributed in the area (*Smith 1933-1943, Ali and Ripley 1983, Daniel 1983, Prater 1993, Murthy and Chandrasekhar1988*). Since birds may be considered as indicators for monitoring and understanding human impacts on ecological systems (*Lawton, 1996*).

117. Based on the Wildlife Protection Act, 1972 (*WPA 1972, Anonymous 1991, Upadhyay 1995, Chaturvedi and Chaturvedi 1996*) species were short-listed as Schedule II or I and where referred during the study. As per the study, there is no endangered / red list species in the study area.

118. **Birds.** The different species of birds are observed in the study area during the study period and they are given below and also enlisted in the Table 38. The common important birds species observed in the study area are*Acridotheres tristicus,Alcedo atthis, Anas crecca, Ardea alba, Ardea cinerea, Bubo, Bubulcus ibis, pycnonotus jokonus, Centropus sinensis, Cinnvris lotensis, Corvus corvus, Corvus splendens, Coryllis vaeralis, Dicrurus macrocerus, Egretta garzetta, Estrilda amanda va, Gallinula chloropus, Gallus gallus, Haliastur Indus, Hierococcyx varius, Coracias benghalensis, Lalage sykesi, Megalaima merulinus, Merops leschenaultia, Microfus affinis, Micropterus brachyrus, Muscicapa latirostris, Myctrea leucopcephala, Nectarinia asiatica, oriolus oriolus, Passer domisticus, Phalococorax carbo, Phalococorax Niger, Ploceus phillppines, Podiceps yuficolis, Pycnonotus cafer and Temenuchus pagodarum.*

119. **Reptiles**. The common reptile's species that are observed in the study area were *Rana tigrina, Lepus nigricollis, Funabulus palmarum, Rattus norvegicus, Herpestes edwardii, Bandicota indica and Rana hexadactyla.*

Table 38: List of the Faunal Diversity of the Study Area

Technical Name	Common Name	Distribution
Acridotheres tristicus	Common myna	Common
Alcedo atthis	Common Kingfisher	Common
Anas crecca	Common teal	Observed
Ardea alba	Large egret	Common
Ardea cinerea	Grey heron	Common
Bubo	Indian great horned Owl	Common
Bubulcus ibis	Cattle Egret	Common
Centropus sinensis	Crow Pheasant	Common
Cinnvris lotensis	Loten's sunbird	Common
Corvus corvus	Jungle crow	Common
Corvus splendens	House crow	Common
Coryllis vaeralis	Lorikeet	Common
Dicrurus macrocerus	Black Drongo	Common
Egretta garzetta	Little Egret	Common
Estrilda amanda va	Red munia	Rare
Gallinula chloropus	Moor hen	Rare
Gallus gallus	Red Jungle fowl	Common
Haliastur Indus	Brahmny kite	Common
Hierococcyx varius	Common Hawk Cuckoo	Common
Coracias benghalensis	Indian roller	Common
Lalage Sykesi	Black headed cochoo Shrike	Common
Megalaima merulinus	Indian Cuckoo	Common
Merops leschenaultia	Chestnut headed Bee Eater	Common
Microfus affinis	House swift	Common
Micropterus brachyrus	RufoursWood pecker	Observed
Muscicapa latirostris	Brown flycatcher	Rare
Myctrea leucopcephala	Painted stork	Common
Nectarinia asiatica	Purple sunbird	Observed
oriolus oriolus	Indian Oriole	Common
Passer domisticus	House Sparrow	Common
Phalococorax carbo	Large coramant	Common
Phalococorax nicer	Little coramant	Common
Ploceus phillppines	Weaver bird	Common
Podiceps yuficolis	Little grebe	Observed
Pycnonotus cafer	Red vented bulbul	Common
pycnonotus jokonus	White brewed Bulbul	Common
Temenuchus pagodarum	Brahmny Myna	Common
calotes versicolor	Common garden lizard	Rare
Bangarus spp	Krait	Rare
Naja Naja	Indian cobra	Rare
Rana hexadactyla	Frog	Common
Rana tigrina	Bull frog	Common
Lepus nigricollis	Hare	Herbivorous
Funabulus palmarum	Squirrel	Herbivorous
Rattus norvegicus	Field mouse	Herbivorous
Herpestes edwardii	Common mongoose	Carnivorous
Bandicota indica	Bandicoot	Herbivorous

Source: Divisional Forest Officer.

120. **Aquatic Ecology/ Environment.** Water samples were collected from Mullaiperiyar Dam and it was centrifuged to concentrate the planktonorganisms. Each sample was made up to 100

ml after removing from the centrifuge tube. General phytoplanktons were studied for quantitative andqualitative details. To assess the species diversity and the seasonal dynamics of different species of phytoplankton in the Mullaiperiyar Dam, all the different genera were identified and they were counted individually. Phytoplankton identified in the Mullaiperiyar Dam belongs to four classes namely *Cyanophyceae, Euglenophyceae, Bacillariophyceae* and *Chlorophyceae*. Average seasonal density of phytoplankton varied from 250 cells (southwest monsoon) to 496 cells (pre-monsoon). In general higher phytoplankton density was much more pronounced during thepre-monsoon than the monsoon periods in the Mullaiperiyar Dam. The common fish species observed in the Mullai Periyar River includes *Puntius melanampyx, Puntius carnaticus, Puntius amphibious, Puntius fasciatus, Puntius mahecola, Devario aequipinnatus, Garra mullya, Travancoria jonesi* and *Nemacheilus guntheri.* As per the IUCN category, the fish species are categorised under Least Concern.

D. Socio-economic Environment

1. Demography

121. Total population of the Madurai Municipal Corporation is 1,846,801 as per 2011 census. The detail of population is given in the Table 39.

Table 39: Details Considered (As Per 2011 Census)

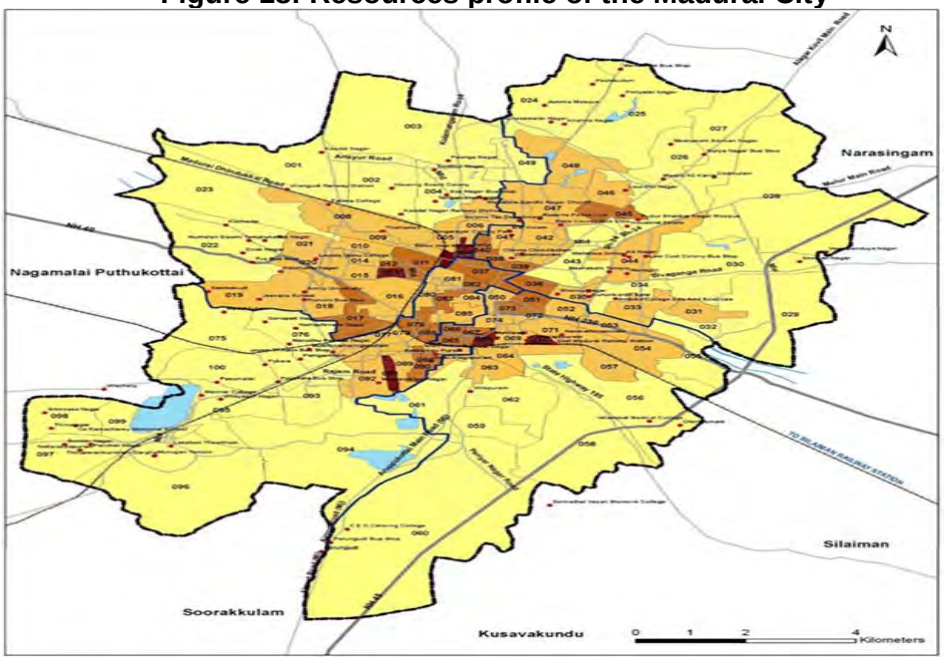
Description	Nos.
Total Population	1,846,801
In the age group 0-6 years	185,526
Scheduled Castes (SC)	151,124
Scheduled Tribes (ST)	6,230
Literates	1,485,340
Illiterate	361,461
Total Worker	728,895
Main Worker	662,665
Marginal Worker	64,230
Non Worker	1,119,906
Number of Households	479,851

Source: Census 2011.

2. Sex Ratio

122. The sex ratio of 999 females per 1,000 males is higher than the national average of 944. Madurai metropolitan area constitutes the third largest metropolitan area in Tamil Nadu and the 24th in India. 8.99% of the population was under 6 years of age.

Figure 18: Resources profile of the Madurai City



3. Work Force Participation

123. The details of work force participation is given in the Table 40.

(i) Madurai ranks 9th with respect to the share in State GDP having 3.67% contribution to the total state GDP;
(ii) Major economic activities are trade & commerce, tourism related activities and to some extent industrial activities;
(iii) The city houses various health care facilities, automobile, rubber, chemical, and textile manufacturing industries and has also developed as a second-tier city for information technology as well;
(iv) Increasing trend of tertiary sector with involvement of 87% population indicating major role of tourism and trade;
(v) The secondary sector comprising majorly the household handloom industry has declined from 4.06% in 2001 to 3.61% in 2011;
(vi) The Work Force Participation Rate is 39% showing an increase over the past decade; and
(vii) Share of marginal workers has grown from 4.31% in 2001 to 7.49% in 2011 indicating the high percentage of daily wages workers coming from adjacent areas to the city.

Table 40: Details of work force participation rate

Details	Number	Growth %
Primary sector	8,683	2%
Secondary sector	20,614	4%
Tertiary sector	499,264	94%
Total main worker	528,561	36%
Marginal worker	42,767	3%

Details	Number	Growth %
Total non-worker	899,427	61%
Total population	1,470,755	
Work participation rate	36%	

4. Housing Scenario

124. The details of house stocks are given in Table 41 and the quality of housing are given in Table 42.

(i) Present housing stock is adequate with 80% houses under residential use and 20% under mixed area;
(ii) The growth in housing stock during the period of 2001-2011 was 27%; and
(iii) There is considerable increase in number of liveable (67%) and dilapidated houses (34%) in the city.

Table 41: Details of Housing Stock

Parameters	2001	2011	Growth (%)
Total Census Houses	240,666	329,775	27
Vacant Houses	10,516	16,776	37
Occupied Houses	230,150	312,999	26
Residential Use	194,552	262,163	26
Residential Cum Other Purpose	35,598	50,836	30

Table 42: Quality of Housing

Parameters	2001	2011	Growth (%)
Good	185,986	223,042	17
Livable	13,122	40,904	68
Dilapidated	982	312,999	39
	200,090	265,561	25

5. Infrastructure

125. **Transport and Traffic.** Road development, public transport services and suburban rail transport are recognized as essential for the efficient functioning of the urban system. The major arterial & sub-arterial road corridors and other roads are developed and maintained by National Highway, State Highway and the local bodies concerned respectively. As regards traffic management and enforcement, the same is looked after by the City Traffic Police in respect of Greater City Area and District Police for the remaining City Area. The public bus transport is with State Transport Corporation.

6. Education

126. There are 47 approved institutions of the university in and around the city consisting of autonomous colleges, aided colleges, self-financing colleges, constituent colleges, evening colleges and other approved institutions. There are seven polytechnics and five Industrial training institutes (ITIs) in Madurai, with the Government ITI and the Government Polytechnic for Women.

7. Water Supply

127. Water Supply Department is taking care of planning and formulating water supply schemes, execution of scheme works and maintenance of water supply. Functions such as provision of new water service connection, conversion of category of service connection, name change, clearing of blocks in water supply. Redressal of other grievances are also carried out by MMC.

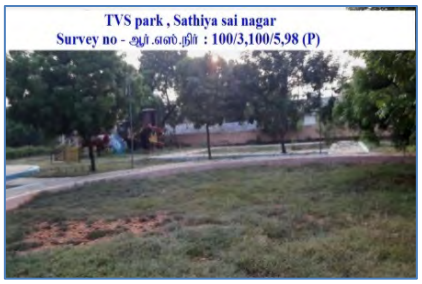
8. Industries

128. Madurai is one of the few rubber growing areas in South India, and there are rubberbased industries in Madurai. Automobile manufacturers are the major consumers of rubber components produced in the city. There are numerous textiles, granite and chemical industries operating in Madurai. Madurai is promoted as a second-tier city for IT and some software companies have opened their offices in Madurai. Software Technology Parks of India, an agency of the Government of India, has authorised several such companies to receive benefits under its national information technology development program. The state government proposed two IT-based Special Economic Zones (SEZ) in Madurai, and these have been fully occupied by various IT companies.

Table 43: Subproject site Environmental Features

S. No	Old OHT No	Infrastructure	Location and Environmental Features	Site Photograph
1.	25	Semparuthi Nagar–NZ1	An overhead tank having a capacity of 18 lakhs liter (LL) will be constructed in Madurai Municipal Corporation Vilangudi, Semparuthi nagar park vacant land at ward no.23 Vilangudi having an area of 400 m^2. It will be located in West; compound wall will be constructed around the OHT.	
2.	24	Muthuramalinga Puram Bykara (ward 100)	An overhead tank having a capacity of 5 LL will be constructed in Madurai Municipal Corporation Muthuramalingapuram near to Existing OHT land at ward no.100 Muthuramalingapuram, Bykara having an area of 196 sqmt. It will be located in Centre, compound wall will be constructed around the OHT.	
3.	51	Muthuramalinga puram	A sump having capacity of 3 lakhs liter will be constructed in Madurai Municipal Corporation Moolakarai sump vacant land at ward no.99 Moolakarai sump having area at 81 m^2. It will be located in North; compound wall will be constructed around the OHT.	
4.	23	Muniyandi Kovil street (Ward 100,75)	An overhead tank having a capacity of 4 LL will be constructed in Madurai Municipal Corporation Muniyandi kovil street, Muniyandi kovil backside at ward no.75 & 100 Muniyandi kovil having an area of 81 m^2. It will be located in southwest; compound wall will be constructed around the OHT.	

S. No	Old OHT No	Infrastructure	Location and Environmental Features	Site Photograph
5.	50	Balaji Nagar – SZ12	An overhead tank having capacity of 5 LL will be constructed in Madurai Municipal Corporation thiruparankudram vacant land at ward no.99 Thiruparankundram having area at 196 m^2. It will be located in Right side of the park; compound wall will be constructed around the OHT.	
6.	48	Harveypatti – SZ10	An overhead tank having capacity of 10 LL will be constructed in Madurai Municipal Corporation Harveypatti park vacant land at ward no.98 Harveypatti having area at 400 m^2. It will be located in south; compound wall will be constructed around the OHT.	
7.	49	Kurinchi Nagar – SZ11 (Thirunagar)	An overhead tank having capacity of 5 LL will be constructed in Madurai Municipal Corporation Thirunagar Kurinchi nagar, Utchayamedu vacant land at ward no.98 Kurinchi nagar having area at 196 m^2. It will be located in Northeast; compound wall will be constructed around the OHT.	
8.	16	Muthupatti Nagar near PS	An overhead tank having a holding capacity of 20 LL will be constructed in Madurai Municipal Corporation, Muthupatti nagar at ward no.93 (Vacant land near Pumping Station) having an area of 729 m^2. The OHT will be located in Northeast direction, provided with a compound wall.	

S. No	Old OHT No	Infrastructure	Location and Environmental Features	Site Photograph
9.	14	TVS Park Sathya sai Nagar	An overhead tank having a holding capacity of 25 LL will be constructed in Madurai Municipal Corporation Satheyasai nagar, at ward no.77 (Vacant land available in Sundarajapuram Park) having an area at 700 m^2. The OHT will be located in Eastern direction, provided with acompound wall	
10.	15	TVS Park Sathya sai Nagar	An overhead tank having a holding capacity of 25 LL will be constructed in Madurai Municipal Corporation (TVS Park) Sathyasai nagar at ward no.92 having an area at 700 m^2. The OHT will be located in southern direction, provided with compound wall.	
11.	45	Villapuram – SZ6 (Ward – 61)	An overhead tank having capacity of 10 LL will be constructed in Madurai Municipal Corporation Villapuram existing OHT vacant land at ward no.61 Villapuram OHT having area at 400 m^2. It will be located in Southwest, compound wall will be constructed around the OHT.	
12.	43	MMC Colony – SZ 5	An overhead tank having capacity of 15 LL will be constructed in Madurai Municipal Corporation Avaniyapuram MMC colony vacant land at ward no.94 MMC colony having area at 250 m^2. It will be located in east; compound wall will be constructed around the OHT.	
13.	44	MMC Colony – SZ4	An overhead tank having capacity of 10 LL will be constructed in Madurai Municipal Corporation Avaniyapuram MMC colony vacant land at ward no.94 MMC colony having area at 200 m^2. It will be located in west; compound wall will be constructed around the OHT.	

S. No	Old OHT No	Infrastructure	Location and Environmental Features	Site Photograph
14.	47	Vellakkal – SZ8	An overhead tank having capacity of 11 LL will be constructed at opposite side of Vellakkal Corporation bungalow vacant land at ward no.94 Vellakkal having area at 200 m^2. It will be located in east; compound wall will be constructed around the OHT.	
15.	19	Vaalaithoppu Corporation Ground	An overhead tank havinga holding capacity of 25 LL will be constructed in Madurai Municipal Corporation, Vaalaithoppu (towards Chinthamani main road from Kamarajar salai) at ward no.64 (vacant land) having an area of 900 m^2. The OHT will be located in center, provided with, compound wall	
16.	41	Chinna Anuppanadi – SZ2	An overhead tank having capacity of 15 LL will be constructed in Madurai Municipal Corporation Chinna anupanadi school playground vacant land at ward no. 56 Chinna Anupanadi having area at 400 m^2. It will be located in West; compound wall will be constructed around the OHT.	
17.	42	Gurunathar Koil – SZ3 (Chinnthamani)	An overhead tank having capacity of 12 LL will be constructed in Madurai Municipal Corporation Chinthamani near to Gurunathan kovil land at ward no. 58 Iravathanallur burial ground having area at 225 m^2. It will be located in east; compound wall will be constructed around the OHT.	
18.	17	Thideer Nagar	An overhead tank having a holding capacity of 30 LL will be constructed in Madurai Municipal Corporation (vacant land available near to fire station) having an area at 1200 m^2.	

S. No	Old OHT No	Infrastructure	Location and Environmental Features	Site Photograph
19.	2	Sellur Kanmai – Composting yard Sector 6	An overhead tank having a holding capacity of 25 LL will be constructed in an old composting yard in sector 6 at ward o.n2 Sellur Kanmai having an area of 900 m^2. It will be located in southwest direction; compound wall will be constructed around the OHT.	
20.	4	Sellur Kanmai – Composting yard Sector 6	An overhead tank having a holding capacity of 25 lakhs litre will be constructed in an Old composting yard in sector 6 at ward No.2 Sellur Kanmai having an area of 900 m^2. It will be located in Southwest direction; compound wall will be constructed around the OHT.	
21.	29	Indranagar – NZ2	An overhead tank having a capacity of 15 lakhs litre will be constructed in Madurai Municipal Corporation Indiranagar, Karisalkulam 2nd railway gate crossing vacant land at ward No.1 Karisalkulam having area at 400 m^2. It will be located in Northwest, compound wall will be constructed around the OHT.	
22.	30	Park Town – NZ5	An overhead tank having capacity of 13 lakhs liter will be constructed in Madurai Municipal Corporation Meenakshi nagar, Thapalthanthi nagar NGO colony park, Park Town vacant land at ward No.4 Park Town having area at 400 m^2. It will be located in South; compound wall will be constructed around the OHT.	
23.	32	EB Colony – NZ7	An overhead tank having capacity of 18 LL will be constructed in Madurai Municipal Corporation EB colony vacant land at ward No.25 EB colony having area at 400 m^2. It will be located in Northeast; compound wall will be constructed around the OHT.	

S. No	Old OHT No	Infrastructure	Location and Environmental Features	Site Photograph
24.	37	Poriyalar Nagar	An overhead tank having capacity of 7 lakhs liter will be constructed in Madurai Municipal Corporation Pandian nagar – Engineer nagar park vacant land at ward No.24 Pandian nagar – Engineer nagar having area at 50 m^2. It will be located in South, compound wall will be constructed around the OHT.	
25.	34	Bharath Nagar	An overhead tank having capacity of 20 lakhs liter will be constructed in Madurai Municipal Corporation Bharathnagar, vacant land at ward No.23 having area at 1200 m^2. It will be located in south; compound wall will be constructed around the OHT.	
26.	35	Island Nagar – NZ8 (Ward – 48)	An overhead tank having capacity of 12 lakhs liter will be constructed in Madurai Municipal Corporation Island nagar near to pond vacant land at ward No.48 Island nagar having area at 200 m^2. It will be located in West; compound wall will be constructed around the OHT.	
27.	3	Sellur Lorry Stand	An overhead tank having a holding capacity of 30 LL will be constructed in Madurai Municipal Corporation, Southside of Sellur Lorry Stand at ward no.37 having area at 900 m^2. Compound wall will be constructed around the OHT.	
28.	6	SMP Colony near Mayor Bungalow (MPS site)	An overhead tank having a holding capacity of 10 lakhs litre will be constructed in Madurai Municipal Corporation, SMP colony at ward no.33 (vacant land near to Mayor Bungalow) having an area at 200 m^2. The OHT will be located in southwest direction, provided with a compound wall.	

S. No	Old OHT No	Infrastructure	Location and Environmental Features	Site Photograph
29.	39	Shenpagathottam – NZ15	An overhead tank having capacity of 25 LL will be constructed in Madurai Municipal Corporation Shenpagathottam park-2 near to Anna nagar channel vacant land at ward No.33 Shenpagathottam having area at 650 m^2. It will be located in northeast; compound wall will be constructed around the OHT.	
30.	7	KK Nagar (Central Veg. Market)	An overhead tank having a holding capacity of 12 LL will be constructed in Madurai Municipal Corporation, KK nagar Mellur main road, at ward no.45 (in the vacant land available in Mattuthavani Vegetable Market) having an area of 196 m^2. The OHT will be located in southeast direction, provided with compound wall.	
31.	13	Kochadai back side of Pumping station	An overhead tank having a holding capacity of 25 LL will be constructed in Madurai Municipal Corporation at ward no.22 (vacant land near Commissioner Bungalow Kochadai) having an area of 729 m^2. The OHT will be located in Northwest direction, provided with a compound wall.	
32.	12	VKP Nagar Madakulam	An overhead tank having a holding capacity of 20 LL will be constructed in Madurai Municipal Corporation, Madakkulam VKP nagar at ward no.76 having area at 729 m^2. The OHT will be located in southern direction, provided with compound wall.	
33.	10	Arappalayam Two-wheeler Parking	An overhead tank having a holding capacity of 12 LL will be constructed in a vacant land available in the ward no.10 (behind Arapalayam Two-wheeler stand) having an area of 200 m^2. The OHT will be located in Northwest direction, provided witha compound wall	

S. No	Old OHT No	Infrastructure	Location and Environmental Features	Site Photograph
34.	20	AVSS Hospital behind MPS Santhaipettai	An overhead tank having a holding capacity of 20 LL will be constructed in Madurai Municipal Corporation, Santhaipettai, at ward no.53 (Vacant land available at backside of main pumping station) having area of 900 m^2. It will be located in eastern direction, provided with compound wall.	
35.	21	Meenakshi Nagar	An overhead tank having a holding capacity of 15 LL will be constructed in Madurai Municipal Corporation, at ward no.54 (vacant land available in Meenakshi Nagar near to Theppakulam Kamaraj Statue) having an area of 750 m^2. The OHT will be located in eastern direction, provided with compound wall.	
36.	53	Ulaganeri – NZ 11 (Ward – 28)	An overhead tank having capacity of 12 LL will be constructed in Madurai Municipal Corporation Ulaganeri near to High court street existing OHT vacant land at ward no.28 Ulaganeri having area at 400 m^2. It will be located in west; compound wall will be constructed around the OHT.	
37.	54	Pandian Nagar – NZ12	An overhead tank having capacity of 25 LL will be constructed in Madurai Municipal Corporation Pandiyan nagar near to Pandi kovil police station vacant land at ward no.31 Pandiyan nagar having area at 1225 m^2. It will be located in southwest; compound wall will be constructed around the OHT.	

129. The distribution main, feeder main and conveying main will be laid along the edge of the streets and roads without affecting the existing infrastructures. Before commencing the pipe laying work, necessary road cut restoration charges will be paid to the concerned Department and permission will be obtained to cut open the road. On completion of the pipe laying work, the roads will be properly filled and consolidated with excavated earth and intimated to the Department concerned. The National highways authority and State highways authority will carry out the restoration of road.

V. ANTICIPATED ENVIRONMENTAL IMPACTS AND MITIGATION MEASURES

130. Potential environmental impacts of the proposed infrastructure components are presented in this section. Mitigation measures to minimize/mitigate negative impacts, if any, are recommended along with the agency responsible for implementation. Monitoring actions to be conducted during the implementation phase is also recommended to reduce the impact.

131. Screening of potential environmental impacts are categorized into four categories considering subproject phases: location impacts and design impacts (pre-construction phase), construction phase impacts and operations and maintenance phase impacts.

(i) **Location impacts** include impacts associated with site selection and include loss of on-site biophysical array and encroachment either directly or indirectly on adjacent environments. It also includes impacts on people who will lose their livelihood or any other structures by the development of that site;

(ii) **Design impacts** include impacts arising from Investment Program design, including technology used, scale of operation/throughput, waste production, and ancillary services;

(iii) **Construction impacts** include impacts caused by site clearing, earthworks, machinery, vehicles and workers. Construction site impacts include erosion, dust, noise, traffic congestion and waste production; and

(iv) **Operation and Maintenance impacts** include impacts arising from the operation and maintenance activities of the infrastructure facility. These include routine management of operational waste streams, and occupational health and safety issues.

132. Screening of environmental impacts has been based on the impact magnitude (negligible/moderate/severe – in the order of increasing degree) and impact duration (temporary/permanent).

133. This section of the IEE reviews possible project-related impacts, in order to identify issues requiring further attention and screen out issues of no relevance. ADB SPS, 2009 require that impacts and risks will be analyzed during pre-construction, construction, and operational stages in the context of the project's area of influence. The ADB Rapid Environmental Assessment Checklist in http://www.adb.org/documents/guidelines/environmental_assessment/eaguidelines002.asp has been used to screen the project for environmental impacts and to determine the scope of the IEE.

134. In the case of this project, most of the individual elements involves simple construction and operation. By using the gravity based system, impacts will be minimum. Most of the predicted impacts are associated with the construction process, and are produced because that process is invasive, involving excavation and earth movements and being mostly located on the roadside (SH, NH, ODR and rural roads) so will not cause direct impact on biodiversity values. The project will be located in the properties held by the local government and access to the project location is through public rights-of-way (ROW) and existing roads. The head works site is the only land need to be procured for an extent of 2 acres, for which consent from the owner of the land has been obtained. Land acquisition is in process, and is with Revenue Department with private owner now negotiation. The details of the land acquisition is covered under the resettlement plan.

A. Pre-Construction Impacts- Design and Location

135. **Design of the Proposed Components**. The Central Public Health and Environment Engineering Organization (CPHEEO) manual suggests a design period of 15/30 years. The water

supply components were designed following the recommendations of the CPHEEO manual for water supply and treatment.

136. Impacts arise from the design of the project including the technology used, scale of operation, waste production, discharge specification, pollution sources and ancillary services.

137. Impacts associated with the planning mainly depend on the site selection. Location impacts include on-site biophysical array and encroachment / impact either directly or indirectly on adjacent environments. It also includes the impacts on the people who might lose their properties or livelihoods due to the development of the proposed site.

138. Construction works in the Madurai Municipal Corporation area, the pipelines are to be laid on or along the roads in the unused vacant land adjacent to the roads within the project area. In the narrow roads (where there is no vacant land adjoining road), pipeline will be buried within the road right of way. However, considering the narrow and busy lanes, temporary impacts are likely during construction stage.

139. **Site selection of sources of materials**. Extraction of materials can disrupt natural land contours and vegetation resulting in accelerated erosion, disturbance in natural drainage patterns, ponding and water logging, and water pollution. To mitigate the potential environmental impacts, locations of quarry site/s and borrow pit/s (for loose material other than stones) would be included in the design specifications and on plan drawings. Priority would be sites already permitted by Mining Department. If other sites are necessary, these would to be located away from population centers, drinking water intakes and streams, cultivable lands, and natural drainage systems; and in structurally stable areas even if some distance from construction activities. It will be the construction contractor's responsibility to verify the suitability of all material sources and to obtain the approval of the PIU (Madurai Municipal Corporation). If additional quarries will be required after construction is started, then the Construction Contractor shall use the mentioned criteria to select new quarry sites, with written approval of Madurai Municipal Corporation.

B. Construction Impacts

140. **Impact on Air Quality**. During construction period, the impacts on air quality are mainly due to the material movement and the actual construction activities. Due to material movement air, quality over the immediate influence area will be affected though, not in significant levels. There will be increase in the dust levels. In order to reduce the dust emissions in the construction area due to material transport and construction activities, provisions should be made for sprinkling of water on all the roads in the area of improvement. It should be ensured that

(i) construction debris is removed daily;
(ii) construction requiring street closings should be performed during off-peak hours;
(iii) idling of delivery trucks or other equipment should not be permitted during periods of unloading or when they are not in active use;
(iv) low emission construction vehicles should be used wherever possible; and
(v) as soon as construction is over the surplus earth should be utilised to fill up low-lying areas. In no case, loose earth should be allowed to pile up in the streets.

141. Anticipated impacts during the construction phase are discussed below along with appropriate mitigation measures to avoid, minimize or mitigate those impacts to acceptable levels.

142. **Sources of Materials**. For the construction work, the required materials like coarse aggregate and fine aggregate will be obtained from the permitted / licensed quarries by Department of Geology & Mining, Government of Tamil Nadu. Contractor should not create/use

any new borrow pits / quarries. The contractor should also make a concerted effort to re-use as much excavated material from this project as possible.

143. The construction contractor will be required to:

(i) Obtain construction materials only from government-approved quarries with prior approval from Madurai Municipal Corporation;
(ii) Madurai Municipal Corporation to review, and ensure that proposed quarry sources have all necessary clearances/ permissions in place prior to approval;
(iii) Contractor to submit to Madurai Municipal Corporation on a monthly basis documentation on material obtained from each source (quarry/ borrow pit); and
(iv) Avoid creation of new borrow areas, quarries, etc., for the project; if unavoidable, contractor to obtain all clearances and permissions as required under law, including environmental clearance prior to approval by Madurai Municipal Corporation.

144. Air Pollution during Construction work, especially from earthwork activities, coupled with dry and windy working conditions, material and debris transport, and works along the public roads carrying significant traffic, have high potential to generate dust. Significant quantities of earthwork will be conducted in the subproject, spread all over the project area. Nearly10,00,000 m^3 of earthwork is anticipated from the subproject, and 90-95% of which will be reused for filling the trenches. Also, emissions from construction vehicles, equipment, and machinery used for excavation and construction will induce impacts on the air quality. Anticipated impacts include dust and increase in concentration of vehicle-related pollutants such as carbon monoxide, sulfur oxides, particulate matter, nitrous oxides, and hydrocarbons. Dust generation from construction work in individual and confined work sites for underground tank (UGT), OHT, etc., will be mainly during the initial construction phase of earthwork, as the site is confined, dust can be effectively controlled with common measures. Dust generation will be significant during pipe laying along the roads. Increase in dust/ particulate matter in ambient air is detrimental and may have adverse impacts on people and environment. To mitigate the impacts, construction contractors will be required to:

(i) For all construction works

(a) Damp down the soil and any stockpiled material on site by water sprinkling (3-4 times a day before the start of work, 1-2 times in between, and at the end of the day) when working in the roads there should permanently be one person responsible for directing when water sprinkling needs to take place to stop the dust moving;
(b) Reduce the need to sprinkle water by stabilizingsurface soils where loaders, support equipment and vehicles will operate by using water and maintain surface soils in a stabilized condition;
(c) Apply water prior to levelling or any other earth moving activity to keep the soil moist throughout the process;
(d) Cover the soil stocked at the sites with tarpaulins and surround by dust screens;
(e) Control access to work area, prevent unnecessary movement of vehicle, public trespassing into work areas; limiting soil disturbance will minimize dust generation;
(f) Use tarpaulins to cover the loose material (soil, sand, aggregate etc.,) when transported by open trucks;
(g) Control dust generation while unloading the loose material (particularly aggregate, sand, soil) at the site by sprinkling water and unloading inside

the barricaded area, minimize the drop height when moving the excavated soil;

(h) Clean wheels and undercarriage of haul trucks prior to leaving construction site;

(i) Ensure that all the construction equipment, machinery is fitted with pollution control devises, which are operating correctly, and have a valid pollution under control (PUC) certificate; and

(j) No vehicles or plant to be left idling at site generators to be at placed maximum distance from properties.

(ii) For pipe laying works

(a) Barricade the construction area using hard barricades (of 2 m height) on both sides;

(b) Initiate site clearance and excavation work only after barricading of the site is done;

(c) Confine all the material, excavated soil, debris, equipment, machinery (excavators, cranes, etc.), to the barricaded area;

(d) Limit the stocking of excavated material at the site; remove the excess soil from the site immediately to the designated disposal area;

(e) Undertake the work section wise a 100 m section should be demarcated and barricaded; open up several such sections at a time, but care shall be taken to locate such sections in different zones;

(f) Conduct work sequentially - excavation, pipe laying, backfilling; testing section-wise (for a minimum length as possible) so that backfilling, stabilization of soil can be done;

(g) Remove the excavated soil of first section to the disposal site; as the work progresses sequentially, by the time second section is excavated, the first section will be ready for back filling, use the freshly excavated soil for back filling, this will avoid stocking of material, and minimize the dust; and

(h) Backfilled trench at any completed section after removal of barricading will be the main source of dust pollution. The traffic, pedestrian movement and wind will generate dust from backfilled section. Road restoration shall be undertaken immediately.

145. Excavation and refilling activities disturb the topsoil, and under the influence of wind, traffic, pedestrians, and other activities etc., produces dust. There is large potential to generate significant quantities of dust after refilling the trench, and prior to road relaying. It is a common practice not to restore the road immediately after refilling the trench so as to allow sufficient time for the refilled material to stabilize naturally. Given the dry and windy conditions, and heavy traffic and other activities along the roads, the refilled trenches with loose topsoil along the roads will generate maximum dust and create very unhealthy conditions. Moreover, as the barricades/ dust screens will removed after the trench is refilled, there will be absolutely nothing to control the dust generation. Dust control activities like wetting of topsoil will not be effective given the site conditions. It is therefore necessary to restore/ relay the road surface immediately or takesuitable steps to arrest the dust. Soil consolidation technique shall be used so that road can be restored immediately.

146. While obtaining permission for the proposed raw water transmission main from NH, SH & rural roads, the necessaryrestoration charges will be paid and accordingly the respective department will restore their roads.

147. **Generation of Construction Wastes**. Solid wastes generated from the construction activities are excess excavated earth (spoils), discarded construction materials, cement bags, wood, steel, oils, fuels and other similar items. Domestic solid wastes may also be generated from the workers' camp. Improper waste management could cause odor and vermin problems, pollution and flow obstruction of nearby watercourses and could negatively impact the landscape. Earthwork excavation in the road will be reused for leveling the roadside and earth excavation from other location will be safely disposed to corporation lands.

148. The following mitigation measures to minimize impacts from waste generation shall be implemented by the contractor:

(i) Prepare and implement a Construction Waste (Spoils) Management Plan (format is given in Appendix 4);
(ii) Avoid stockpiling any excess spoils at the site for long time. Excess excavated soils should be disposed to corporation lands;
(iii) If disposal is required, the site shall be selected preferably from barren, infertile lands; sites should locate away from residential areas, forests, water bodies and any other sensitive land uses;
(iv) Domestic solid wastes should be properly segregated in biodegradable and non-biodegradable for collection and disposal to designated solid waste disposal site; create a compost pit at workers camp sites for disposal of biodegradable waste; non-biodegradable / recyclable material shall be collected separately and sold in the local recycling material market;
(v) Prohibit burning of construction and/or domestic waste;
(vi) Ensure that wastes are not haphazardly thrown in and around the study area; provide proper collection bins, and create awareness to use the dustbins; recycle waste material where possible; and
(vii) Conduct site clearance and restoration to original condition after the completion of construction work; PIU to ensure that site is properly restored prior to issuingof construction completion certificate.

149. **Surface Quality Impacts.** Madurai and surrounding region receive average rainfall and there are a number of natural and man-made drainage channels crossing the city to carry the runoff safely. Runoff from the excavated areas and material and waste soil stocks likely to contain silt, and this silt runoff will deteriorate the water bodies due to silting. Large-scale silting is likely to lead to flooding. This impact will however be considered only during rainy season. These potential impacts are temporary and are of short-term duration only and to ensure these are mitigated, construction contractor will be required to:

(i) Avoid stockpiling of earth fill especially during the monsoon season unless covered by tarpaulins or plastic sheets;
(ii) Prioritize re-use of excess spoils and materials in the construction works. If spoils will be disposed, consult with Madurai city municipal corporation on designated disposal areas;
(iii) Install temporary silt traps or sedimentation basins along the drainage leading to the water bodies;
(iv) Place storage areas for fuels and lubricants away from any drainage leading to water bodies; and
(v) Dispose any wastes generated by construction activities in designated sites; and
(vi) Conduct surface quality inspection according to the EMP.

150. **Aquatic Environmental Impacts.** The intake well is proposed on the banks of the Mullai Periyar River and hence it will not have a direct impact on the existing aquatic ecology of the river.

Information obtained from the secondary sources reveals that there are no movement/ migration of fish species/ fish breeding ground or endangered fish species/ aquatic animals found in the River Mullai Periyar. Hence the proposed Intake well construction works will not have any impact on the fish species/ fish breeding pattern. However, care shall be taken to avoid deposition/ disposal of construction waste / accidental spillage of construction material into the river and also construction works shall be restricted during the monsoon seasons.

151. **Water Treatment Plant.** The raw water source is not suitable for the drinking purpose, so the water treatment plant (WTP) is proposed to treat raw water to meet the drinking water standards before distribution. The proposed WTP will be constructed in 12.5-acre land at Pannaipatti Village. The treatment plant layout has to be planned to treat 125 MLD of raw water. The proposed WTP will be based on conventional treatment process involving coagulation, flocculation, sedimentation, filtration process, disinfection etc. The construction of WTP is proposed under Design and Build basis as per the process specified to suit the available site.

152. To ensure optimal utilization and reduction of wastage, necessary design is incorporatedin WTP to recycle the wash water. The backwash water (3% of capacity) from proposed WTP will be stored within the premises for further recirculation. For reuse and recirculation of the backwash water, proper recirculation system will be installed in the proposed WTP. From the recycled quantity, a maximum of 2.5% out of 3% and the balance 0.5% will be utilized for gardening and other uses inside the WTP site. Prior to discharge/ reuse the backwash will be tested in the Laboratory proposed in the WTP site.

153. Sludge from the Water Treatment Plant is proposed to be dried in the sludge drying beds. The dried sludge will be stored in stockyardwithin the WTP premises and it will be disposed periodically or in the area identified by the Madurai Municipal Corporation at a maximum distance of 30 km from WTP. The drained water from sludge drying bed and supernatant water from sludge thickener will be sent into re-circulation sump. The sludge shall be taken to the sludge balance tank and from there discharge to nearby drain. The filtrate will be recirculated to the raw water distribution chamber.

154. **Chlorine use in Water Treatment Plant.** There is invariably a safety risk when considerable quantities of chlorine are handled at the WTP. The per day consumption of chlorine is around 1 tonne. Therefore, the yearly consumption is 365 tonnes at the WTP. The cylinders will be stored in a bay with individual foundations with trunnion wheels as support for easy handling. The cylinders are kept in horizontal positions on the trunnion wheels. An EOT crane with electrical motor is provided for safe handling to reduce the man usage, as it is a hazard gas. To avoid any risk to workers and public, the chlorination facility at the WTP will be provided with all appropriate safety features and equipment to meet with any accidental eventuality, which may include:

(i) chlorine neutralization pit with a lime slurry feeder;
(ii) proper ventilation, lighting, entry and exit facilities;
(iii) facility for isolation in the event of major chlorine leakage;
(iv) personal protection and safety equipment for the operators in the chlorine plant; the emergency repair kit, personal safety kit like full body cover, oxygen kit for breathing, face mask, body shower and eye washers would be provided
(v) laboratory facility shall not be housed within the chlorination facility;
(vi) provide training to the staff in safe handling and application of chlorine; this shall be included in the contract of chlorinator supplier;
(vii) visible and audible alarm facilities to alert chlorine gas leak;

(viii) supplier of chlorinator equipment shall provide standard operating manual for safe operation and as well as maintenance and repairs; preferably these shall be provided both in English and Tamil Languages; and

(ix) If the chlorine storage will be within 100 m of any sensitive receptor, the projectwill involve them in the emergency response planning. In this project, nearest residential unit are located about 260 m from the proposed WTP plant. Therefore, the project will not involve them in the emergency response planning.

155. **Noise and Vibration Levels**.The water distribution station sites are located within habitations, where there are houses, schools and hospitals, religiousplaces and businesses. During construction stage increase in noise level may be caused by excavation, particularly breaking of cement concrete or bitumen roads for the purpose oflaying of pipe, operation of construction equipment, and the transportation of equipment, materials, and people. Vibration generated from construction activity, for instance from the use of pneumatic drills, will have impact on nearby buildings. The construction contractor will be required to:

(i) Plan activities in consultation with PIU so that activities with the greatest potential to generate noise are conducted during periods of the day which will result in least disturbance, especially near schools and other sensitive receptors;

(ii) Minimize noise from construction equipment by using vehicle silencers, fitting jackhammers with noise-reducing mufflers, and use portable street barriers to minimise sound impact to surrounding sensitive receptor;

(iii) Maintain maximum sound levels not exceeding 70 decibels (dBA) when measured at a distance of 10 m or more from the vehicle/s;

(iv) Identify any buildings at risk from vibration damage and avoiding any use of pneumatic drills or heavy vehicles in the vicinity; if any building at risk, structural survey be completed prior to work, to provide baseline in case any issues from vibration, and if building is structurally unsound that measures taken to avoid any further damage;

(v) Horns should not be used unless it is necessary to warn road users or animals of the vehicle's approach; and

(vi) Consult local communities in advance of the work to identify and address key issues, and avoid working at sensitive times, such as religious and cultural festivals.

156. **Accessibility and Traffic Disruptions**. Madurai City Municipal Corporation is maintaining 1,572.38 km length of roads. 22.58 km of Stone cut & Tiles paved roads.

Table 44: Details of the Type of Roads and its Lengths

Roads	Length in km
Bus Route Roads	162.87 km
Ring Road	27.20 km
Internal Road	239.66 km
Total	**532.22 km**

Sl. No.	Roads	Length in km
1	B.T. Roads	947.94
2	C.C. Road	268.99
3	Metal Roads	125.50
4	Sand Road	207.52
5	Stone cut & Tiles paved roads	22.58
	Total	**1,572.38**

Sl. No	Road Category	Length (km)
1	Municipal Roads	661.81
2	Highways & Major District Roads	34.00
	Total	**695.81**

km = kilometer.

157. The main roads in the MMC carries considerable traffic. These roads are also centers of commercial activities. Internal roads in the project area are narrow, except in the newly developing residential layout, which comparatively have wide roads. Pipes to be laid across some of the arterial roads. In other corporation maintained busy roads, work will be taken up during non-traffic hours/ night hours without much hindrance to the free flow of traffic. Potential impact is negative but short term and reversible by mitigation measures. The construction contractor will be required to:

(i) plan transportation routes so that heavy vehicles do not use narrow local roads, except in the immediate vicinity of delivery sites;
(ii) schedule transport and hauling activities during non-peak hours;
(iii) locate entry and exit points in areas where there is low potential for traffic congestion;
(iv) keep the site free from all unnecessary obstructions;
(v) drive vehicles in a considerate manner;
(vi) coordinate with City Traffic Office for temporary road diversions and necessary provision of traffic aids if transportation activities cannot be avoided during peak hours;
(vii) notify affected sensitive receptors by providing sign boards informing nature and duration of construction works and contact numbers for concerns/complaints;
(viii) provide planks across trenches in front of businesses, and ensure works are completed quickly to avoid disruption; and
(ix) avoid full street closure.

158. **Surface and Groundwater Quality**. Another physical impact that is often associated with excavation is the effect on drainage and the local water table if groundwater and surface water collect in the voids. To ensure that water will not pond in pits and voids near subproject location, the construction contractor will be required to conduct excavation works on non-monsoon season.

159. **Accessibility.** Some of the roads in the subproject sites are narrow thus excavation and trenching works along right on the ways, hauling of construction materials and operation of equipment on- site can cause traffic problems. Potential impact is negative but short term and reversible by mitigation measures. The construction contractor will be required to:

(i) Plan transportation routes so that heavy vehicles do not use narrow local roads, except in the immediate vicinity of delivery sites;
(ii) Schedule transport and hauling activities during non-peak hours;
(iii) Locate entry and exit points in areas where there is low potential for traffic congestion;
(iv) Keep the site free from all unnecessary obstructions;
(v) Drive vehicles in a considerate manner;
(vi) Coordinate with Coimbatore Traffic Office for temporary road diversions and with for provision of traffic aids if transportation activities cannot be avoided during peak hours;
(vii) Notify affected sensitive receptors by providing sign boards informing nature and duration of construction works and contact numbers for concerns/complaints;
(viii) Provide planks across trenches in front of businesses, and ensure works are

completed quickly to avoid disruption; and

(ix) Avoid full street closure.

160. **Socio-Economic – Income**. Sites for all project components are carefully selected in government owned lands. However, few temporary shops are located in the roadside that are likey to be affected due to the proposed raw water transmission line. For the loss of the livelihood, compensation has been estimated and mention in the resettlement plan. For this project, in the intake location there is an acquisition for 2 acres land from private owner accordingly compensation has been worked out. The details of the compensation is given in the resettlement plan. During the project implementation, blocking of access to the business / livelihood activities are envisaged, especially during pipeline laying along the roads, may impact the income of households. However, given the alignment of pipeline is within the road carriage way, and also the measures suggested for ensuring accessibility during pipe laying works are notable but temporary impact is envisaged. Some shops and other premises along the roads may lose business income if the access will be impededdue to excavation of trenches, the presence of heavy vehicles and machinery, etc. Access disruption to hospitals, socio cultural places etc., will cause inconvenience to the public. Implementation of the following best construction measures will avoid the disturbance reduce the inconvenience and disturbance to the public.

(i) Inform all businesses and residents about the nature and duration of any work well in advance so that they can make necessary preparations;
(ii) Do not block any access; leave spaces for access between barricades/mounds of excavated soil and other stored materials and machinery, and providing footbridges so that people can crossover open trenches;
(iii) Barricade the construction area and regulate movement of people and vehicles in the vicinity, and maintain the surroundings safely with proper direction boards, lighting and security personnel – people should feel safe to move around
(iv) Control dust generation;
(v) Immediately consolidate the backfilled soil and restore the road surface, this will also avoid any business loss due to dust and access inconvenience of construction work;
(vi) Employee best construction practices, speed up construction work with better equipment, increase workforce, etc., in the areas with predominantly commercial, and with sensitive features like hospitals, and schools;
(vii) Consult businesses and institutions regarding operating hours and factoring this in work schedules; and
(viii) Provide sign boards for pedestrians to inform nature and duration of construction works and contact numbers for concerns/complaints.

161. **Socio-Economic – Employment**. Manpower will be required during the construction stage. This can result in generation of temporary employment and increase in local revenue. Thus, potential impact is positive and long-term. The construction contractor will be required to:

(i) Employ local labour force as far as possible;
(ii) If available, secure construction materials from local market;

162. **Occupational Health and Safety**. Workers need to be mindful of the occupational hazards which can arise from working in confined areas such as trenches, working at heights, near the heavy equipment operating areas, etc. Potential impacts are negative and long-term but reversible by mitigation measures. The construction contractor will be required to:

(i) Follow all national, state and local labour laws (indicative list is in Appendix 2);
(ii) Develop and implement site-specific occupational health and safety (OHS) plan which shall include measures such as: (a) safe and documented construction

procedures to be followed for all site activities; (b) ensuring all workers are provided with and use personal protective equipment; (c) OHS Training for all site personnel; (d) excluding public from the work sites; and (e) documentation of work-related accidents; follow international standards such as the World Bank Group's Environment, Health and Safety Guidelines;

(iii) Ensure that qualified first aid trained professional is deployed at all times. Equipped first-aid stations shall be easily accessible throughout the sites;
(iv) Secure all installations from unauthorized intrusion and accident risks;
(v) Provide OHS orientation training to all new workers to ensure that they are apprised of the basic site rules of work at the site, personal protective protection, and preventing injuring to fellow workers;
(vi) Provide visitor orientation if visitors to the site can gain access to areas where hazardous conditions or substances may be present. Ensure also that visitor/s do not enter hazard areas unescorted;
(vii) Ensure the visibility of workers through their use of high visibility vests and other PPEs when working in or walking through heavy equipment operating areas;
(viii) Ensure moving equipment is outfitted with audible back-up alarms;
(ix) Mark and provide sign boards for hazardous areas such as energized electrical devices and lines, service rooms housing high voltage equipment, and areas forstorage and disposal. Signage shall be in accordance with international standards and be well known to, and easily understood by workers, visitors, and the general public as appropriate;
(x) Provide supplies of potable drinking water;
(xi) Provide clean eating areas where workers are not exposed to hazardous or noxious substances; and
(xii) Disallow worker exposure to noise level greater than 85 dB (A) for a duration of more than 8 hours per day without hearing protection. The use of hearing protection shall be enforced actively.

163. **Community Health and Safety**. Excavations along the roads & narrow streets and hauling of equipment and vehicles have potential to create safety risks to the community. Excavations without any proper protection may endanger the close by buildings. Hazards posed to the public, specifically in high-pedestrian areas may include traffic accidents and vehicle collision with pedestrians. Potential impact is negative but short-term and reversible by mitigation measures. The construction contractor will be required to:

(i) Confine work areas; prevent public access to all areas where construction works are on-going through the use of barricading and security personnel;
(ii) Attach warning signs, blinkers to the barricading to caution the public about the hazards associated with the works, and presence of deep excavation;
(iii) Minimize the duration of time when the trench for laying pipe is left open through careful planning; plan the work properly from excavation to refilling and road relaying;
(iv) Control dust pollution – implement dust control measures as suggested under air quality section;
(v) Ensure appropriate and safe passage for pedestrians along the work sites;
(vi) Provide road signs and flag persons to warn of on-going trenching activities;
(vii) Restrict construction vehicle movements to defined access roads and demarcated working areas (unless in the event of an emergency);
(viii) Enforce strict speed limit (20-30 kmph) for plying on unpaved roads, construction tracks;

(ix) Provide temporary traffic control (e.g., flagmen) and signs where necessary to improve safety and smooth traffic flow;
(x) Where traffic is diverted around crossings, traffic control or careful selection of the exit from the working areas will be provided with the aim of ensuring that vehicles join the road in a safe manner;
(xi) At sensitive locations particularly where there are schools and markets close to the road, awareness of safety issues will be raised through neighbourhood awareness meetings;
(xii) All drivers and equipment operators will undergo safety training; and
(xiii) Maintain regularly the construction equipment and vehicles; use manufacturer-approved parts to minimize potentially serious accidents caused by equipment malfunction or premature failure.

164. **Construction Camps.** Contractor may require to set up construction camps – for temporary storage of construction material (pipes, cement, steel, fixtures, fuel, lubricants, etc.), and stocking of surplus soil, and may include separate living areas for migrant workers. The contractor will however be encouraged to engage local workers as much as possible. Operation of work camps can cause temporary air, noise and water pollution, and may become a source of conflicts, and unhealthy environment if not operated properly. Potential impacts are negative but short-term and reversible by mitigation measures. The construction contractor will be required to:

(i) select a camp site away from residential areas (at least 100 m buffer shall be maintained) or locate the camp site within the existing facilities of City Corporation;
(ii) avoid tree cutting for setting up camp facilities;
(iii) provide a proper fencing/compound wall for camp sites;
(iv) camp site shall not be located near (100 m) water bodies, flood plains flood prone/low lying areas, or any ecologically, socially, archeologically sensitive areas
(v) separate the workers living areas and material storage areas clearly with a fencing and separate entry and exit;
(vi) camp shall be provided with proper drainage, there shall not be any water accumulation;
(vii) provide drinking water, water for other uses, and sanitation facilities for employeesdrinking water should be regularly tested to confirm that drinking water standards are met;
(viii) prohibit employees from cutting of trees for firewood; contractor should provide cooking fuel (cooking gas); firewood not allowed;
(ix) train employees in the storage and handling of materials which can potentially cause soil contamination;
(x) wastewater from the camps shall be disposed properly either into sewer system, if sewer system is not available, provide on-site sanitation with septic tank and soak pit arrangements (100 m away from surface water body or groundwater well);
(xi) recover used oil and lubricants and reuse or remove from the site;
(xii) manage solid waste according to the following preference hierarchy: reuse, recycling and disposal to designated areas; provide a compost pit for biodegradable waste, and non-biodegradable / recyclable waste shall be collected and sold in local market;
(xiii) remove all wreckage, rubbish, or temporary structures which are no longer required; and
(xiv) at the completion of work, camp area shall be cleaned and restored to pre-project conditions and submit report to PIU; PIU to review and approve camp clearance and closure of work site.

C. Operation and Maintenance Impacts

165. The WTP plant is the source for generation of noise during operation. However, the residential units are located away from the WTP. High inside noise levels can affect the health of operators and staff at the facilities, and therefore, noise levels need to be maintained within and outside the plant at acceptable levels. To eliminate the issue, it is proposed to:

(i) Procure good quality latest technology pumps that guarantee controlled noise at a level of around 80 dB (A) at a distance of 1m.
(ii) Use appropriate building materials and construction techniques for WTP, which can absorb sound rather than reflect noise.
(iii) Use acoustic enclosures – manufacturer certified for all pumps and motors.
(iv) Procure only CPCB approved generators[2] to meet air emission and noise level requirements;
(v) Provide sound mufflers for ventilators in the plant rooms; and soundproof doors; and
(vi) Provide earplugs designated for noise reduction to workers working within the WTP, where the noise level will be within 80dB (A). Noise level will be limited to 45 dB (A) outside the WTP and at the boundary.

166. The main O&M activities of the proposed infrastructure will be detection and repair of leaks and pipe bursts. These are, however, likely to be minimal as proper design and selection of good quality pipe material should mean that leaks are minimal. Leak repair work will be similar to the pipe laying work as earlier explained. Trenches will be dug to reveal the leaking area and the faulty connection will be re-fitted, or the pipe will be removed and replaced if necessary.

167. **Recurrence of blockage and leakage problems.** Although impact is likely to be minimal due to new and well-designed efficient system; it should be ensured that leak detection and restoration time is minimized to the extent possible.

168. To ensure that water delivered to consumers at all times meets the drinking water standards, the following measures are suggested:

(i) Preparation and implementation of a water quality surveillance as part of the project to ensure that supplied water meets the drinking water standards; and
(ii) Surveillance program will be organized to ensure the water quality of the consumer water.

D. Cumulative Impact Assessment

169. The cumulative impact assessment (CIA) examined the interaction between the subproject's residual effects (i.e., those effects that remain after mitigation measures have been

[2] Central Pollution Control Board (CPCB) has published Genset notifications, which includes specification for emission limits for new Diesel Engines (upto 800 kW) and Noise limits for Generator sets which runs with Diesel as Fuel type.

Emission limits for DG's

POWER RANGE	HC+ NO_X	CO	PM	SMOKE
	g/kWh			m^{-1}
Up to 19 kW	7.5	3.5	0.3	0.7
>19 kW Up to 75 kW	4.7	3.5	0.3	0.7
>75 kW Up to 800 kW	4.0	3.5	0.2	0.7

Noise limit shall not exceed 75 dB (A) at 1 m distance.

The generators that are in line with the specifications shall be procured. The requirement for the same is specified in the BoQ that are to be monitored to ensure that generation of noise and potential deterioration of ambient air quality will be avoided.

applied) and those associated with other past, existing and reasonably foreseeable future projects or activities. The interaction of residual effects associated with multiple projects and/or activities can result in cumulative impacts, both positive and negative. The subproject's potential cumulative effects were considered with respect to valued environmental components (VECs) in the categories of environmental, socio-economic, and heritage resources in four areas:

(i) Of any potential residual project effects that may occur incrementally overtime;
(ii) Consideration of other known relevant projects or activities within the specified study area boundaries, even if not directly related to the subproject;
(iii) Potential overlapping impacts that may occur due to other developments, even if not directly related to the proposed project; and
(iv) Future developments that is reasonably foreseeable and sufficiently certain to proceed.

170. The subproject IEE has identified the VECs as air quality, water (surface and groundwater) quality, noise, geophysical (hydrogeological), traffic management, social- economic and socio-community, and human health. There are no foreseeable projects that will overlap with the subproject.

171. Given the water supply requirement in Madurai municipal corporation will be met and the source from River Mullai periyar river at lower camp is considered adequate, there are no significant cumulative impacts expected on the future water supply.

172. Air quality effects will occur during construction. Consequently, although emissions of common air contaminants (CAC) and fugitive dust may be elevated in proximity to active work sites, this impact will be short-term and localized to the immediate vicinity of the alignment. Greenhouse Gas (GHG) emissions may increase as a result of project activities (i.e., vehicle and equipment operation, concrete production, disposal of excavated material, land filling of residual wastes). Given the subproject's relatively minor contribution to CAC and GHG emissions during construction, the overall significance rating of both these potential residual effects is considered to be negligible during construction.

173. During construction, noise levels in the immediate proximity of most work sites are expected to increase. The duration of this exposure will be relatively brief. This exposure represents a temporary, localized, adverse residual effect of low to moderate significance for affected receptors. Structural damage due to ground vibrations is unlikely; there may annoyance to spatially located receptors during construction. Noise levels associated with the project operations will be largely imperceptible as the service reservoirs are located in relatively small sites within the city proper.

174. Land use/traffic management concerns will occur spatially during construction. During construction, site-specific mitigation measures will be implemented to address temporary disruptions to land use and access in the vicinity of the alignment such as road and sidewalk closures, traffic delays and detours, parking modifications, and increased volumes of construction–related traffic. There should be improved traffic movement along the alignment once construction is completed. Since the subproject will be built in undeveloped land earmarked for service reservoirs purposes, it will not conflict with existing or planned land use. However, following improvement in infrastructures and services, added residential developments, commercial and business facilities and increased densities are expected to develop and enhance the subproject area. This can be considered a long-term cumulative benefit of the subproject.

175. Adverse impacts such as localized disruption of vehicle traffic and pedestrian movements in areas along the alignment, and elevated CAC and fugitive dust emissions in proximity to work

sites, elevated noise and vibration levels and visual impacts will occur during construction. These short-term effects will be mitigated by providing alternate travel routes or alternating traffic movements and, where possible, access to businesses, schools and residences. However, upon completion of construction the socio-community will benefit from improved water supply system. This is considered a long-term cumulative benefit.

176. Development at the intake and water treatment plant sites and in the vicinity of the subproject may result in similar impacts relative to water quality and soils, but each impacts are independent of one another and are mitigated on a site-specific basis. Further, while water quality impacts have the ability to compound when taking into account regional water basins into consideration, the subproject will be required to adhere to the mandatory state and local laws, ordinances, regulations, and water quality standards. Regional geologic impacts do not generally compound, and are limited to the site at which they occur.

177. No adverse residual effects to human health will occur as a result of subproject construction or operation. While exposure to elevated noise levels and fugitive dust and CAC emissions will occur in proximity to subproject work sites during construction, due to their short-term, localized nature, these effects are expected to be minor and insignificant with no measurable effects on human health. During the subproject operation, the generation of wastewater / sewage will have a negative impact to the environment. However, it will be managed through the existing UGSS facility in Madurai Municipal Corporation, which is already covering 72 wards out 100 wards. For the remaining 28 wards, DPR is under preparation (which is in the advance stage). Hence, by implementing the same, Madurai Corporation shall have UGSS facility for the entire city (comprising 100 wards). The subproject operations will benefit the general public by contributing to the long-term improvement of water supply system and community livability in Madurai Municipal Corporation.

VI. PUBLIC CONSULTATION AND INFORMATION DISCLOSURE

A. Overview

178. The active participation of stakeholders including local community, NGOs, etc., in all stages of project preparation and implementation is essential for successful implementation of the project. It will ensure that the subprojects are designed, constructed, and operated with utmost consideration to local needs, ensures community acceptance, and will bring maximum benefits to the people. Public consultation and information disclosure is necessary as per the ADB policy.

179. Most of the main stakeholders have already been identified and consulted during preparation of this IEE, and any others that are identified during project implementation will be brought into the process in the future. Primary stakeholders of the subproject are residents, shopkeepers and businesspeople who live and work near sites where facilities will be built (OHT), government and utility agencies responsible for provision of various services in project area. Secondary stakeholder are NGOs and CBOs working in the area, community representatives, beneficiary community in general, government agencies, TNUIFSL and Government of Tamil Nadu.

B. Public Consultation

180. The public consultation and disclosure program is a continuous process throughout the project implementation, including project planning, design and construction.

1. Consultation during Project Preperation

181. The subproject proposal is formulated by Madurai Municipal Corporationin consultation with the public representatives in the project area to suit their requirements and as per CPHEEO norms.

182. Focus-group discussions with the local public and other stakeholders were conducted to learn their views and concerns. General public and the people residing along the project activity areas were also consulted. A project area level consultation workshop was conducted with the public representatives and prominent citizens, NGOs etc., on 8 March 2018 at conference hall, 13 March 2018 at Uthamapalayam, 16 March 2018 at Pennycuick hall and 16 March 2018 at Collectors office. (Details are enclosed as Appendix 9).

183. A total of 36 OHT locations has been identified for water distribution under the “Dedicated Water Supply Scheme for Madurai Municipal Corporation from MullaiPeriyar at Lower camp”. Out of 36 OHT’s, 24 OHT locations were identified for conducting public consultations, which was held from 13 to 15 February 2019. The locations were selected based on the presence of socially important locations including the public park area, playground, burial ground, temples, etc., consultation was held. The outcome of the consultation has been enclosed as Appendix 16.

184. It was observed that people are willing to extend their cooperation, as the proposed project will provide protected water supply for their households, which will enhance basic infrastructure service levels and overall living standard of the public. Also, they are expecting that the work should be implemented at the earliest. Public demanded for advance notice before construction and proper warning signs along the construction area to avoid inconvenience and the project completed within the stipulated contract period. The road should be restored properly after the pipe laying work completed.

2. Consultation during construction

185. Prior to start of construction, PIU will conduct information dissemination sessions at various places and solicit the help of the local community, leaders/prominent for the project work. Focus group meetings, as required, will be conducted to discuss and plan construction work (mainly pipeline work) with local communities to reduce disturbance and other impacts and also regarding the project grievance redress mechanism. Project information and construction schedule will be provided to the public. A constant communication will be established with the affected communities to redress the environmental issues likely to surface during construction phase. Contractor will provide prior public information (in Tamil and English) about the construction work in the area, once 7 days prior to the start of work and again a day before the start of work via pamphlets (a sample public information template is provided in Appendix 8). At the work sites, public information boards will also be provided to disseminate project related information.

C. Information Disclosure

186. Executive summary of the IEE will be translated in Tamil and made available at the offices of PMU and PIU and also displayed on their notice boards. Hard copies of the IEE will be accessible to citizens as a means to disclose the document and at the same time creating wider public awareness. Electronic version of the IEE in English and executive summary in Tamil will be placed in the official website of the TNUIFSL and Madurai Municipal Corporationafter approval of the IEE by the ADB. Stakeholders will also be made aware of grievance register and redress mechanism.

187. Public information campaigns to explain the project details to a wider population will be conducted. Public disclosure meetings will be conducted at key project stages to inform the public of progress and future plans. Prior to start of construction, the PIU will issue notification on the start date of implementation in local newspapers A board showing the details of the project will be displayed at the construction sites for the information of general public.

188. Local communities will be continuously consulted regarding location of construction camps, access and hauling routes and other likely disturbances during construction. The road closure together with the proposed detours will be communicated via advertising, pamphlets, radio broadcasts, road signage, etc.

VII. GRIEVANCE REDRESS MECHANISM

189. A common GRM will be in place to redress social, environmental or any other project related grievances. The GRM described below has been developed in consultation with stakeholders. Public awareness campaign will be conducted to ensure that awareness on the project and its grievance redress procedures is generated. The campaign will ensure that the poor, vulnerable and others are made aware of grievance redress procedures and entitlements per project entitlement matrix, and PMU and concerned PIU will ensure that their grievances are addressed.

190. Affected persons will have the flexibility of conveying grievances/suggestions by dropping grievance redress/suggestion forms in complaints/suggestion boxes or through telephone hotlines at accessible locations, by e-mail, by post, or by writing in a complaints register in Madurai Municipal Corporation offices. Madurai Municipal Corporations safeguards officer will have the responsibility for timely grievance redress on safeguards and gender issues and for registration of grievances, related disclosure and communication with the aggrieved party.

191. GRM provides an accessible, inclusive, gender-sensitive and culturally appropriate platform for receiving and facilitating resolution of affected persons' grievances related to the project. A two-tier grievance redress mechanism is conceived, one, at project level and another, beyond project level. For the project level GRM, a grievance redress cell (GRC) will be established in PIU/MMC; safeguards officer, supported by the Deputy Construction Manager, along with support Engineer – Construction management supervision consultant (CMSC) (non key expert) and social, gender and environmental safeguards of CMSC will be responsible for creating awareness among affected communities and help them through the process of grievance redress, recording and registering grievances of non-literate affected persons.

192. GRM aims to provide a time-bound and transparent mechanism to voice and resolve social and environmental concerns linked to the project. All grievances – major or minor, will be registered. Documentation of the name of the complainant, date of receipt of the complaint, address/contact details of the person, location of the problem area, and how the problem was resolved will be undertaken. Madurai Municipal Corporation will also be responsible for follow-through for each grievance, periodic information dissemination to complainants on the status of their grievance and recording their feedback (satisfaction/dissatisfaction and suggestions).

193. In case of grievances that are immediate and urgent in the perception of the complainant, the contractor, and supervision personnel of the CMSC and PIU will resolve the issue on site, and any issue that is not resolved at this level will be dealt at PIU head level for immediate resolution. Should the PIU fail to resolve any grievance within the stipulated time period, the unresolved grievances will be taken up at MCMC level. In the event that certain grievances cannot be resolved even at MCMC level., particularly in matters related to land purchase/acquisition, payment of compensation, environmental pollution etc., they will be referred to the Grievance Redress Committee (GRC) headed by the District Collector. Any issue which requires higher than district level inter-departmental coordination or grievance redress, will be referred to the State level Steering Committee.

194. GRC will meet every month (if there are pending, registered grievances), determine the merit of each grievance, and resolve grievances within specified time upon receiving the complaint-failing which the grievance will be addressed by the state-level Steering Committee. The Steering Committee will resolve escalated/unresolved grievances received.

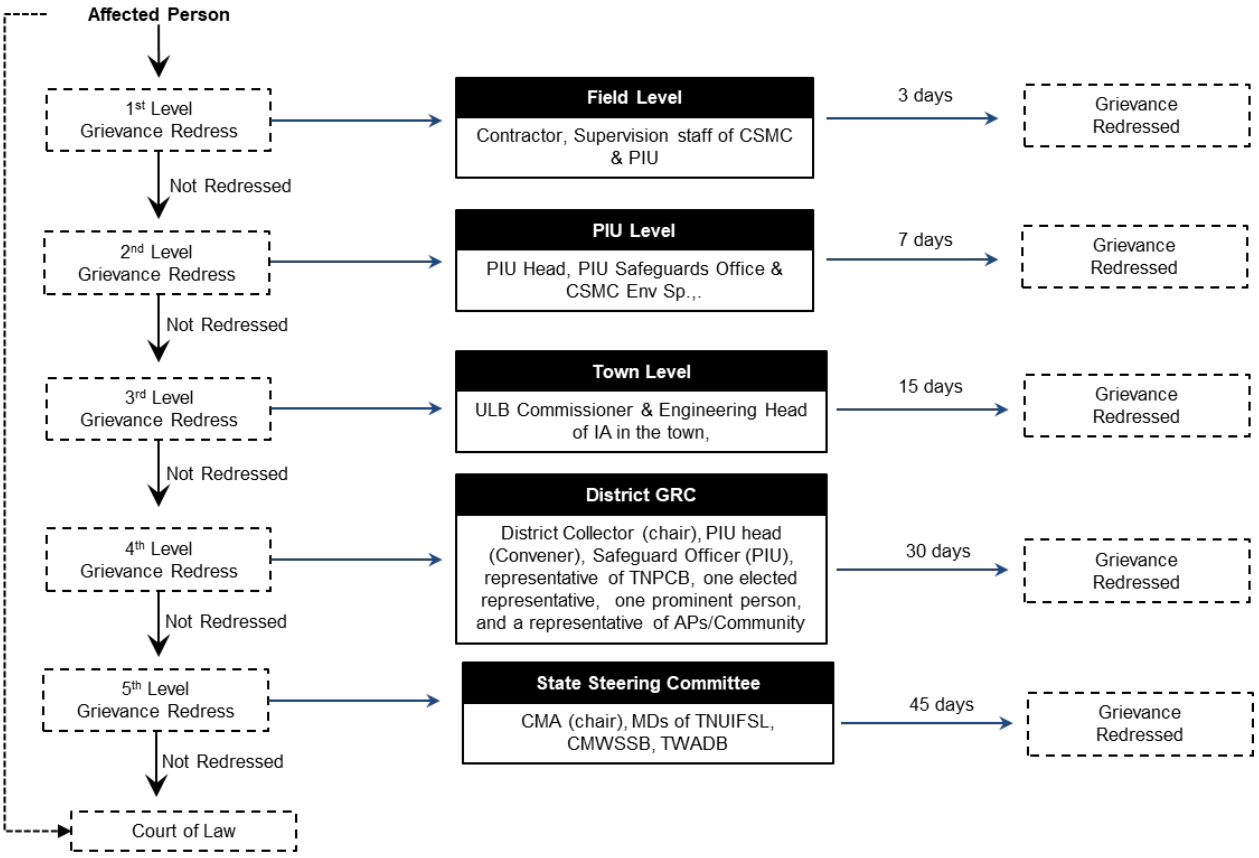
195. **Composition of GRC**. GRC will be headed by the District Collector, and members include PIU head, Safeguards Officer of PIU, representative of TNPCB, one elected representative / prominent citizen from the area, and a representative of affected community. GRC must have a women member.

196. State level steering committee will include Commissioner of Municipal Administration as chair, member include managing directors of TNUIFSL, Chennai Metropolitan Water Supply and Sewerage Board, TWAD Board and others as necessary.

197. **Areas of Jurisdiction**.The areas of jurisdiction of the GRC, headed by the District Collector will be (i) all locations or sites within the district where subproject facilities are proposed, or (ii) their areas of influence within the District. The Steering Committeewill have jurisdictional authority across the state (i.e., areas of influence of subproject facilities beyond district boundaries, if any).

198. The multi-tier GRM for the project is outlined below (Figure 19), each tier having time-bound schedules and with responsible persons identified to address grievances and seek appropriate persons' advice at each stage, as required. The GRC will continue to function throughout the project duration. The implementing agencies/ULBs shall issue notifications to establish the respective PIU level grievance redress cells, with details of composition, process of grievance redress to be followed, and time limit for grievance redress at each level.

Figure 19: Proposed TNUFIP Grievance Redress Mechanism



AP = affected person, CMA = Commissionerate of Municipal Administration, CMWSSB = Chennai Metropolitan Water Supply and Sewerage Board, CMSC = Construction, Management and Supervision Consultant, GRC = grievance redress committee, IA = implementing agency, PIU = Project Implementation Unit, TNUIFSL = Tamil Nadu Urban Infrastructure Financial Services Limited, TWADB = Tamil Nadu Water and Drainage Board, ULB = urban local body.

199. **Recordkeeping**. Records of all grievances received, including contact details of complainant, date the complaint was received, nature of grievance, agreed corrective actions and the date these wereeffected and final outcome will be kept by PIU in Madurai Municipal Corporation (with the support of CMSC) and submitted to PMU.

200. **Information dissemination methods of the GRM**. The PIU, assisted by CMSC will be responsible for information dissemination to affected persons and general public in the project area on grievance redress mechanism. Public awareness campaign will be conducted to ensure that awareness on the project and its grievance redress procedures is generated. The campaign will ensure that the poor, vulnerable and others are made aware of grievance redress procedures and entitlements per agreed entitlement matrix including. whom to contact and when, where / how to register grievance, various stages of grievance redress process, time likely to be taken for redress of minor and major grievances, etc. Grievances received and responses provided will be documented and reported back to the affected persons. The number of grievances recorded and resolved, and the outcomes will be displayed / disclosed in the PIU, offices, ULB notice boards and on the web, as well as reported in the semi-annual environmental and social monitoring

reports to be submitted to ADB. A Sample Grievance Registration Form has been attached in Appendix 3.

201. **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 PIU's abilityto prevent and address grievances.

202. **Costs.** All costs involved in resolving the complaints (meetings, consultations, communication and reporting/information dissemination) will be borne by Madurai Municipal Corporation. Cost estimates for grievance redress are included in resettlement cost estimates.

203. **Country legal procedure**. An aggrieved person shall have access to the country's legal system at any stage, and accessing the country's legal system can run parallel to accessing the GRM and is not dependent on the negative outcome of the GRM.

204. **ADB's Accountability Mechanism.** In the event that the established GRM is not in a position to resolve the issue, the affected person also can use the ADB Accountability Mechanism through directly contacting (in writing) the Complaint Receiving Officer (CRO) at ADB headquarters or the ADB India Resident Mission. The complaint can be submitted in any of the official languages of ADB's developing member countries. Before submitting a complaint to the Accountability Mechanism, it is recommended that affected people make a good faith effort to resolve their problems by working with the concerned ADB operations department (in this case, the resident mission). Only after doing that, and if they are still dissatisfied, they could approach the Accountability Mechanism. The ADB Accountability Mechanism information will be included in the project-relevant information to be distributed to the affected communities, as part of the project GRM.

VIII. ENVIRONMENTAL MANAGEMENT PLAN

205. An EMP has been developed to provide mitigation measures to reduce all negative impacts to acceptable levels.

206. The EMP will guide the environmentally sound construction of the subproject and ensure efficient lines of communication between TNUIFSL, PMU, implementing agency, PIU, Consultants and Contractors. The EMP will (i) ensure that the activities are undertaken in a responsible non-detrimental manner; (ii) provide a pro-active, feasible and practical working tool to enable the measurement and monitoring of environmental performance on site (iii) guide and control the implementation of findings and recommendations of the environmental assessment conducted for the subproject; (iv) detail specific actions deemed necessary to assist in mitigating the environmental impact of the subproject; and (v) ensure that safety recommendations are complied with. The EMP includes a monitoring program to measure the environmental condition and effectiveness of implementation of the mitigation measures. It will include observations on- and off-site, document checks, and interviews with workers and beneficiaries.

207. The contractor will be required to submit to PIU/Madurai City Municipal Corporation, for review and approval, a site environmental management plan (SEMP) including (i) proposed sites/locations for construction work camps, storage areas, hauling roads, lay down areas, disposal areas for solid and hazardous wastes; (ii) specific mitigation measures following the approved EMP; and (iii) monitoring program as per SEMP. No works are allowed to commence prior to approval of SEMP.

208. A copy of the EMP/approved SEMP will be kept on site during the construction period at all times. The EMP included in the bid and contract documents to ensure compliance to the conditions set out in this document.

209. For civil works, the contractor will be required to (i) carry out all of the mitigation and monitoring measures set forth in the approved EMP; and (ii) implement any corrective or preventative actions set out in safeguards monitoring reports that the employer will prepare from time to time to monitor implementation of this IEE, EMP and SEMP. The contractor shall allocate budget for compliance with these IEE, EMP and SEMP measures, requirements and actions.

210. The following tables show the potential environmental impacts, proposed mitigation measures and responsible agencies for implementation and monitoring.

Table 45: Design Stage Environmental Impacts and Mitigation Measures

Field	Anticipated Impact	Mitigation Measures	Responsibility of Mitigation	Cost and Source of Funds
Water Treatment Plant	Deficient treatment due to substandard operation / system malfunction	(i) Design process to meet the Indian Standards for Drinking Water - Specification (IS 10500:2012). Ensuring continuous uninterrupted power supply. (ii) Providing operating manual with all standard operating procedures (SOPs) for operation and maintenance of the facility (iii) Necessary training to urban local body (ULB) staff dealing with water treatment plant (WTP). (iv) Extended contractor period for operations and maintenance (O&M), proper transfer of facility to ULB with adequate technical know-how on O&M and hands-on training to ULB staff	Program implementation unit (PIU)	Project Costs
	Disposal of Sludge	(i) After drying, the dried sludge will be stored in stockyard within the WTP premises and it will be disposed periodically or in the area identified by the Madurai Municipal Corporation at a maximum distance of 30 km from WTP. (ii) The water from sludge drying bed under drain is recirculated into recirculation sump. The supernatant water from Sludge Thickener will be sent into re-circulation sump. The sludge shall be taken to the sludge balance tank and from there discharge to nearby drain. The filtrate will be re-circulated to the raw water distribution chamber	PIU	Project Costs
	Storage of chemicals and other hazardous materials	(i) The separate place in the WTP site should be identified for the safe storage and handling of chemicals and other hazardous materials with proper display of requirements and marking as protected area. (ii) Providing specific appliances for safe working of personnel in critical areas like chlorination plant shall be ensured.	PIU	Project Costs
	Reuse of Back wash water	The backwash water from proposed WTP should be stored within the premises for further recirculation. It helps to minimize the raw water demand. For reuse and recirculation of the backwash water, proper recirculation system should be installed in WTP.	PIU	Project Costs
	Risk and Safety	(i) Adopt the World Bank EHS guidelines related to occupational health and safety (refer https://www.ifc.org/wps/wcm/connect/e22c050048855ae0875cd76a6515bb18/Final%2B-%2BWater%2Band%2BSanitation.pdf?MOD=AJPERES) (ii) Use only liquid chlorine. Strictly, the chlorine gas will not be used in the water treatment plant.	PIU	
Distribution network - raw water main,	Nuisance due to leaks, overflows,	(i) Limit the depth wherever possible	PIU	Project Costs

Field	Anticipated Impact	Mitigation Measures	Responsibility of Mitigation	Cost and Source of Funds
clear water transmission main	contamination of water, occupation health and safety of workers, etc.	(ii) In unavoidable cases, where networks are to be laid close to storm water drains, appropriate pipe material shall be selected (stoneware pipes shall be avoided) (iii) For shallow depth and especially in narrow roads, use small inspection chambers;		
Over Head Tanks	Energy consumption	(i) Using low-noise and energy efficient pumping systems (ii) Efficient Pumping system operation (iii) Installation of Variable Frequency Drives (VFDs)	PIU	Project Costs
Trees on Project Location	Tree cutting	(i) Minimize removal of trees by adopting to site condition and with appropriate layout design/alignment, (ii) Obtain prior permission for tree cutting (iii) Plant and maintain 10 trees for each tree that is removed	PIU	Project Costs

Table 46: Pre-Construction Stage Environmental Impacts and Mitigation Measures

Field	Anticipated Impact	Mitigation Measures	Responsible for Implementation	Cost and Source of Funds
Construction of check dam and Head works	Change of stream course due to diversion channels to construct intake structures and check dam	(i) No appreciable change to the river course shall occur due to diversion channel and intake structures & check dam should be constructed accordingly. (ii) The cofferdam will be provided for construction of check dam and head work without any disturbance of river water flow.	Contractor / Program implementation unit (PIU)	Project Costs
	Impact on the aquatic environment/ ecology	The check dam should be provided with Sluice gates (upstream and downstream of the shutters, smooth concrete bed apron should be provided to ensure that free flow occurs) through which the ecological flow in the river has to be maintained during the lean season. The sluice should act as a path for aquatic species including phytoplankton, zooplankton, fish species and reptiles	Contractor / Program implementation unit (PIU)	Project Costs
	Protection of topsoil	Topsoil from the Head works site should be stored in stock piles and that can be used for gardening purposes at Head works site which will be an environmental enhancing measure	Contractor/ PIU	Project Costs

Field	Anticipated Impact	Mitigation Measures	Responsible for Implementation	Cost and Source of Funds
	Disposal of construction debrisand excavated materials.	The contractor should make use of the excavated material and construction debris for service road construction purpose.	Contractor / PIU	Project Costs
	Downstream users (impacts arisingdue to cofferdams, etc.)	Ensure that the stream is not obstructed, affecting the downstream users due to cofferdams, etc.	Contractor / PIU	Project Costs
	Water quality in the source / water bodies	Establish the baseline water quality prior to initiation of construction and to be periodically monitored.	Contractor / PIU	Project Costs
	Restoring river bed / water source	After completion of work, ensure the restoring of river bed to its natural shape free from any debris or construction junk material that may obstruct the flow.	Contractor / PIU	
	Safety measures	i) Barricading of construction site/ trench locations at all times in a day with adequate signage. ii) Where loose soil is met with, shoring and strutting shall be provided to avoid collapse of soil. iii) The contractor shall supply all necessary safety appliances such as safety goggles, helmets, safety belts, earplugs, mask etc., to workers and staff.	Contractor / PIU	Project Costs
Construction of transmission lines including OHTs, WTP	Compensatory plantation of trees	Compensatory plantation of atleast ten the number trees felled should be done in line with competent authority guidelines	Contractor / PIU	Project Costs
	Disposal of construction debris and excavated materials.	The Contractor shall identify the sites for debris disposal and should be finalized prior to start of the earthworks; taking into account the following a) The dumping does not impact natural drainage courses b) no endangered / rare flora is impacted by such dumping c) The dumping site should be located at least 1.0 km away Settlement area. d) Dumping site should be located in nonresidential areas in the downwind side e) It should be located at least 100m from the designated forest land. f) Avoid disposal on productive land. g) Minimize the construction debris by balancing the cut and fill requirements.	Contractor / PIU	Project Costs

Field	Anticipated Impact	Mitigation Measures	Responsible for Implementation	Cost and Source of Funds
	Protection of top soil	The top soil to be protected and compacted after completion of work, where the pipelines run, including open lands and agricultural lands.	Contractor	Project Costs
	Safety Aspects	(i) Adequate precautions shall be taken to prevent the accidents and from the machineries. All machines used shall confirm to the relevant Indian standards Code and shall be regularly inspected by the PIU. (ii) Adequate precautions shall be taken while carrying out excavation, laying pipelines, operation of machinery near the power transmission towers and lines. Safety clearance requirements shall be met with. (iii) Labourers shall be periodically trained for the safety precautions for working near the power transmission lines. (iv) Emergency contact numbers shall be made available at the place of work. (v) Where loose soil is met with, shoring and strutting shall be provided to avoid collapse of soil. (vi) Protective footwear and protective goggles should be provided to all workers employed on mixing of materials like cement, concrete etc. (vii) Welder's protective eye-shields shall be provided to workers who are engaged in welding works. (viii) Earplugs shall be provided to workers exposed to loud noise, and workers working in crushing, compaction, or concrete mixing operation. (ix) The contractor shall supply all necessary safety appliances such as safety goggles, helmets, safety belts, earplugs, mask etc., to workers and staffs. (x) The contractor will make sure that during the construction work all relevant provisions of the Factories Act, 1948 and the Building and other Construction Workers (regulation of Employment and Conditions of Services) Act, 1996 are adhered to. (xi) The contractor shall not employ any person below the age of 14 years for any work and no woman will be employed on the work of painting with products containing lead in any form.	Contractor	Project Costs

Field	Anticipated Impact	Mitigation Measures	Responsible for Implementation	Cost and Source of Funds
Batching and Crusher plant	Setting up of Batching and Crushers Plant,	i) Hot mix plants, crushers and ready-mix concrete batching plants shall be located at least 500 m away from the nearest habitation. ii) Contractor shall obtain NOCs / Consent to Establishment & Operate the plants from the Tamil Nadu State Pollution Control Board (TNPCB) and submit a copy to the PIU. iii) Specifications of hot mix plants and batching plants, other construction vehicles, equipment and machinery to be procured will comply to the relevant Bureau of Indian Standard (BIS) norms and with the requirements of the relevant current emission control legislations	Contractor	Project Costs
	Water for construction	(i) The contractor should source the requirement of water preferentially from surface water bodies, such as rivers and tank in the project area. Boring of any tube wells are prohibited. To avoid disruption / disturbance to other water users, the contractor should extract water from fixed locations. (ii) Only at locations where surface water sources are not available, the contractors can contemplate extraction of groundwater. Consent from the PIU engineer that no surface water resource is available in the immediate area for the project is a pre – requisite prior to extraction of groundwater. The contractor must need to comply with the requirements of the State Groundwater Department and seek their approval for doing so. (iii) The use of surface water by the contractor should be allowed only after written permission/consent of the community/panchayat/ owner indicating the quantum of water allowed to be drawn.	Contractor	Project cost
Sources of Materials	Extraction of materials can disrupt natural land contours and vegetation resulting in accelerated erosion, disturbance in natural drainage patterns, ponding and water	(i) Obtain construction materials only from government approved quarries with prior approval of PIU (ii) PIU to review, and ensure that proposed quarry sources have all necessary clearances/ permissions in place prior to approval (iii) Contractor to submit to PIU on a monthly basis documentation on material obtained from each source (quarry/ borrow pit)	Contractor to prepare list of approved quarry sites and sources of materials with the approval of PIU	Project cost

Field	Anticipated Impact	Mitigation Measures	Responsible for Implementation	Cost and Source of Funds
	logging, and water pollution.	(iv) Avoid creation of new borrow areas, quarries etc., for the project; if unavoidable, contractor to obtain all clearances and permissions as required under law, including Environmental Clearance (EC) prior to approval by PIU		
	Identification and selection of Quarries	(i) The contractor should source materials (like gravel, aggregates) from existing licensed quarries with the suitable materials for construction. (ii) Apart from approval of the quality of the quarry materials, the engineer's (PIU) representative will verify the legal status of the quarry operation, as to whether approval under Mining Department is obtained.	Contractor in coordination with PIU	Project cost
	Sand	The contractor will identify sand quarries with requisite approvals for the extraction of sand under Tamil Nadu Minor Minerals Concession Rules, 1959 (Corrected upto 31.3.2001or latest) for use in the project.	Contractor in coordination with PIU	Project cost
Submission of updated EMP / SEMP; EMP implementation and reporting	Unsatisfactory compliance to EMP	(i) Appoint EHS Supervisor by CMSC to ensure EMP implementation (ii) Submission of updated EMP/ SEMP (iii) Timely submission monthly of monitoring reports including documentary evidence on EMP implementation such as photographs	Contractor	Contractor cost
Utilities	Telephone lines, electric poles and wires, water lines within proposed project area	(i) Identify and include locations and operators of these utilities in the detailed design documents to prevent unnecessary disruption of services during construction phase; and (ii) Require construction contractors to prepare a contingency plan to include actions to be taken in case of unintentional interruption of services.	Contractor & PIU	Project cost

Field	Anticipated Impact	Mitigation Measures	Responsible for Implementation	Cost and Source of Funds
Construction work camps, stockpile areas, storage areas, and disposal areas.	Conflicts with local community; disruption to traffic flow and sensitive receptors	(i) Prioritize areas within or nearest possible vacant space in the project location; (ii) If it is deemed necessary to locate elsewhere, consider sites that will not promote instability and result in destruction of property, vegetation, irrigation, and drinking water supply systems; (iii) Do not consider residential areas; (iv) Take extreme care in selecting sites to avoid direct disposal to water body, which will inconvenience the community. (v) For excess spoil disposal, ensure (a) site shall be selected preferably from barren, infertile lands. In case agricultural land needs to be selected, written consent from landowners (not lessees) will be obtained; (b) debris disposal site shall be at least 200 m away from surface water bodies; (c) no residential areas shall be located within 100 m downwind side of the site; and (d) site is minimum 100 m away from sensitive locations like settlements, ponds/lakes or other water bodies.	Contractor to finalize locations in consultation and approval of PIU	Contractor cost
Consents, permits, clearances, NOCs, etc.	Failure to obtain necessary consents, permits, NOCs, etc. can result to design revisions and/or stoppage of works	(i) Obtain all necessary consents, permits, clearance, NOCs, etc. prior to award of civil works. (ii) Ensure that all necessary approvals for construction to be obtained by contractor are in place before start of construction (iii) Acknowledge in writing and provide report on compliance all obtained consents, permits, clearance, NOCs, etc.	Contractor and PIU	Cost of obtaining all consents, permits, clearance, NOCs, etc. prior to start of civil works responsibility of PIU

Field	Anticipated Impact	Mitigation Measures	Responsible for Implementation	Cost and Source of Funds
Chance finds	Damage / disturbance to artifacts	(i) Construction contractors to follow these measures in conducting any excavation work (ii) Create awareness among the workers, supervisors and engineers about the chance finds during excavation work (iii) Stop work immediately to allow further investigation if any finds are suspected; (iv) Inform Archeological Survey of India / State Archaeological Department if a find is suspected and taking any action they require to ensure its removal or protection in situ.	Contractor and PIU	Contractor cost
Works in proposed area	Degradation of water quality due to entry of silt laden runoff	(i) No earthworks should be conducted during the monsoon season in general, and in particular no earth work to be conducted in subproject areas during monsoon season (ii) Stockpiled material and earth/soil shall be properly covered with tarpaulins; bunds, silt traps/fences, etc., (iii) Install temporary silt traps or sedimentation basins along the drainage leading to the water bodies; it shall be ensured that no silt laden runoff or traces of fuels, lubricants or chemicals used in construction drains into any public areas. (iv) Place storage areas for fuels and lubricants away from any drainage leading to water bodies; (v) Store fuel, construction chemicals etc., on an impervious floor, also avoid spillage by careful handling; provide spill collection sets for effective spill management (vi) No workers camp sites, storage areas etc., will not be located close to the wetland (< 1 km).	Contractor and PIU	Project cost
Temporary economic impacts	Disruption to vendors, hawkers on ROW during sewer laying works	(i) Contractor is required to provide notice to the shop owners of the need to shift kiosk/wares displayed on ROW as soon as the work plan is ready, with minimum 7 working days. (ii) No works can be commenced unless 100% shifted in sections ready for implementation.	Contractor and PIU	Project cost

Table 47: Construction Stage Environmental Impacts and Mitigation Measures

Field	Anticipated Impact	Mitigation Measures	Responsible for Mitigation	Cost and Source of Funds
Air Quality	Dust, emissions from construction vehicles, equipment, and machinery used for installation of pipelines resulting to dusts and increase in concentration of vehicle-related pollutants such as carbon monoxide, sulfur oxides, particulate matter, nitrous oxides, and hydrocarbons.	**For all construction works** (i) Provide a dust screen (6m high) around the construction sites (ii) Damp down the soil and any stockpiled material on site by water sprinkling;(3-4 times a day - before the start of work, 1-2 times in between, and at the end of the day); when working in the roads there should permanently be one person responsible for directing when water sprinkling needs to take place to stop the dust moving; (iii) Reduce the need to sprinkle water by stabilizing surface soils where loaders, support equipment and vehicles will operate by using water and maintain surface soils in a stabilized condition (iv)Apply water prior to leveling or any other earth moving activity to keep the soil moist throughout the process (v) Cover the soil stocked at the sites with tarpaulins, and surround by dust screens. (vi)Control access to work area, prevent unnecessary movement of vehicle, public trespassing into work areas; limiting soil disturbance will minimize dust generation (vii)Use tarpaulins to cover the loose material (soil, sand, aggregate etc.) when transported by open trucks; minimize the drop height when moving the excavated soil. (viii)Control dust generation while unloading the loose material (particularly aggregate, sand, soil) at the site by sprinkling water and unloading inside the barricaded area (ix)Clean wheels and undercarriage of haul trucks prior to leaving construction site (x)Ensure that all the construction equipment, machinery are fitted with pollution control devises, which are operating correctly, and have a valid pollution under control (PUC) certificate **For pipe laying works** (i) Barricade the construction area using hard barricades (of 2 m height) on both sides (ii) Initiate site clearance and excavation work only after barricading of the site is done (iii) Confine all the material, excavated soil, debris, equipment, machinery (excavators, cranes etc.,), to the barricaded area	Contractor	Project Cost

Field	Anticipated Impact	Mitigation Measures	Responsible for Mitigation	Cost and Source of Funds
		(iv) Limit the stocking of excavated material at the site; remove the excess soil from the site immediately to the designated disposal area (v) Undertake the work section wise: a 500 m section should be demarcated and barricaded; open up several such sections at a time, but care shall be taken to locate such sections in different zones (vi)Conduct work sequentially - excavation, Pipe laying, backfilling; testing section-wise (for a minimum length as possible) so that backfilling, stabilization of soil can be done. (vii)Remove the excavated soil of first section to the disposal site; as the work progresses sequentially, by the time second section is excavated, the first section will be ready for back filling, use the freshly excavated soil for back filling, this will avoid stocking of material, and minimize the dust. (viii)Backfilled trench at any completed section after removal of barricading will be the main source of dust pollution. The traffic, pedestrian movement and wind will generate dust from backfilled section. Road restoration shall be undertaken immediately. (ix) Immediately consolidate the backfilled soil and restore the road surface; if immediate road restoration is not possible, provide a layer of plain cement concrete (PCC) of suitable mix on the backfilled trench so that dust generation, erosion is arrested and it will also provide a smooth riding surface for the traffic until the road is properly restored. Backfilled trench without any road restoration is a major source of dust.		

Field	Anticipated Impact	Mitigation Measures	Responsible for Mitigation	Cost and Source of Funds
Surface water quality	Mobilization of settled silt materials, and chemical contamination from fuels and lubricants during construction can contaminate nearby surface water quality. Ponding of water in the pits / foundation excavations	(i) All earthworks be conducted during the dry season to prevent the problem of soil/silt run-off during rains (ii) Avoid stockpiling of earth fill especially during the monsoon season unless covered by tarpaulins or plastic sheetsdo not stock earth/material close to water bodies (at least100 m) (iii) Prioritize re-use of excess spoils and materials in the construction works. If spoils will be disposed, only designated disposal areas shall be used; (iv) Install temporary silt traps, oil traps, or sedimentation basins along the water leading to the water bodies; it shall be ensured that no silt laden runoff or traces of fuels, lubricants or chemicals used in construction drains into nearby water bodies. (v) Place storage areas (with impermeable surface) for fuels and lubricants away from any drainage leading to water bodies; these should be at least 100 m away from water bodies and groundwater wells) (vi) Store fuel, construction chemicals etc., on an impervious floor, also avoid spillage by careful handling; provide spill collection sets for effective spill management (vii) Dispose any wastes generated by construction activities in designated sites; (viii) Conduct surface quality inspection according to the Environmental Monitoring Plan (Table 50&51).	Contractor	Project Cost
	Water accumulation in trenches/pits	(i) As far as possible control the entry of runoff from upper areas into the excavated pits, and work area by creation of temporary drains or bunds around the periphery of work area (ii) Pump out the water collected in the pits / excavations to a temporary sedimentation pond; dispose off only clarified water into drainage channels/streams after sedimentation in the temporary ponds (iii) Consider safety aspects related to pit collapse due to accumulation of water	Contractor	Project Cost
Noise Levels	Increase in noise level due to earth-moving and excavation equipment, and the transportation of equipment, materials, and	(i) Plan activities in consultation with PIU so that activities with the greatest potential to generate noise are conducted during periods of the day which will result in least disturbanceespecially near schools and other sensitive receptors (ii) Minimize noise from construction equipment by using vehicle silencers, fitting jackhammers with noise-reducing mufflers, and use portable street barriers to minimise sound impact to surround sensitive receptor; and	Contractor	Project Cost

Field	Anticipated Impact	Mitigation Measures	Responsible for Mitigation	Cost and Source of Funds
	people, and vibration	(iii) Maintain maximum sound levels not exceeding 70 decibels (dB(A)) when measured at a distance of 10 m or more from the vehicle/s. (iv) Identify any buildings at risk from vibration damage and avoiding any use of pneumatic drills or heavy vehicles in the vicinity;if any building at risk, structural survey be completed prior to work, to provide baseline in case any issues from vibration, and if building is structurally unsound that measures taken to avoid any further damage (v) Horns should not be used unless it is necessary to warn other road users or animals of the vehicle's approach; (vi) Consult local communities in advance of the work to identify and address key issues, and avoid working at sensitive times, such as night times religious and cultural festivals.		
Landscape and aesthetics – waste generation	Impacts due to excess excavated earth, excess construction materials, and solid waste such as removed concrete, wood, packaging materials, empty containers, spoils, oils, lubricants, and other similar items.	(i) Prepare and implement a Construction Waste Management Plan (refer Appendix 4) (ii) As far as possible utilize the debris and excess soil in construction purpose, for example for raising the ground level or construction of access roads etc., (iii) Avoid stockpiling any excess spoils at the site for long time. Excess excavated soils should be disposed off to approved designated areas immediately (iv) If disposal is required, the site shall be selected preferably from barren, infertile lands; sites should located away from residential areas, forests, water bodies and any other sensitive land uses (v) Domestic solid wastes should be properly segregated in biodegradable and non-biodegradable for collection and disposal to designated solid waste disposal site; create a compost pit (with impermeable bottom and sides)at workers camp sites for disposal of biodegradable waste; non-biodegradable / recyclable material shall be collected separately and sold in the local recycling material market (vi) Residual and hazardous wastes such as oils, fuels, and lubricants shall be disposed offvia licensed (by TNPCB) third parties; (vii) Prohibit burning of construction and/or domestic waste; (viii) Ensure that wastes are not haphazardly thrown in and around the project site; provide proper collection bins and create awareness to use the dustbins recycle waste material where possible.	Contractor	Project Cost

Field	Anticipated Impact	Mitigation Measures	Responsible for Mitigation	Cost and Source of Funds
		(ix) Conduct site clearance and restoration to original condition after the completion of construction work; PIU to ensure that site is properly restored prior to issuing of construction completion certificate.		
Accessibility and traffic disruptions	Traffic problems and conflicts near project locations and haul road	**Pipe laying works** (i) Prepare a pipe laying work implementation plan in each zone separately and undertake the work accordingly; ensure that for each road where the work is being undertaken there is an alternative road for the traffic diversion; take up the work in sequential way so that public inconvenience is minimal; prepare traffic management plans for each section (refer sample in Appendix 5) (ii) Plan the pipe laying work in coordination with the traffic police; provide temporary diversions, where necessary with clear signage and effectively communicate with general public (iii) Avoiding conducting work in all roads in a colony at one go; it will render all roads unusable due to excavations at the same time, creating large scale inconvenience (iv) Undertake the work section wise: a 100m section should be demarcated and barricaded; open up several such sections at a time, but care shall be taken to locate such sections in different zones (v) Confine work areas in the road carriageway to the minimum possible extent; all the activities, including material and waste/surplus soil stocking should be confined to this area. Proper barricading should be provided; avoid material/surplus soil stocking in congested areas – immediately removed from site/ or brought to the as and when required (vi) Limit the width of trench excavation as much as possible by adopting best construction practices; adopt vertical cutting approach with proper shoring and bracing; this is especially to be practiced in narrow roads and deeper excavation; if they deep trenches are excavated with slopes, the roads may render completely unusable during the construction period (vii) Leave spaces for access between mounds of soil to maintain access to the houses / properties; access to any house or property shall not be blocked completely; alternative arrangements, at least to maintain pedestrian access at all times to be provided (viii) Provide pedestrian access in all the locations; provide wooden/metal planks with safety rails over the open trenches at each house to maintain the access.	Contractor	Project Cost

Field	Anticipated Impact	Mitigation Measures	Responsible for Mitigation	Cost and Source of Funds
		(ix)Inform the affected local population about the work schedule a week before, and a day before to start of work (x)Plan and execute the work in such a way that the period of disturbance/ loss of access is minimum. (xi)Keep the site free from all unnecessary obstructions; (xii)Notify affected public-by-public information notices, providing signboards informing nature and duration of construction works and contact numbers for concerns/complaints. (xiii)At work site, public information/caution boards shall be provided including contact for public complaints **Hauling (material, waste/debris and equipment) activities** (i) Plan transportation routes so that heavy vehicles do not use narrow local roads, except in the immediate vicinity of delivery sites (ii)Schedule transport and hauling activities during non-peak hours (peak hours 7 to 10 AM and 4 to 7 PM); (iii)Locate entry and exit points in areas where there is low potential for traffic congestion; (iv)Drive vehicles in a considerate manner (v)Notify affected public by public-information notices, providing sign boards informing nature and duration of construction works and contact numbers for concerns/complaints.		
EMP Implementation Training	Irreversible impact to the environment, workers, and community	(i) Project manager and all key workers will be required to undergo training on EMP implementation including spoils/waste management, Standard operating procedures (SOP) for construction works; occupational health and safety (OH and S), core labor laws, applicable environmental laws, etc.	Contractor	Contractor cost
Socio-Economic Loss of access to houses and business	Loss of income	(i) Inform all businesses and residents about the nature and duration of any work well in advance so that they can make necessary preparations; (ii)Do not block any access; leave spaces for access between barricades/mounds of excavated soil and other stored materials and machinery, and providing footbridges so that people can crossover open trenches (iii)Barricade the construction area and regulate movement of people and vehicles in the vicinity, and maintain the surroundings safely with proper direction boards, lighting and security personnel – people should feel safe to move around (iv)Control dust generation	Contractor	Contractor cost

Field	Anticipated Impact	Mitigation Measures	Responsible for Mitigation	Cost and Source of Funds
		(v) Immediately consolidate the backfilled soil and restore the road surface; this will also avoid any business loss due to dust and access inconvenience of construction work. (vi) Employee best construction practices, speed up construction work with better equipment, increase workforce, etc., in the areas with predominantly commercial, and with sensitive features like hospitals, and schools; (vii) Consult businesses and institutions regarding operating hours and factoring this in work schedules; and (viii) Provide sign boards for pedestrians to inform nature and duration of construction works and contact numbers for concerns/complaints.		
Socio-Economic – Employment	Generation of temporary employment and increase in local revenue	(i) Employ local labour force as far as possible (ii) Comply with labor laws	Contractor	Contractor cost
Occupational Health and Safety	Occupational hazards which can arise during work	(i) Follow all national, state and local labour laws (indicative list is in Appendix 2); (ii) Develop and implement site-specific occupational health and safety (OH and S) Plan which shall include measures such as: (a) safe and documented construction procedures to be followed for all site activities; (b) ensuring all workers are provided with and use personal protective equipment; (c) OH and S Training for all site personnel, (d) excluding public from the work sites; and (e) documentation of work-related accidents; Follow International Standards such as the World Bank Group's Environment, Health and Safety Guidelines. (iii) Ensure that qualified first-aider is available at all times. Equipped first-aid stations shall be easily accessible throughout the sites; (iv) Secure all installations from unauthorized intrusion and accident risks (v) Provide H and S orientation training to all new workers to ensure that they are apprised of the basic site rules of work at the site, personal protective protection, and preventing injuring to fellow workers; (vi) Provide visitor orientation if visitors to the site can gain access to areas where hazardous conditions or substances may be present. Ensure also that visitor/s do not enter hazard areas unescorted;	Contractor	Contractor cost

Field	Anticipated Impact	Mitigation Measures	Responsible for Mitigation	Cost and Source of Funds
		(vii) Ensure the visibility of workers through their use of high visibility vests and other PPE when working in or walking through heavy equipment operating areas; (viii) Ensure moving equipment is outfitted with audible back-up alarms; (ix) Mark and provide sign boards for hazardous areas such as energized electrical devices and lines, service rooms housing high voltage equipment, and areas for storage and disposal. Signage shall be in accordance with international standards and be well known to, and easily understood by workers, visitors, and the general public as appropriate; and (x) Disallow worker exposure to noise level greater than 85 dBA for duration of more than 8 hours per day without hearing protection. The use of hearing protection shall be enforced actively. (xi) Provide supplies of potable drinking water; (xii) Provide clean eating areas where workers are not exposed to hazardous or noxious substances		
Community Health and Safety.	Traffic accidents and vehicle collision with pedestrians during material and waste transportation	(i) Consult PIU before locating project offices, sheds, and construction plants; (ii) Select a campsite away from residential areas (at least 100 m buffer shall be maintained) or locate the campsite within the existing facilities of City Corporation. (iii) Avoid tree cutting for setting up camp facilities. (iv) Provide a proper fencing/compound wall for campsites. (v) Camp site shall not be located near (100 m) water bodies, flood plains flood prone/low lying areas, or any ecologically, socially, archeologically sensitive areas. (vi) Separate the workers living areas and material storage areas clearly with a fencing and separate entry and exit. (vii) Ensure conditions of liveability at work camps are maintained at the highest standards possible at all times; living quarters and construction camps shall be provided with standard materials (as far as possible to use portable ready to fit-in reusable cabins with proper ventilation); thatched huts, and facilities constructed with materials like GI sheets, tarpaulins, etc., shall not be used as accommodation for workers. (viii) Camp shall be provided with proper drainage, there shall not be any water accumulation.	Contractor	Contractor cost

Field	Anticipated Impact	Mitigation Measures	Responsible for Mitigation	Cost and Source of Funds
		(ix)Provide drinking water, water for other uses, and sanitation facilities for employees; drinking water should be regularly tested to confirm that drinking water standards are met. (x)Prohibit employees from cutting of trees for firewood; contractor should provide cooking fuel (cooking gas); firewood not allowed (xi)Train employees in the storage and handling of materials which can potentially cause soil contamination (xii)Wastewater from the camps shall be disposed properly either into sewer system; if sewer system is not available, provide on-site sanitation with septic tank and soak pit arrangements (100 m away from surface water body or groundwater well) (xiii)Recover used oil and lubricants and reuse or remove from the site; (xiv)Manage solid waste according to the following preference hierarchy: reuse, recycling and disposal to designated areas; provide a compost pit for biodegradable waste, and non-biodegradable / recyclable waste shall be collected and sold in local market (xv)Remove all wreckage, rubbish, or temporary structures which are no longer required; and (xvi)At the completion of work, camp area shall be cleaned and restored to pre-project conditions, and submit report to PIU; PIU to review and approve camp clearance and closure of work site		
Work Camps and worksites	Temporary air and noise pollution from machine operation, water pollution from storage and use of fuels, oils, solvents, and lubricants Unsanitary and poor living conditions for workers	(i) As far as possible located the camp site within the work sites; if any camp to be established outside these, then select a camp site away from residential areas (at least 100 m buffer shall be maintained) (ii) Avoid tree cutting for setting up camp facilities (iii) Ensure that a proper compound wall is provided, and erect a wind/dust screen around (iv) Camp site shall not be located near (100 m) water bodies, flood plains flood prone/low lying areas, or any ecologically, socially, archeologically sensitive areas (v) Separate the workers living areas and material storage areas clearly with a fencing and separate entry and exit (vi) Provide proper temporary accommodation with proper materials, adequate lighting and ventilation, appropriate facilities for winters and summers; ensure conditions of livability at work camps are maintained at the highest standards possible at all times;	Contractor	Contractor cost

Field	Anticipated Impact	Mitigation Measures	Responsible for Mitigation	Cost and Source of Funds
		(vii) Consult PIU before locating project offices, sheds, and construction plants; (viii) Minimize removal of vegetation and disallow cutting of trees (ix) Ensure conditions of livability at work camps are maintained at the highest standards possible at all times; living quarters and construction camps shall be provided with standard materials (as far as possible to use portable ready to fit-in reusable cabins with proper ventilation); thatched huts, and facilities constructed with materials like GI sheets, tarpaulins, etc., shall not be allowed as accommodation for workers (x) Camp shall be provided with proper drainage, there shall not be any water accumulation (xi) Provide drinking water, water for other uses, and sanitation facilities for employees (xii) Prohibit employees from cutting of trees for firewood; contractor should be provide proper facilities including cooking fuel (oil or gas; fire wood not allowed) (xiii) Train employees in the storage and handling of materials which can potentially cause soil contamination (xiv) Recover used oil and lubricants and reuse or remove from the site (xv) Manage solid waste according to the following preference hierarchy: reuse, recycling and disposal to designated areas; provide a compost pit for biodegradable waste, and non-biodegradable / recyclable waste shall be collected and sold in local market (xvi) Remove all wreckage, rubbish, or temporary structures which are no longer required (xvii) At the completion of work, camp area shall be cleaned and restored to pre-project conditions and submit report to PIU; PIU to review and approve camp clearance and closure of work site.		

Field	Anticipated Impact	Mitigation Measures	Responsible for Mitigation	Cost and Source of Funds
Post-construction clean-up	Damage due to debris, spoils, excess construction materials	(i) Remove all spoils wreckage, rubbish, or temporary structures (such as buildings, shelters, and latrines) which are no longer required; and (ii) All excavated roads shall be reinstated to original condition. (iii) All disrupted utilities restored (iv) All affected structures compensated (v) The area that previously housed the construction camp is to be checked for spills of substances such as oil, paint, etc. and these shall be cleaned up. (vi) The contractor must arrange the cancellation of all temporary services. (vii) Request PIU to report in writing that worksites and camps have been vacated and restored to pre-project conditions before acceptance of work.	Contractor	Contractor cost

Table 48: Operation Stage Environmental Impacts and Mitigation Measures

Field	Anticipated Impact	Mitigation Measures	Responsible for Mitigation	Cost and Source of Funds
WTP operation	Public health, safety and environmental impacts	(i) Ensure proper knowledge transfer, hands-on training to municipal staff engaged in WTP operation has been provided by Contractor prior to handover of facility (ii) Ensure continuous uninterrupted power supply (iii) Operate and maintain the facility following standard operating procedures of operational manual (iv) Undertake preventive and periodic maintenance activities as required (v) Conduct periodic training to workers (vi) Monitoring water quality and safety in chemical handling	DBOT contractor and PIU	Operating costs
Operation and maintenance of distribution system	Blocks, overflows, system malfunction, occupational health and safety	(i) Establish regular maintenance program, including: • Regular cleaning of grit chambers and lines to remove grease, grit, and other debris that may lead to water backups. Cleaning should be conducted more frequently for problem areas • Inspection of the condition of storage reservoirs (OHT's) and identifying areas that need repair or maintenance. Items to note may include cracked/deteriorating pipes; leaking joints or seals; frequent line blockages; lines that generally flow at or near capacity; and • Monitoring of water flow to identify potential inflows and outflows (ii) Develop an Emergency Response System for the water system leaks, burst and overflows, etc. (iii) Provide all necessary personnel protection equipment	PIU	Operating costs

Table 49: Construction Stage Environmental Monitoring Plan

Monitoring field	Monitoring location	Monitoring parameters	Frequency	Responsibility	Cost and Source of Funds
Construction disturbances, nuisances, public and worker safety,	All work sites	Implementation of construction stage EMP including dust control, noise control, traffic management, and safety measures. Site inspection checklist to review implementation is appended at Appendix 6	Weekly during construction	Supervising staff and safeguards specialists of CMSC	Staff and consultant costs are part of incremental administration costs
Ambient air quality	locations 50 m downwind direction near WDS work sites in the sub project area;	• PM_{10}, $PM_{2.5}$ NO_2, SO_2, CO	Once before start of construction and Quarterly (yearly 4-times) during construction period	Contractor in consultation with CMSC	Cost for implementation of monitoring measures responsibility of contractor
Ambient noise	locations near water distribution station;	• Day time and nighttime noise levels	Once before start of construction and Quarterly (yearly 4-times) during construction period	Contractor in consultation with CMSC	Cost for implementation of monitoring measures responsibility of contractor
Surface water quality	Lower Camp, Cumbum, Chinnamanur and Theni	• pH, oil and grease, Cl, F, NO3, TC, FC, Hardness, Turbidity BOD, COD, DO, Total Alkalinity	Once before start of construction and Half yearly during construction period	Contractor in consultation with CMSC	Cost for implementation of monitoring measures responsibility of contractor
Soil Monitoring	Near work sites	• Monitoring of Pb, SAR and Oil & Grease	Once before start of construction and Quarterly (early 4-times) during construction period	Contractor in consultation with CMSC	Cost for implementation of monitoring measures responsibility of contractor

Table 50: Operation Stage Environmental Monitoring Plan

Monitoring field	Monitoring location	Monitoring parameters	Frequency	Responsibility	Cost and Source of Funds
Monitoring the water quality for IS: 10500 at head works / source before WTP (Water treatment plant).	Inlet of WTP	Turbidity Color Odor pH value @ 25ºC Total Dissolved Solids @105ºC Calcium (as Ca) Chlorides (as Cl^-) Magnesium (as Mg) Sulphates (as SO_4^{-2}) Total Alkalinity (as $CaCO_3$) Total Hardness (as $CaCO_3$) Iron (as Fe) Free Residual Chlorine, Total Coliform	Monthly Once	DBOT Contractor will hold the responsibility for 10 years (as per the condition of the contract) and after that the responsibility lies with the PIU	Operating Cost
Monitoring the water quality for IS: 10500 at WTP outlet.	Outlet of WTP		Monthly Once		
Monitoring the water quality at various points in the distribution system.	Various locations in the distribution system	Residual chlorine	Daily Random sampling month	Madurai Municipal Corporation	Operating Cost
Noise level monitoring	Near to WTP, Headworks)	Day time and nighttime noise levels (24 hours)	Monthly Once		

A. Implementation Arrangements

211. The Municipal and Water Supply Department (MAWS) acting through TNUIFSL will be the executing agency. A program steering committee, headed by Principal Secretary, MAWS, Government of Tamil Nadu, will provide overall guidance and strategic directions to the program. A PMU for TNUFIP, headed by the Managing Director, TNUIFSL acting as Program Director will be established within TNUIFSL for overall management, planning, implementing, monitoring, reporting, and coordinating TNUFIP. The CMA will act as the Deputy Program Director in the PMU. The project ULBs, represented by respective Municipal Commissioners, will be the implementing agencies for works in cities/towns and will establish PIUs headed by a municipal engineer as full-time Project Manager. PIUs will comprise of dedicated staff responsible for overseeing implementation of projects on a day-to-day basis. The PIUs will be supported by a CMSC recruited by TNUIFSL. For the institutional capacity, public awareness, and urban governance component, CMA acting through its Commissioner, will establish a PIU and appoint a governance improvement and awareness consultant (GIAC) responsible for supporting these activities. The implementing agency for this subproject is Madurai Municipal Corporation. A PIU will be established in Madurai Municipal Corporationheaded by City Engineer (Madurai Municipal Corporation) and comprising dedicated full-time staff from engineering and other departments of Madurai Municipal Corporation. PIU under the Madurai Municipal Corporation will be responsible for planning, implementation, monitoring and supervision, and coordination of all activities of subproject. A CMSC will be appointed to assist PIU in day-to-day implementation of the subproject.

212. **Safeguards Compliance Responsibilities**. ESS in the PMU in TNUIFSL will have overall responsibility of safeguard compliance with norms. ESS Managers report to Vice President in the Projects Wing. ESS Managers (TNUIFSL) will report to the Head, Projects Division. The Assistant Executive Engineer in charge of the project, will coordinate safeguard tasks at Madurai Municipal Corporation. As expert support is available to Madurai Municipal Corporation via CMSC, and the role of Assistant Executive Engineer will be mainly to coordination, overseeing the implementation of safeguard tasks, grievance redress and reporting.

213. **PMU Safeguard Responsibilities.** Key tasks and responsibilities of the ESS Manager (Environment), for this subproject include the following:

1. DPR finalization and Bidding stage:

(i) Ensure that all design related measures of the EMP are included designs;
(ii) Ensure that EMP is included in bidding documents and civil works contracts including requirement for EHS supervisor with the contractor;
(iii) Ensure that the bid/contract documents include specific provisions requiring contractors to comply with all applicable labour laws and core labour standards;
(iv) Ensure that staff required for implementation of EMP (EHS officer) is included in the bid requirements;
(v) Ensure that EMP cost is included in the project cost; and
(vi) Prior to invitation of bids and prior to award of contract, ensure that all clearance/permissions as required for implementation of subproject are in place to the extent possible.

2. Construction stage:

(i) Prior to start of construction:

(a) Ensure that all necessary clearances/permissions/licences, including that of contractor's are in place prior to start of construction; and
(b) provide oversight on environmental management aspects of subprojects and ensure EMPs are implemented by PIU and contractors.

(ii) Oversee and provide guidance to the PIU to properly carry out the environmental monitoring as per the EMP;
(iii) Oversee grievance redress mechanism to address any grievances brought about in a timely manner; ensure that records are properly maintained;
(iv) Consolidate quarterly environmental monitoring reports from PIU and submit semi-annual monitoring reports to TNUIFSL; and
(v) Oversee site closures to ensure that all work / facility sites are restored properly prior to issuing work completion certificate to the contractor.

3. Operation stage:

214. Ensure that operation of water supply system developed under the subproject is in compliancewith all government regulations, standards and conditions, such as consent to operate (CTO) for WTP from TNPCB.

215. **PIU Safeguard Responsibilities**. Key tasks and responsibilities of the PIU assisted by CMSC for this subproject include the following:

1. DPR finalization and Bidding stage:

(i) Include design related measures of the EMP in the project design and DPR;
(ii) Include EMP in the bidding documents and civil works contracts, including requirement of staff (EHS supervisor) with contractor for EMP implementation;
(iii) Provide necessary budget in the project as IEE for EMO Implementation;
(iv) Ensure that the bid/contract documents include specific provisions requiring contractors to comply with all applicable labour laws and core labour standards including:
a. Labour welfare measures and provision of amenities;
b. Prohibition of child labour as defined in national legislation for construction and maintenance activities;
c. Equal pay for equal work of equal value regardless of gender, ethnicity, or caste;
d. Elimination of forced labour;
e. The requirement to disseminate information on sexually transmitted diseases, including HIV/AIDS, to employees and local communities surrounding the project *sites.
(v) In the pre-bid meeting, provide insight into EMP measures, and overall compliance requirements to the bidders; and
(vi) Obtain all clearance/permissions as required for implementation of subproject, prior to invitation of bids and/or prior to award of contract / prior to construction as appropriate.

2. Construction stage:

(i) Identify regulatory clearance requirements and obtain all necessary clearances prior to start of construction; ensure construction work by contractor is conducted in compliance with all government rules and regulations including pollution control, labour welfare and safety etc.;

(ii) Prior to start of construction organize an induction course for the training of contractors, preparing them on EMP implementation, environmental monitoring, and on taking immediate action to remedy unexpected adverse impacts or ineffective mitigation measures found during the course of implementation;

(iii) Ensure contractor compliance with staff resources as per the IEE/EMP/Bid;

(iv) Guide contractor on updating EMP / preparing Site Environmental Plan at the start of the project;

(v) Update IEE and EMP; ensure that IEE reflects the final design being implemented by contractor;

(vi) Conduct public consultation and information disclosure as necessary;

(vii) Take necessary action for obtaining ROW;

(viii) Supervise day-to-day EMP implementation on site by contractor, including the environmental monitoring plan;

(ix) Supervise ambient environmental monitoring by contractors;

(x) Take corrective actions when necessary to ensure no environmental impacts;

(xi) Submit quarterly environmental monitoring reports to PMU;

(xii) Conduct continuous public consultation and awareness;

(xiii) Address any grievances brought about through the grievance redress mechanism in a timely manner as per the EMP;

(xiv) Monitor Contractor's compliance with the measures set forth in the EMP and any corrective or preventative actions set forth in a safeguards monitoring report that the PMU will prepare from time to time;

(xv) Implement corrective or preventative actions in case of non-compliance or new/unanticipated impacts;

(xvi) Inform PMU promptly in case if any significant impacts surfaces, which were not identified in the IEE and develop necessary corrective actions as necessary and ensure implementation by the contractors; include all such impacts and suggested actions in the Quarterly Environmental Monitoring Reports;

(xvii) Implementation grievance redress system, and undertake appropriate actions to redress the complaints; ensure that complaints/grievances are addressed in a timely manner and resolutions are properly documented;

(xviii) Review and approve monthly progress reports submitted by Contractor on EMP compliance;

(xix) Prepare quarterly environmental monitoring reports and submit to PMU /TNUIFSL; and

(xx) Provide any assistance in environmental safeguard related tasks as required by PMU to ensure compliance and reporting to ADB.

3. Operation stage:

(i) Obtain all clearances as required for operation of project prior to operation, such as consent to operate (CTO) for WTP from TNPCB;

(ii) Conduct environmental management and monitoring activities as per the EMP; and

(iii) Ensure that conveyance system constructed and operated with all necessary clearances and approvals, and compliance with standards and conditions.

216. Contractor's Responsibilities:

1. Bidding stage:

(i) Understand the EMP requirements and allocate necessary resources (budget, staff, etc.); and
(ii) Understand the regulatory compliance requirements related to labour welfare, safety, environment etc.

2. Construction stage:

(i) Mobilize EHS Supervisor prior to start of work;
(ii) Prepare SEMP and submit to PIU in MMC;
(iii) Ensure that all regulatory clearances (both projects related and contractor related) are in place prior start of the construction work;
(iv) Confirm with PIU availability of rights of way at all project sites prior to start of work;
(v) Prepare and submit:
  a. Construction waste management (CWM) plan (sample is in Appendix 4);
  b. Traffic management plan (sample is Appendix 5).
(vi) Implement the mitigation measures as per the EMP including CWM and traffic management plans;
(vii) Follow the EMP measures/guidelines for establishment of temporary construction camps, construction waste disposal sites, and material borrow areas, etc.;
(viii) Implement EMP and ensure compliance with all the mitigation and enhancement measures;
(ix) Conduct environmental monitoring (air, noise, water, etc.), as per the EMP;
(x) Undertake immediate action as suggested by PIU to remedy unexpected adverse impacts or ineffective mitigation measures found during the course of implementation;
(xi) Submit monthly progress reports on EMP implementation to PIU;
(xii) Act promptly on public complaints and grievances related to construction work and redress in a timely manner in coordination with PIU and CMSC; and
(xiii) Comply with applicable government rules and regulations.

B. Training Needs

217. Table 51 presents the outline of capacity building program to ensure EMP implementation. These capacity building and trainings will be conducted at the offices of PMU and PIU by the environmental safeguards specialist of PMU / PIU and their consultants, which are part of project implementation set-up, and therefore no separate or additional costs are envisaged. Adequate costsare already considered in project's capacity building program. The detailed program and specific modules will be customized for the available skill set after assessing the capabilities of the target participants and the requirements of the project by the PMU.

Table 51: Outline Capacity Building Program on EMP Implementation

Description	Target Participants and Venue	Cost and Source of Funds
1. Introduction and Sensitization to Environmental Issues (1 day) - ADB Safeguards Policy Statement - Government of India and Tamil Nadu applicable safeguard laws, regulations and policies including but not limited to core labor standards, OHS, etc. - Incorporation of EMP into the project design and contracts - Monitoring, reporting and corrective action planning	All staff and consultants involved in the project At PMU (combined program for all PIU)	Included in the overall program cost
2. EMP implementation (1/2 day) - EMP mitigation and monitoring measures -Roles and responsibilities - Public relations, - Consultations - Grievance redress - Monitoring and corrective action planning - Reporting and disclosure - Construction site SOP - Chance find (archeological) protocol - AC pipe protocol - Traffic management plan - Waste management plan - Site clean-up and restoration	All PIU staff, contractor staff and consultants involved in the subproject At PIU	To be conducted by CMSC at the PIU office; part of project implementation cost
3. Contractors Orientation to Workers (1/2 day) - Environment, health and safety in project construction	Before start of work, regular briefing is done once in every month. Daily briefing on safety prior to start of work All workers (including unskilled laborers)	Contractors' EHS officer to conduct program, with guidance of CMSC

ADB = Asian Development Bank, CMSC = Construction Management and Supervision Consultant, EHS = environmental Health and Safety, EMP = environmental management plan, OHS = occupational health and safety, PMU = program management unit, PIU = program implementation unit, SOP = standard operating procedures.

C. Monitoring and Reporting

218. Immediately after mobilization and prior to commencement of the works, the contractor will submit a compliance report to PIU in Madurai Municipal Corporation that all identified pre-construction mitigation measures as detailed in the EMP are undertaken. Baseline Environmental monitoring as indicated in the construction stage environmental monitoring plan should be conducted and the analysis of the outcome should be shared in the compliance report. Contractor should confirm that the staff for EMP implementation (EHS supervisor) is mobilized. PIU will review and approve the report and permit commencement of works.

219. During construction, results from internal monitoring by the contractor will be reflected in their monthly EMP implementation reports to the PIU. CMSC will monitor, review and advise contractors for corrective actions if necessary. QuarterlyEnvironmental Monitoring Report (QEMR) summarizing compliance and corrective measures, if any, taken will be prepared by CMSC team at PIU and submitted to PMU (Report format is at Appendix 7). During operation,

PIU will conduct management and monitoring actions as per the operation stage EMP, and submit to PMU annual report.

220. Based on PIU Quarterly Environmental Monitoring Reports (QEMR) and oversight visits to subproject work sites, PMU will submit semi-annual Environmental Monitoring Report (EMR). Once concurrence from the ADB is received the report will be disclosed on TNUIFSL and Madurai Municipal Corporation websites.

221. ADB will review project performance against the TNUFIPcommitments as agreed in the legal documents (loan and project agreements etc.). The extent of ADB's monitoring and supervision activities will be commensurate with the project's risks and impacts. Monitoring and supervising of social and environmental safeguards will be integrated into the project performance management system.

D. EMP Implementation Cost

222. Most of the mitigation measures require the contractors to adopt good site/ engineering practices, which should be part of their normal procedures, so there are unlikely to be major costs associated with compliance. The costs, which are specific to EMP implementation and are not covered elsewhere in the projects, are given below.

Table 52: Cost Estimates to Implement the environmental management plan

S. No.	Particulars	Stages	Unit	Total Number	Rate (₹)	Cost (₹)	Costs Covered By
A.	**Mitigation Measures**						
1	Provision for Transplantation	Construction	Per tree	150	16,000	2,400,000	Project costs (PIU)
2	Provision for tree cutting and compensatory plantation measures (1:10 ratio replantation)	Construction	Per tree	1500	200	300,000	Project costs (PIU)
	Preparation of plans traffic management plan, waste (spoils) management plan etc.), traffic management at work sites (Pavement Markings, Channelizing Devices, Arrow Panels and Warning Lights) (packages 1, 3 and 4)	Construction	Lump sum	3	600,000-	1,800,000	Civil works contractor
	Subtotal (B)					**4,500,000**	
B.	**Monitoring Measures**						

S. No.	Particulars	Stages	Unit	Total Number	Rate (₹)	Cost (₹)	Costs Covered By
1	Air quality monitoring	Construction	per sample	432	7000	3,024,000	Civil works contractor
2	Noise levels monitoring	Construction	Per sample	520	3000	1,560,000	
3	Water monitoring	Construction	Per sample	176	7500	1,320,000	
4	**Soil Quality Monitoring**	Construction	Per sample	**256**	**6000**	**1,536,000**	
	Subtotal (C)					**7,440,000/-**	
C.	**Capacity Building**						
1.	Training on EMP implementation	Pre-construction				**-**	Project costs (PIU)
2.	Contractors Orientation to Workers on EMP implementation	Prior to dispatch to worksite				-	
	Subtotal (D)						
	Total (A+B+C)				**INR**	**11,940,000/-**	

EMP = environmental management plan, PMU = program management unit, PIU = program implementation unit.

X. CONCLUSION AND RECOMMENDATIONS

223. The process described in this document has been assessed for the environmental impacts of all elements of the proposed water supply system for Madurai Municipal Corporation. All potential impacts were identified in relation to Designing, pre-construction, construction, and operation phases. Planning principles and design considerations have been reviewed and incorporated into the site planning and design process wherever possible; thus, environmental impacts pertaining to the project design or location were not significant. Mitigation measures have been developed to reduce all negative impacts to acceptable levels. These were discussed with specialists responsible for the engineering aspects, and as a resultof significant measures have already been included in the designs for the infrastructure.

224. A proposed 125 MLD water treatment plant will be installed and the treated water of quantity 125 MLD will be utilized / managed to fulfill the intermediate demand gap of MMC.

225. The project will be carried out in the properties of the local government and the access to the project location will be made through public ROW and existing roads. Hence, the head works site is the only land need to be procured, this would be for an extent of 2 acres, for which consent from the owner of the land has been obtained. Land acquisition by Madurai Municipal Corporation is under progress and the details of the land acquisition is covered under the resettlement plan.

226. Except pipe laying works, all other construction activities will be confined to the selected sites, and the interference with the general public and community around is minimal. There will be temporary negative impacts, arising mainly from construction dust and noise, hauling of construction material, waste and equipment on local roads (traffic, dust, safety etc.), mining of construction material, occupation health and safety aspects. Pipeline works will be conducted along edge of public roads in an urban area congested with people, activities and traffic, subproject is likely to have significant impacts during construction. Impacts mainly arise from the construction dust and noise; from the disturbance of residents, businesses, traffic by the construction work, safety risk to workers, public and nearby buildings due to deep trench excavations, especially in narrow roads, dust, access impediment to houses and business, disposal of large quantities of construction waste, etc. These are all general impacts of construction in urban areas, and there are well developed methods of mitigation that are suggested in the EMP.

227. Once the new system is operating, the facilities will operate with routine maintenance, which should not affect the environment. Improved system operation will comply with the O&M manual and standard operating procedures to be developed for all the activities. Pre audit will be carried out prior to operation of the scheme.

228. Mitigation will be assured by a program of environmental monitoring conducted during construction and operation to ensure that all measures are implemented, and to determine whether the environment is protected as intended. This will include observations on- and off-site, document checks, and interviews with workers and beneficiaries, and any requirements for remedial action will be reported to the PMU. Mitigation and monitoring measures, along with the project agency responsible for such actions, which would form part of the EMP.

229. Stakeholders were involved in developing the IEE through face-to-face discussions. Views expressed by the stakeholders were incorporated into the IEE and the planning and development of the project. The IEE will be made available at public locations and will be disclosed to a wider audience via Madurai Municipal Corporation and ADB websites. The consultation process will be

continued during project implementation, as required, to ensure that stakeholders are engaged in the project and have the opportunity to participate in its development and implementation.

230. The project's grievance redress mechanism will provide the citizens with a platform to redress their grievances, and describes the informal and formal channels, time frame, and mechanisms for resolving complaints about environmental performance.

231. The EMP will assist the project agencies and contractor in mitigating the environmental impacts and guide them in the environmentally sound execution of the proposed project. A copy of the updated EMP/ SEMP shall be kept on-site during the construction period at all times. The EMP shall be made binding on all contractors operating on the site, to ensure compliance to the conditions set out in this document.

232. The citizens of the subprojects area of Madurai City Municipal Corporation (MCMC) is the beneficiaries of this subproject. The new water supply system will provide safe drinking water of acceptable standard for the public which will improve the over-all public health in the project area. Diseases due to poor water quality, such as Cholera, diarrhoea and dysentery will be prevented so people should spend less on healthcare and lose fewer working days due to illness, so their economic status should also improve, as well as their overall health.

233. Therefore, as per ADB SPS, the project is classified as Environmental Category 'B' and does not require further Environmental Impact Assessment. Madurai Municipal Corporation shall update this IEE during the implementation phase to reflect any changes, amendments.

RAPID ENVIRONMENTAL ASSESSMENT CHECKLIST **WATER SUPPLY**

Screening Questions	Yes	No	Remarks
A. PROJECT SITING IS THE PROJECT AREA…			
▪ Densely populated?	✓		Subproject activities are in the urban areas of Tamil Nadu State. The central areas of the project towns are characterized by densely populated areas with narrow streets, while the outer areas are sparsely developed with wider roads. The outer areas (which are mainly recently added areas to the municipal limits) also comprise densely populated core town/village habitations surrounded by agricultural and vacant lands. Newly developing residential areas have low density and well-planned layouts.
▪ Heavy with development activities?	✓		
▪ Adjacent to or within any environmentally sensitive areas?			
▪ Cultural heritage site		✓	There are 413 nationally protected monuments in 27 districts of Tamil Nadu. The ADB Mission team confirmed during pre- and fact-finding missions that water supply subproject components' locations are not within nor adjacent to any protected monuments.
▪ Protected Area		✓	In Tamil Nadu State, there are 5 national parks, 15 wildlife sanctuaries (including four tiger reserves), 15 bird sanctuaries, and two conservation reserves. The ADB Mission team confirmed during pre- and fact-finding missions that Tranche 2 locations are not in these protected areas.
▪ Wetland		✓	
▪ Mangrove		✓	
▪ Estuarine		✓	
▪ Buffer zone of protected area		✓	There are 3 biosphere reserves in Tamil Nadu. Biosphere reserves have vast areas and may cover urban and developing areas. The ADB Mission team confirmed during pre- and fact-finding missions that Tranche 2 locations are components are/will be in the biosphere core zones.
▪ Special area for protecting biodiversity		✓	
▪ Bay		✓	
B. POTENTIAL ENVIRONMENTAL IMPACTS Will the Project cause…			
▪ pollution of raw water supply from upstream wastewater discharge from communities, industries, agriculture, and soil erosion runoff?		✓	**Not anticipated.** The Mission team confirmed during pre- and fact-finding missions that Tranche 2 raw water sources are no upstream wastewater discharge.
▪ impairment of historical/cultural monuments/areas and loss/damage to these sites?		✓	**Not anticipated.** The Mission team confirmed during pre- and fact-finding missions that Tranche 2 locations are not within nor adjacent to any protected historical/cultural

Screening Questions	Yes	No	Remarks
			monuments/areas.
▪ hazard of land subsidence caused by excessive ground water pumping?		✓	**Not anticipated.** Groundwater will not be used as source.
▪ social conflicts arising from displacement of communities?		✓	**Not anticipated.** Physical displacement is not anticipated. Temporary impacts to businesses may occur during pipelaying works and will be addressed through resettlement plans prepared to comply with ADB SPS requirements.
▪ conflicts in abstraction of raw water for water supply with other beneficial water uses for surface and ground waters?		✓	**Not anticipated.** The design engineers and project preparatory team confirmed required amount of water by subprojects is negligible compared to the volumetric flow rates and availability of the surface water source. The IEEs provided lean season flows and availability to downstream users.
▪ unsatisfactory raw water supply (e.g. excessive pathogens or mineral constituents)?		✓	**Not anticipated.** There are no sources of pollution upstream of the intakes. Monitoring and analysis conducted on raw water sources during design phase indicate good quality water (no pathogens and heavy metals). The WTPs are designed as state-of-the-art facilities.
▪ delivery of unsafe water to distribution system?		✓	**Not anticipated.** The WTPs are designed as state-of-the-art facilities which includes on-site and timely monitoring of treated water prior to distribution. O&M Manuals will be developed as part of the contracts. Necessary equipment and training to workers will be provided under TNUIFP. The ULBs will be trained on standard operating procedures and maintenance to ensure facilities are functioning according to the designs.
▪ inadequate protection of intake works or wells, leading to pollution of water supply?		✓	**Not anticipated.** The design engineers and project preparation consultants confirmed protection of intake works are included in the design and specifications.
▪ over pumping of ground water, leading to salinization and ground subsidence?		✓	**Not applicable.**
▪ excessive algal growth in storage reservoir?		✓	**Not anticipated.** The design engineers and project preparation consultants confirmed all overhead tanks and ground-level reservoirs are covered.
▪ increase in production of sewage beyond capabilities of community facilities?		✓	**Not anticipated.** New sewerage system will be developed at the project area
▪ inadequate disposal of sludge from water treatment plants?		✓	**Not applicable.** The WTP designs include sludge handling and treatment facilities. O&M Manual will include testing procedures, parameters and restriction on re-use of treated sludge. Only if it meets the Government of India standards for soil conditioner and fertilizer then will be allowed for re-use and strictly for non-food crops only.

Screening Questions	Yes	No	Remarks
▪ inadequate buffer zone around pumping and treatment plants to alleviate noise and other possible nuisances and protect facilities?		✓	**Not anticipated.** WTPs will include buffer zones as required and condition in the Consent to Establish by the Tamil Nadu State Pollution Control Board.
▪ impairments associated with transmission lines and access roads?		✓	**Anticipated during construction but temporary, site-specific and can be mitigated.** Complete road blocks are not envisaged. In narrow roads, traffic may be diverted but access will be ensured for pedestrians. Works will be conducted during dry season. Contractors are required to submit traffic management plan as part of site-specific EMP.
▪ health hazards arising from inadequate design of facilities for receiving, storing, and handling of chlorine and other hazardous chemicals.	✓		**Anticipated but can be managed.** Potential hazard during O&M phase but not significant and can be mitigated. Chlorine will be handled by qualified and trained personnel. Dealing with chlorine chemicals will follow the proper handling of the chemical per source or manufacturer's manual. No other hazardous chemicals will be involved.
▪ dislocation or involuntary resettlement of people?	✓		**Anticipated but can be managed.** Any involuntary resettlement impact is addressed in the resettlement plan prepared per ADB SPS.
▪ disproportionate impacts on the poor, women and children, Indigenous Peoples or other vulnerable groups?		✓	**Not anticipated.** The contractor will be encouraged to hire workers from the local labor force.
▪ noise and dust from construction activities?	✓		**Anticipated but temporary, site-specific and can be mitigated.** No blasting activities envisaged. Nuisance/disturbance due to elevated noise may be experienced by sensitive receptors during construction. Noise will be minimized with mitigation measures specified in the EMPs. During operations, noise may be experienced by sensitive receptors due to WTP operations. This will be avoided by including noise barriers and enclosure of noise-producing components to meet IFC EHS' WHO guideline values and/or national standards, whichever is more stringent.
▪ increased road traffic due to interference of construction activities?	✓		**Anticipated during construction but temporary, site-specific and can be mitigated.** Complete road blocks are not envisaged. In narrow roads, traffic may be diverted but access will be ensured for pedestrians. Works will be conducted during dry season. Contractors are required to submit traffic management plan as part of site-specific EMP.
▪ continuing soil erosion/silt runoff from construction operations?	✓		**Anticipated during construction but temporary, site-specific and can be mitigated.** EMPs and contract provisions include requirement for contractors to provide

Screening Questions	Yes	No	Remarks
			silt control measures.
▪ delivery of unsafe water due to poor O&M treatment processes (especially mud accumulations in filters) and inadequate chlorination due to lack of adequate monitoring of chlorine residuals in distribution systems?		✓	**Not anticipated.** The WTPs are designed as state-of-the-art facilities which includes on-site and timely monitoring of treated water prior to distribution. Each WTP will include laboratory to conduct monitoring of drinking water quality per WHO Drinking Water Guideline Values. Parameters to be monitored include residual chlorine. O&M Manuals will be developed as part of the contracts. Necessary equipment and training to workers will be provided under TNUIFP. The ULBs will be trained on standard operating procedures and maintenance to ensure facilities are functioning according to the designs.
▪ delivery of water to distribution system, which is corrosive due to inadequate attention to feeding of corrective chemicals?		✓	**Not anticipated.** Treated water will be tested prior to distribution (see above) to ensure it meets WHO Drinking Water Guideline Values. The O&M Manual, standard operating procedures, equipment, trainings and regular maintenance (which are part of the contracts) will ensure safe drinking water is supplied to the system.
▪ accidental leakage of chlorine gas?		✓	**Not applicable.** Chlorine gas will not be used. During operations, sodium hypochlorite solution or dry calcium hypochlorite will be used. The EMPs include measures and monitoring requirements conforming with IFC EHS Guidelines. O&M Manuals will include health and safety requirements for managing chemicals.
▪ excessive abstraction of water affecting downstream water users?		✓	**Not anticipated.** The design engineers and project preparatory team confirmed required amount of water by subprojects is negligible compared to the volumetric flow rates and availability of the surface water source. The IEEs provided lean season flows and availability to downstream users.
▪ competing uses of water?		✓	
▪ increased sewage flow due to increased water supply		✓	**Not anticipated.** The increased sewage flow will be handled by the sewage management system included in TNUFIP Tranches 1 and 2.
▪ increased volume of sullage (wastewater from cooking and washing) and sludge from wastewater treatment plant		✓	
▪ large population influx during project construction and operation that causes increased burden on social infrastructure and services (such as water supply and sanitation systems)?		✓	**Not anticipated.** Engaging local labor will be a priority in TNUFIP.
▪ social conflicts if workers from other regions or countries are hired?		✓	**Not anticipated.** Engaging local labor will be a priority in TNUFIP.
▪ risks to community health and safety due to the transport, storage, and	✓		**Anticipated but can be mitigated.** Construction will not involve use of explosives

Screening Questions	Yes	No	Remarks
use and/or disposal of materials such as explosives, fuel and other chemicals during operation and construction?			and chemicals. During operations, chlorination prior to distribution is required. The EMPs include measures and monitoring requirements conforming with IFC EHS Guidelines. O&M Manuals will include health and safety requirements for managing chemicals.
▪ community safety risks due to both accidental and natural hazards, especially where the structural elements or components of the project are accessible to members of the affected community or where their failure could result in injury to the community throughout project construction, operation and decommissioning?		✓	**Not anticipated.** Work area will be clearly demarcated. WTPs, overhead tanks and ground-level reservoirs are located inside ULB properties with compound walls and security personnel. Only workers and project-concerned members will be allowed to enter the sites. PIUs, in coordination with water and sanitation committees, will disseminate information on community health and safety.

CHECKLIST FOR PRELIMINARY CLIMATE RISK SCREENING

Screening Questions		Score	Remarks[a]
Location and Design of project	Is siting and/or routing of the project (or its components) likely to be affected by climate conditions including extreme weather-related events such as floods, droughts, storms, landslides?	1	Some project locations may experience flooding during heavy rains. No components will be sited in river flood plains, drainage channels, etc. Locations may however be in low-lying areas. Adequate measures will be included in the designs to safeguard facilities from extreme events.
	Would the project design (e.g. the clearance for bridges) need to consider any hydro-meteorological parameters (e.g., sea-level, peak river flow, reliable water level, peak wind speed etc.)?	1	Intakes and other structures (e.g., pumping stations, STPs) located in or close to rivers/water bodies, low lying flat lands, etc., to be designed with proper hydro-meteorological parameters
Materials and Maintenance	Would weather, current and likely future climate conditions (e.g. prevailing humidity level, temperature contrast between hot summer days and cold winter days, exposure to wind and humidity hydro-meteorological parameters likely affect the selection of project inputs over the life of project outputs (e.g. construction material)?	0	No significant effect
	Would weather, current and likely future climate conditions, and related extreme events likely affect the maintenance (scheduling and cost) of project output(s)?	0	No significant effect
Performance of project outputs	Would weather/climate conditions and related extreme events likely affect the performance (e.g. annual power production) of project output(s) (e.g. hydro-power generation facilities) throughout their design life time?	0	No significant effect

[a] If possible, provide details on the sensitivity of project components to climate conditions, such as how climate parameters are considered in design standards for infrastructure components, how changes in key climate parameters and sea level might affect the siting/routing of project, the selection of construction material and/or scheduling, performances and/or the maintenance cost/scheduling of project outputs.

Options for answers and corresponding score are provided below:

Response	Score
Not Likely	0
Likely	1
Very Likely	2

Responses when added that provide a score of 0 will be considered low risk project. If adding all responses will result to a score of 1-4 and that no score of 2 was given to any single response, the project will be assigned a medium risk category. A total score of 5 or more (which include providing a score of 1 in all responses) or a 2 in any single response will be categorized as high risk project.

Result of Initial Screening (Low, Medium, High): _____

Salient Features of Major Labor Laws Applicable to Establishments Engaged in Construction of Civil Works

(i) Workmen Compensation Act, 1923 - The Act provides for compensation in case of injury by accident arising out of and during the course of employment.

(ii) Payment of Gratuity Act, 1972 - Gratuity is payable to an employee under the Act on satisfaction of certain conditions on separation if an employee has completed 5 years' service or more or on death at the rate of 15 days wages for every completed year of service. The Act is applicable to all establishments employing 10 or more employees.

(iii) Employees' PF and Miscellaneous Provisions Act, 1952 - The Act provides for monthly contributions by the employer plus workers at 10% or 8.33%. The benefits payable under the Act are: (a) Pension or family pension on retirement or death as the case may be; (b) deposit linked insurance on the death in harness of the worker; (c) payment of PF accumulation on retirement/death etc.

(iv) Maternity Benefit Act, 1951 - The Act provides for leave and some other benefits to women employees in case of confinement or miscarriage etc.

(v) Contract Labour (Regulation and Abolition) Act, 1970 - The Act provides for certain welfare measures to be provided by the Contractor to contract labor and in case the Contractor fails to provide, the same are required to be provided by the Principal Employer by Law. The principal employer is required to take Certificate of Registration and the Contractor is required to take a License from the designated Officer. The Act is applicable to the establishments or Contractor of principal employer if they employ 20 or more contract labor.

(vi) Minimum Wages Act, 1948 - The employer is supposed to pay not less than the Minimum Wages fixed by appropriate Government as per provisions of the Act if the employment is a scheduled employment. Construction of Buildings, Roads, Runways are scheduled employment.

(vii) Payment of Wages Act, 1936 - It lays down as to by what date the wages are to be paid, when it will be paid and what deductions can be made from the wages of the workers.

(viii) Equal Remuneration Act, 1979 - The Act provides for payment of equal wages for work of equal nature to Male and Female workers and not for making discrimination against Female employees in the matters of transfers, training and promotions etc.

(ix) Payment of Bonus Act, 1965 - The Act is applicable to all establishments employing 20 or more workmen. The Act provides for payments of annual bonus subject to a minimum of 8.33 % of wages and maximum of 20 % of wages to employees drawing Rs. 3,500/- per month or less. The bonus to be paid to employees getting Rs. 2,500/- per month or above up to Rs.3,500/- per month shall be worked out by taking wages as Rs.2,500/- per month only. The Act does not apply to certain establishments. The newly set up establishments are exempted for five years in certain circumstances. Some of the State Governments have reduced the employment size from 20 to 10 for the purpose of applicability of the Act.

(x) Industrial Disputes Act, 1947 - The Act lays down the machinery and procedure for resolution of industrial disputes, in what situations a strike or lock-out becomes illegal and what are the requirements for laying off or retrenching the employees or closing down the establishment.

(xi) Industrial Employment (Standing Orders) Act, 1946 - It is applicable to all establishments employing 100 or more workmen (employment size reduced by some of the States and Central Government to 50). The Act provides for laying down rules governing the conditions of

employment by the employer on matters provided in the Act and get the same certified by the designated Authority.

(xii) Trade Unions Act, 1926 - The Act lays down the procedure for registration of trade unions of workmen and employees. The trade unions registered under the Act have been given certain immunities from civil and criminal liabilities.

(xiii) Child Labor (Prohibition and Regulation) Act, 1986 - The Act prohibits employment of children below 14 years of age in certain occupations and processes and provides for regulation of employment of children in all other occupations and processes. Employment of child labor is prohibited in Building and Construction Industry.

(xiv) Inter-State Migrant Workmen's (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 (who has recruited workmen in one state for employment in the establishment situated in another state). The inter-state migrant workmen, in an establishment to which this Act becomes applicable, are required to be provided certain facilities such as housing, medical aid, traveling expenses from home up to the establishment and back, etc

(xv) The Building and Other Construction Workers (Regulation of Employment and Conditions of Service) Act, 1996 and the Cess Act of 1996 - All the establishments who carry on any building or other construction work and employ 10 or more workers are covered under this Act. All such establishments are required to pay Cess at rate not exceeding 2% of the cost of construction as may be notified by the Government. The employer of the establishment is required to provide safety measures at the building or construction work and other welfare measures, such as canteens, first-aid facilities, ambulance, housing accommodation for workers near the workplace etc. The employer to whom the Act applies has to obtain a registration certificate from the Registering Officer appointed by the Government.

Sample Grievance Registration Form
(To be available in Tamil and English)

The _____Project welcomes complaints, suggestions, queries, and comments regarding project implementation. We encourage persons with grievance to provide their name and contact information to enable us to get in touch with you for clarification and feedback.
Should you choose to include your personal details but want that information to remain confidential, please inform us by writing/typing *(CONFIDENTIAL)* above your name. Thank you.

Date	Place of registration	Project Town Project:			
Contact information/personal details					
Name		Gender	* Male * Female	Age	31.
Home address					
Place					
Phone no.					
E-mail					
Complaint/suggestion/comment/question Please provide the details (who, what, where, and how) of your grievance below: If included as attachment/note/letter, please tick here:					
How do you want us to reach you for feedback or update on your comment/grievance?					

FOR OFFICIAL USE ONLY

Registered by: (Name of official registering grievance)	
Mode of communication: Note/letter E-mail Verbal/telephonic	
Reviewed by: (Names/positions of officials reviewing grievance)	
Action taken:	
Whether action taken disclosed:	Yes No
Means of disclosure:	

Sample Outline Spoils (Construction Waste) Management Plan

- The Spoil Management Plan should be site specific and be part of the monthly Construction Management Plan;
- The contractor, in consultation with the PIU, has to find out appropriate location/s for the disposal of the excess soil generated. The spoils should be deposited only at these sites;
- Further precautions need to be taken in case of the contaminated spoils;
- The vehicle carrying the spoil should be covered properly; and
- The spoils generating from each site should be removed on the same day or immediately after the work is complete. The site / road should be restored to the original condition.

I. Spoils information

The spoil information contains the details like (a) The type / material; (b) Potential contamination by that type; (c) Expected volume (site / component specific); and (d) Spoil Classification etc.

II. Spoils management

The Spoil Management section gives the details of (a) Transportation of spoil; (b) disposal site details; (c) Precautions taken; (d) Volume of contaminated spoil, if present; (d) Suggested reuse of disposal of the spoil.

III. Documentation

The volume of spoil generated (site specific, date wise), site disposed, reuse / disposal details should be documented properly.

Sample Outline Traffic Management Plan

A. Principles for TMP around the Water Supply Scheme Implementation Sites

1. One of the prime objectives of this TMP is to ensure the safety of all the road users along the work zone, and to address the following issues:

(i) the safety of pedestrians, bicyclists, and motorists travelling through the construction zone;
(ii) protection of work crews from hazards associated with moving traffic;
(iii) mitigation of the adverse impact on road capacity and delays to the road users;
(iv) maintenance of access to adjoining properties; and
(v) addressing issues that may delay the project.

B. Operating Policies for TMP

2. The following principles will help promote safe and efficient movement for all road users (motorists, bicyclists, and pedestrians, including persons with disabilities) through and around work zones while reasonably protecting workers and equipment.

(i) Make traffic safety and temporary traffic control an integral and high-priority element of project from planning through design, construction, and maintenance;
(ii) Inhibit traffic movement as little as possible;
(iii) Provide clear and positive guidance to drivers, bicyclists, and pedestrians as they approach and travel through the temporary traffic control zone;
(iv) Inspect traffic control elements routinely, both day and night, and make modifications when necessary;
(v) Pay increased attention to roadside safety in the vicinity of temporary traffic control zones;
(vi) Train all persons that select, place, and maintain temporary traffic control devices;
(vii) Keep the public well informed; and
(viii) Make appropriate accommodation for abutting property owners, residents, businesses, emergency services, railroads, commercial vehicles, and transit operations.

3. **Figure A5.1** illustrates the operating policy for TMP for the construction of water pipes along various types of roads.

C. Analyze the impact due to street closure

4. Apart from the capacity analysis, a final decision to close a particular street and divert the traffic should involve the following steps:

(i) Approval from the Greater Corporation/ Highways / Public Works Department (PWD) to use the local streets as detours;
(ii) Consultation with businesses, community members, traffic police, PWD, etc, regarding the mitigation measures necessary at the detours where the road is diverted during the construction;
(iii) Determining of the maximum number of days allowed for road closure, and incorporation of such provisions into the contract documents;
(iv) Determining if additional traffic control or temporary improvements are needed along the detour route;

(v) Considering how access will be provided to the worksite;
(vi) Contacting emergency service, school officials, and transit authorities to determine if there are impacts to their operations; and
(vii) Developing a notification program to the public so that the closure is not a surprise. As part of this program, the public should be advised of alternate routes that commuters can take or will have to take as result of the traffic diversion.

5. If full road-closure of certain streets within the area is not feasible due to inadequate capacity of the detour street or public opposition, the full closure can be restricted to weekends with the construction commencing on Saturday night and ending on Monday morning prior to the morning peak period.

Figure A5.1: Policy Steps for the TMP

Review	• Review construction schedule and methods
Traffic Re-Circulation	• Identify initial traffic recirculation and control policy
Traffic Diversions	• Identify routes for traffic diversions • Analyse adverse impact and mitigation at the detours
Full Road Colsures	• Begin community consultation for consensus • Finalise or determine alternate detours
Temporary parking	• Identify temporary parking (on and off -street) • Discuss with CMC, owner, community for use
Police Coordination	• Coordinate with theTraffic Police to enforce traffic and diversions
Install control devices	• Install traffic control devices (traffic cones, sgns, lightings, etc)
Awareness	• Conduct campaigns, publicity, and notify public about street closure
Public Redress	• Develop a mechanism to address public grievances regarding disruptons (traffic, utilities, and diversions)

D. Public awareness and notifications

6. As per discussions in the previous sections, there will be travel delays during the constructions, as is the case with most construction projects, albeit on a reduced scale if utilities and traffic management are properly coordinated. There are additional grounds for travel delays in the area, as most of the streets lack sufficient capacity to accommodate additional traffic from diverted traffic as a result of street closures to accommodate the works.

7. The awareness campaign and the prior notification for the public will be a continuous activity which the project will carry out to compensate for the above delays and minimize public

claims as result of these problems. These activities will take place sufficiently in advance of the time when the roadblocks or traffic diversions take place at the particular streets. The reason for this is to allow sufficient time for the public and residents to understand the changes to their travel plans. The project will notify the public about the roadblocks and traffic diversion through public notices, ward level meetings and city level meeting with the elected representatives.

8. The PIU will also conduct an awareness campaign to educate the public about the following issues:

(i) Traffic control devices in place at the work zones (signs, traffic cones, barriers, etc.);
(ii) Defensive driving behaviour along the work zones; and
(iii) Reduced speeds enforced at the work zones and traffic diversions.

9. It may be necessary to conduct the awareness programs/campaigns on road safety during construction.

10. The campaign will cater to all types of target groups i.e. children, adults, and drivers. Therefore, these campaigns will be conducted in schools and community centres. In addition, the project will publish a brochure for public information. These brochures will be widely circulated around the area and will also be available at the PIU, and the contractor's site office. The text of the brochure should be concise to be effective, with a lot of graphics. It will serve the following purpose:

(i) Explain why the brochure was prepared, along with a brief description of the project;
(ii) Advise the public to expect the unexpected;
(iii) Educate the public about the various traffic control devices and safety measures adopted at the work zones;
(iv) Educate the public about the safe road user behaviour to emulate at the work zones;
(v) Tell the public how to stay informed or where to inquire about road safety issues at the work zones (name, telephone, mobile number of the contact person; and
(vi) Indicate the office hours of relevant offices.

E. Install traffic control devices at the work zones and traffic diversion routes

11. The purpose of installing traffic control devices at the work zones is to delineate these areas to warn, inform, and direct the road users about a hazard ahead, and to protect them as well as the workers. As proper delineation is a key to achieve the above objective, it is important to install good traffic signs at the work zones. The following traffic control devices are used in work zones:

- Signs
- Pavement Markings
- Channelizing Devices
- Arrow Panels
- Warning Lights

12. Procedures for installing traffic control devices at any work zone vary, depending on road configuration, location of the work, construction activity, duration, traffic speed and volume, and pedestrian traffic. Work will take place along major roads, and the minor internal roads. As such, the traffic volume and road geometry vary. The main roads carry considerable traffic; internal

roads in the new city areas are wide but in old city roads very narrow and carry considerable traffic. However, regardless of where the construction takes place, all the work zones should be cordoned off, and traffic shifted away at least with traffic cones, barricades, and temporary signs (temporary “STOP” and “GO”).

13**.** Illustrates a typical set-up for installing traffic control devices at the work zone of the area, depending on the location of work on the roadway, and road geometrics:

- Work on shoulder or parking lane
- Shoulder or parking lane closed on divided road
- Work in Travel lane
- Lane closure on road with low volume
- Street closure with detour

14. The work zone should take into consideration the space required for a buffer zone between the workers and the traffic (lateral and longitudinal) and the transition space required for delineation, as applicable. For the works, a 30 cm clearance between the traffic and the temporary STOP and GO signs should be provided. In addition, at least 60 cm is necessary to install the temporary traffic signs and cones.

15. Traffic police should regulate traffic away from the work zone and enforce the traffic diversion result from full street closure in certain areas during construction. Flaggers/ personnel should be equipped with reflective jackets at all times and have traffic control batons (preferably the LED type) for regulating the traffic during nighttime.

16. In addition to the delineation devices, all the construction workers should wear fluorescent safety vests and helmets in order to be visible to the motorists at all times. There should be provision for lighting beacons and illumination for night constructions.

Sample Environmental Site Inspection Report

Project Name: Providing comprehensive Water Supply Scheme to Madurai City
Contract Number:

NAME: _____ DATE: _____
TITLE: _____ DMA: _____
LOCATION: _____ GROUP: _____

WEATHER:

Project Activity Stage	Survey	
	Design	
	Implementation	
	Pre-Commissioning	
	Guarantee Period	

Monitoring Items	Compliance
Compliance marked as Yes / No / Not applicable (NA) / Partially Implemented (PI)	
EHS supervisor appointed by contractor and available on site	
Construction site management plan (spoils, safety, schedule, equipment etc.,) prepared	
Traffic management plan prepared	
Dust is under control	
Excavated soil properly placed within minimum space	
Construction area is confined; no traffic/pedestrian entry observed	
Surplus soil/debris/waste is disposed without delay	
Construction material (sand/gravel/aggregate) brought to site as and when required only	
Tarpaulins used to cover sand and other loose material when transported by vehicles	
After unloading , wheels and undercarriage of vehicles cleaned prior to leaving the site	
No AC pipes disturbed/removed during excavation	
No chance finds encountered during excavation	
Work is planned in consultation with traffic police	
Work is not being conducted during heavy traffic	
Work at a stretch is completed within a day (excavation, pipe laying and backfilling)	
Pipe trenches are not kept open unduly	
Road is not completely closed; work is conducted on edge; at least one line is kept open	

Monitoring Items	Compliance
Road is closed; alternative route provided and public informed, information board provided	
Pedestrian access to houses is not blocked due to pipe laying	
Spaces left in between trenches for access	
Wooden planks/metal sheets provided across trench for pedestrian	
No public/unauthorized entry observed in work site	
Children safety measures (barricades, security) in place at works in residential areas	
Prior public information provided about the work, schedule and disturbances	
Caution/warning board provided on site	
Guards with red flag provided during work at busy roads	
Workers using appropriate PPE (boots, gloves, helmets, ear muffs etc)	
Workers conducting or near heavy noise work is provided with ear muffs	
Contractor is following standard and safe construction practices	
Deep excavation is conducted with land slip/protection measures	
First aid facilities are available on site and workers informed	
Drinking water provided at the site	
Toilet facility provided at the site	
Separate toilet facility is provided for women workers	
Workers camps are maintained cleanly	
Adequate toilet and bath facilities provided	
Contractor employed local workers as far as possible	
Workers camp set up with the permission of PIU	
Adequate housing provided	
Sufficient water provided for drinking/washing/bath	
No noisy work is conducted in the nights	
Local people informed of noisy work	
No blasting activity conducted	
Pneumatic drills or other equipment creating vibration is not used near old/risky buildings	

Signature

_____

Sign off

_____	_____
Name	**Name**
Position	**Position**

Quarterly Reporting Format for Madurai Municipal Corporation / PIU

1. Introduction

- Description of subproject implemented by PIU
- Environmental category of the subproject
- Details of site personnel and/or consultants responsible for environmental monitoring
- Subproject status

No.	Subproject Name	Subproject status	List of Works	Progress of Works
		Design☐ **Pre-Construction☐** **Construction☐** **Operational Phase☐**		

2. Compliance status with National/ State/ Local statutory environmental requirements

No.	Subproject Name	Statutory Environmental Requirements	Status of Compliance	Action Required

3. Compliance status with environmental loan covenants, if any

No. (List schedule and paragraph number of Loan Agreement)	Covenant	Status of Compliance	Action Required

4. Compliance status with the environmental management and monitoring plan

- Provide the monitoring results as per the parameters outlined in the EMP. Append supporting documents where applicable, including Environmental Site Inspection Reports.
- There should be reporting on the following items which can be incorporated in the checklist of routine Environmental Site Inspection Report followed with a summary in the semi-annual report send to ADB. Visual assessment and review of relevant site documentation during routine site inspection needs to note and record the following:

    - What are the dust suppression techniques followed for site and if any dust was noted to escape the site boundaries;
    - If muddy water was escaping site boundaries or muddy tracks were seen on adjacent roads;
    - Adequacy of type of erosion and sediment control measures installed on site, condition of erosion and sediment control measures including if these were intact following heavy rain;
    - Are their designated areas for concrete works, and refueling;
    - Are their spill kits on site and if there are site procedure for handling emergencies;
    - Is there any chemical stored on site and what is the storage condition?
    - Is there any dewatering activities if yes, where is the water being discharged;
    - How are the stockpiles being managed;
    - How is solid and liquid waste being handled on site;
    - Review of the complaint management system; and
    - Checking if there are any activities being under taken out of working hours and how that is being managed.

Summary Monitoring Table

Impacts (List from IEE)	Mitigation Measures (List from IEE)	Parameters Monitored (As a minimum those identified in the IEE should be monitored)	Method of Monitoring	Location of Monitoring	Date of Monitoring Conducted	Name of Person Who Conducted the Monitoring
Design Phase						
					-	
Pre-Construction Phase						
Construction Phase						
Operational Phase						

Overall Compliance with EMP

No.	Sub-Project Name	EMP Part of Contract Documents (Y/N)	EMP Being Implemented (Y/N)	Status of Implementation (Excellent/ Satisfactory/ Partially Satisfactory/ Below Satisfactory)	Action Proposed and Additional Measures Required

5. Approach and methodology for environmental monitoring of the project

- Brief description on the approach and methodology used for environmental monitoring of each subproject.

6. Monitoring of environmental impacts on project surroundings (ambient air, water quality and noise levels)

- Brief discussion on the basis for monitoring
- Indicate type and location of environmental parameters to be monitored
- Indicate the method of monitoring and equipment to be used
- Provide monitoring results and an analysis of results in relation to baseline data and statutory requirements

As a minimum the results should be presented as per the tables below.

Air Quality Results

Site No.	Date of Testing	Site Location	Parameters (Government Standards)		
			PM10 $\mu g/m^3$	SO_2 $\mu g/m^3$	NO_2 $\mu g/m^3$

Water Quality Results

Site No.	Date of Sampling	Site Location	Parameters (Monitoring Results)					
			pH	Conductivity µS/cm	BOD mg/L	TSS mg/L	TN mg/L	TP mg/L

Noise Quality Results

Site No.	Date of Testing	Site Location	LA_{eq} (dBA) (Government Standard)	
			Day Time	Night Time

7. Summary of key issues and remedial actions

- Summary of follow up time-bound actions to be taken within a set timeframe.

8. Appendixes

- Photos
- Summary of consultations conducted, if any
- Copies of environmental clearances and permits
- Sample of environmental site inspection report
- Other

PUBLIC INFORMATION NOTICE TEMPLATE

Public Announcement
Madurai Municipal Corporation
Providing Dedicated Water Supply Scheme to Madurai City Corporation

Under this project, works are being conducted by xxxxxxxx Contractor to provide water supply scheme for Madurai Municipal Corporation

As part of this, works for laying pipeline network will be taken up in -------- road----/ street/ lane ……. From……to……. (provide dates).

We request you to kindly co-operate for smooth implementation of the works.

We also request you to drive vehicles / pedestrians to walk carefully

Inconvenience caused is regretted.

PIU - Contact No.
Contractor – Contact no.

Stakeholder Consultation/ Focussed Group Discussion for Dedicated Water Supply Scheme for Madurai Municipal Corporation from Mullai Periyar at Lower Camp

Minutes of meeting for "Dedicated Water Supply Scheme for Madurai Municipal Corporation from Mullai Periyar at Lower Camp" held at Uthamapalyam Town Panchayat office on 13 March 2018.

Officers Present:

Sl. No.	Name	Designation
1	Thiru. P. Manivannan	Deputy Commissioner Madurai Municipal Corporation
2	Thiru. A. Mathuram	City Engineer, Madurai Municipal Corporation
3	Thiru J. Balasanmugam	Thasildhar, Uthamapalayam Taluk, Theni District
4	Thiru. M.Suruli	Head Quarters Thasildhar, Uthamapalayam Taluk, Theni District
5	Thiru S. Ram Kumar	VAO, Mela Gudalur (South)
6	Thiru. M. Asokan	Village Assistant Mela Gudalur (South)
7	Thiru. B. Karutha pandiyan	AEE/VWS, Madurai Municipal Corporation
8	Thiru. P. Mani	JE, Pannaipatti, WTP, Madurai Municipal Corporation

Farmers present:

Sl.No.	Name	Address/Place
1	Thiru P. Gopal	Lower Camp
2	Thiru.VethaMuthu	Lower Camp
3	Thiru. R. S. Paramaraj	Gudalur
4	Thiru.P. Murugeshan	Gudalur
5	Thiru. Veerbabu	Gudalur
6	Thiru. Asokan	Lower Camp

1. The meeting started with a welcome by Thiru.P. Manivannan, Deputy Commissioner of Madurai Municipal Corporation. The City Engineer, Madurai Municipal Corporation has explained the importance of the “Dedicated Water Supply Scheme for Madurai Municipal Corporation from Mullai Periyar at Lower Camp” and explain the Madurai City Population growth, facilities available, existing drinking water details etc, and the Project Area. At the outset of presentation, the following points have been discussed:

- The project head works located in the private land near Lower Camp in Mullai Periyar River and land acquisition has to be made. The City Engineer has requested the land owner to give land for construction of intake well and other components of the project with good opinion;
- The City Engineer further explained the pipeline alignment of the project, the land owner, Thiru Veerbabu has requested the pipeline alignment to be fixed without affecting agricultural land of the farmers;
- All the farmers presented in the meeting and have requested that less numbers of farmers were attended in the meeting, hence the meeting may be shift to Gudalur on 17 March 2018 for explaining the project details and getting good opinion from farmers; and
- Resolved that the “Dedicated Water Supply Scheme for Madurai Municipal Corporation from Mullai Periyar at Lower Camp” withfarmers meeting may be shifted to Gudalur on 17 March 2018 for further discussion.

2. At the end of discussion Thiru. A. Mathuram, City Engineer, Madurai Municipal Corporation thanked everyone for attending the meeting and putting forward their suggestions for the implementation of the project.

City Engineer **Madurai Municipal Corporation**

Minutes of Meeting for "Dedicated Water Supply Scheme for Madurai Municipal Corporation from Mullai Periyar at Lower Camp" held at Gudalur Municipality office Conference on 17 March 2018.

Officers Present:

Sl.No.	Name	Designation
1	Thiru. P. Manivannan	Deputy Commissioner Madurai Municipal Corporation
2	Thiru.A. Mathuram	City Engineer, Madurai Municipal Corporation
3	Thiru J. Balasanmugam	Thasildhar, Uthamapalayam Taluk, Theni District
4	Thiru. M.Suruli	Head Quarters Thasildhar, Uthamapalayam Taluk, Theni District
5	Thiru S. Ram Kumar	VAO, Mela Gudalur (South)
6	Thiru. M. Asokan	Village Assistant Mela Gudalur (South)
7	Thiru. B. Karutha pandiyan	AEE/VWS, Madurai Municipal Corporation
8	Thiru. P. Mani	JE, Pannaipatti, WTP, Madurai Municipal Corporation

Farmers / Public Present:

S.I.No:	Name	Designation
1.	C. Dravidamani	Advisor, Makkal Mantram
2.	V.Krishnamurthy	Assistant president, Makkal Mantram
3.	P.A. Mahindra	Makkal Mantram
4.	P.K.R.	N.S.K.& Farm Manager
5.	K.P.M. Matharsha	President, Makkal Mantram
6.	K.S. Veerbabu	All Farmers Association
7.	K. Shajahan	Secretary, Association for City Welfare Service
8.	K. Prakhas	Farmer
9.	S. Prabhakaran	Reporter, Dinamani
10.	S. S. Murugan	Reporter, Dinathanthi, Malaimazhar

S.I.No:	Name	Designation
11.	P. Pandikumar	Reporter, Danthi TV
12.	N. Senthil kumar	Natural Farmers Association, Theni District
13.	M.Natarajan	Gudalur
14.	C. Silambarasan	General Secretary for Youth, Theni District
15.	D.Raju	Farmers Association
16.	N. Jeyapal	Farmer – Treasurer
17.	V. Kodiarasan	Farmer
18.	N. Mohamed Ibrahim	Gudalur
19.	K. Sangappan	Gudalur
20.	R. Karnan	Gudalur
21.	M.Senkuttuvan	Gudalur
22.	S. RamKumar	VAO, Mela Gudalur (South)
23.	Tmt. C. Saroja	Lower Camp

3. The meeting started with a welcome by Thiru.P. Manivannan, DeputyCommissioner of Madurai Municipal Corporation. The City Engineer, Madurai Municipal Corporation has explained the importance of the dedicated water supply scheme for Madurai Municipal Corporation from Mullai Periyar at Lower Camp" and explain the Madurai City Population growth, facilities available, existing drinking water details etc, and the Project Area. At the outset of presentation, the following points have been discussed.

4. The Following Members have stated in the Meeting about water shortage in the Theni District due to implementation of dedicated water supply scheme for Madurai Municipal Corporation. They have raised the same queries about water drawal from the Periyar Dam and whether it will affect the irrigation facilities of the farmer in the Theni District.

(i) Senguttuvan, Deputy Secretariat, All former association Theni District
(ii) Rajiv, District President, All farmer association Theni District
(iii) Senthilkumar, Deputy President, All farmer association Theni District
(iv) V.Krishnamoorthy, Public Association Gudalur
(v) P.A Gajendran, Public Association Gudalur
(vi) K.P Matharsha, President Public Association Gudalur
(vii) Dhiravidamani, Public Association Gudalur
(viii) Subramanian, Public Association Gudalur
(ix) Veerbabu, All farmer association Gudalur
(x) Shajahan, All farmer association Gudalur
(xi) Pudhurasa, Tamilnadu Consumer Organiser

5. The City Engineer Madurai Municipal Corporation has replied that in the Periyar Dam 200 Cusecs has been allotted for drinking water to the Madurai Municipal Corporation in the allotted quantity only 50 Cusecs will be drawn for above scheme. Remaining 150 Cusecs will be in the river flow and while implementation of Mullai Periyar Scheme will not affect the irrigation and drinking water facilities.

6. In the Meeting Tmt.Saroja, the landowner of Proposed Head Works has agree to give her land for construction of intake wells and other components.

7. At the end of discussion Thiru. A. Mathuram, City Engineer, Madurai Municipal Corporation thanked everyone for attending the meeting and putting forward their suggestions for the implementation of the project.

City Engineer
Madurai Municipal Corporation

Public Hearing Attendees

Madurai Corporation

Meeting: AMRUT - Mullai periyar Meeting.

Date 08.03.18, Time 05:00 P.M

Venue: Conference Hall

Sl. No.	Name	Designation	Signature
1	J. SELVAM	Joint Sec T.N. Madurai Chamber	98421-51818
2	N. JAFFER SADIQ	Asst. Governor / RE Rotary Clubs	98947 80009
3	T. Saravanan	Lions Club	94428 17128
4	T.K. SIVAKUMAR	President, Rotary Club of MADURAI	9344102180
5	S. Chandran	Convenor, Environment Panel, CII, Madurai	9444108500
6	S. Selvam	EE Zone IV	97888 10186
7	S. Arasu	EE Z I	94437 39519
8	S.M. Rajendran	EE Z II	9443639595
9	S. Chandrasekaran	EE Zone 3	[illegible]
10	I. Renganathan	EE (PJ)	[illegible]
11	S. RETHINAVELU	Sr. President T.N. Chamber	9843058153
12	M. Venkatasalapathi	MADURAI ALBOOR	9994596640
13	[illegible]	[illegible]	[illegible]

Dedicated water supply ..... for Madurai corporation.

Meeting : Mullai Periyar meeting

Date...13.03.2016 **Time**.....

Venue :

Sl. No.	Name	Designation	Signature
1			13/3/16
2			
3	P.		
4			
5	M.		
6.			
7.	R.S.		
8.			
9.			
10			
11.	B. Karuthapandiyan	AEE/VWS	13/3/16

(5)

Madurai Corporation

Meeting : [illegible]

Date 16/3/18...., **Time**..............

Venue : [illegible]

Sl. No.	Name	Designation	Signature
1	[illegible]	[illegible]	[illegible]
2	[illegible]	[illegible] WP 31232	[illegible]
3	B. [illegible]	[illegible]	[illegible]
4	[illegible]	[illegible]	S. [illegible]
5	R. [illegible]	[illegible]	[illegible] 9842010090
6	[illegible]	[illegible]	9364576426 S. [illegible]
7	[illegible]	[illegible]	[illegible] 16/3 9865554138
8	D. Perumal	[illegible]	[illegible] 9500[illegible]
9	[illegible]	[illegible]	[illegible] 9[illegible]48 3066
10	N. [illegible]	[illegible]	N. [illegible]
11	S. [illegible]	[illegible]	[illegible]

(6)

Madurai Corporation

Meeting :

Date....16.3.18.., **Time**...............

Venue : collector office.

Sl. No.	Name	Designation	Signature
13.	R.Viswanath	EE/PMC Division/	[signature]
14	G. JEYARAJ	(I/c) Melur Rural (S.L)	[signature]
15	P. Nagaraj.	AM CREDAI	[signature]
16	Balakumar	CSS Rtd Gov	[signature]
17	T. Thiruvarasu	T.N.H.B. I & II Sector Ellis nagar	[signature]
18	T. M. HARI KRISHNAN	TNHB I & II Sec Anaiyur Madurai 17	T. M. H. K
19	C. GNANAGAM	T.N.H.B. Cty, Anaiyur Madurai.17	[signature]
20	A. ALWAR	Viswanathapuram	[signature]
21	A SHEIK HUSSAIN	Extn. Residents Welfare Association	[signature]
22	P. SADAYAPPAN	Mangalavinayagar Nagar S. Alangulam Madurai-17	[signature]
23			
24	R.R.K. [illegible]	[illegible]	[signature]
25	Dr. [illegible]	[illegible]	[signature]
26	P. Chandrasekaran	Park Town Secretary P & T Nagar, Mdu.	[signature]