CUDDALORE STORM WATER DRAINAGE PROJECT

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EXECUTIVE SUMMARY

- **Introduction:**

The Government of India has received finance from the International Bank for Reconstruction and Development (IBRD) in the form of a loan, towards the cost of Tamil Nadu Sustainable Urban Development Project (TNSUDP). GOI intends to apply a portion of the funds to eligible payments under the contract, for which the Tamil Nadu Urban Infrastructure Financial Services Limited (TNUIFSL) entrusted proposals to provide Consultancy assignment for preparation of Detailed Project Report for providing 'Integrated Storm Water Drainage system to Cuddalore Municipality'.

On the request of Cuddalore Municipality, Tenders were floated by TNUIFSL to select the Consultant to prepare the DPR. In the process, M/s Shah Technical Consultants (P) Ltd., have been awarded the work of preparation of DPR for providing Storm Water Drains to Cuddalore Municipality.

This project envisages improvements in the existing Storm Water Drainage system and improvements to Canal/Nallas and doesn't involve any land acquisition.

Projects proposed under TNSUDP shall be implemented safeguarding the environmental and social concerns of the development activity. This Environmental Assessment Report has been prepared as per the TNUIFSL's Environmental and Social Management Framework, which has been prepared exclusively for TNSUDP.

- **Description of Project Area:**

Cuddalore is a special grade Municipality in Cuddalore District and is also the Head Quarters Town of Cuddalore District. This town lies about 185 km South of Chennai. This town is also connected by train with Chennai, Trichy, Tanjore and Salem. The main occupation of the residents of Cuddalore is agriculture. Apart from this fishing and port related industries, Cuddalore houses chemical, pharmacological and energy industries in SIPCOT, an industrial estate set up by the state government. Many educational institutions, Banks, Collectorate and Government Hospital etc. are located in the town. It has a seaport and the famous Padaleeswara Temple. Two rivers namely Pennaiyar and Gedilam are flowing across the town.

This Municipality is situated on the shore of Bay of Bengal. The contour ranges from 0.5m (near sea shore) to 17.50 m (near Capper Hill). The maximum temperature in summer is about 46°C and the minimum temperature is 30°C. The maximum and minimum temperature in winter ranges from 30°C to 18°C respectively. The average annual rainfall is about 1365 mm.

The total area of the Municipality is about 27.69 sq.km. The Municipality is divided into 45 wards. Its total population as per 2011 census is 1,73,636.

- **Water ways in the project area:**

There are 2 major rivers viz., River Thenpennaiyar and Gedilam. River Thenpennaiyar flows in the northern side of project area, flowing from West to East, abutting the boundary. The length of the river within the project area is about 2.4 km. The width of the river varies from 240m to 600 m & the bed level varies from -1.400 m to -3.45 m (MSL).

The Gedilam river almost flows in the middle of the project area, from West to East. The length of the river within the project area is about 3.48 km. The width of the river varies from, about 100m to 300 m & the bed level varies from -3.50 m to -14.45 m (MSL).

The Uppanar odai is very near to sea connecting Gedilam and River Thenpennaiyar. It contains only back waters from Bay of Bengal. The length of the odai within the project area is about 1.85 km. The width of the odai varies from, about 40 m to 240 m & the bed level varies from -2.40 m to 3.50 m (MSL). All the waterways connect to the Gedilam river, which finally connects to Bay of Bengal.

There are also nallahs emerging from Kondangi lake (located outside & west of the town) which flows into the town.

- **Description of existing Underground Sewerage System:**

UGSS has been implemented by TWAD, covering 33 wards out of 45 wards, under Phase-I and for remaining wards, UGSS will be implemented in Phase-II, for which sanction is awaited from the Government. Number of sewerage zones is 13 & length of sewer lines laid is about 150 km. One STP is located in the Eastern side of Town. The process of sewage treatment is Activated Sludge Process (ASP). The capacity of STP is 12.5 MLD.

- **Description of existing Storm Water Drainage System:**

The Municipality has a total road length of about 326 km. The total length of drains is about 118 km (including drains on both the sides of the roads). About 28.50% of the roads are covered by storm water drains. The total length of natural drains, nallah (canals) and rivers is about 32 Km.

- **Issues identified in the existing Storm drainage system:**

The SWD collection system in Cuddalore Municipality has the following basic problems which are the reasons for over flow and flooding, during heavy rains.

  - Deposition of grit
  - Blockages in System
  - Surcharged sewer

- Improper outfall arrangement
- Improper inlet arrangements
- Inadequate vent road culvert
- Improper sloping arrangements
- Improper network arrangements

The width and depth of the culverts in some areas is lesser than the width and depth of the main drains.

Most of the drains out falls are located in the water ways. But the out fall arrangements are not properly constructed with required gradient. Therefore the water stagnation occurs in the terminal reaches of the drainage system.

- **Proposals for Improvements to the Storm Water Drainage System:**

After analyzing the shortfalls in the existing system, topography of the project area, flood prone areas in the town, detailed proposals have been made to alleviate the impacts of flood. The designs of the drains are primarily based on the topography.

Management measures to address the issues in the present Storm Water Drainage System:

All the drains are designed in such a way that the water is conveyed by gravity without pumping. The proposed drains will have proper inlet and outlet arrangements, adequate size and slope, with cover slabs at required locations and proper connectivity to the storm water system upto the disposal point. Proposals are also made for proper cross drainage works at necessary locations, improvement of water bodies and water ways including fencing at vulnerable locations. Sensitization of public to avoid dumping of solid waste into the drains through IEC activities by the ULB is recommended. Extension of UGD to the entire town with ensuring connections to all the households is also recommended.

The above management measures will result in drains free from grit allowing free flow of storm water upto the disposal points. As the drains were designed scientifically using the topography, GIS tools for developing DEM models, water sheds, macro and micro catchment areas. The existing system is modeled in the software and analysed for various scenarios with various parameters and the reaches that failed to carry the flow was identified. Adequate sections were proposed for the sections and checked for its adequacy to cater the estimated flows. The optimum solution is recommended and the following proposals were made:

- ✓ Construction of open and closed drains for a length of 170 km and providing kerbs & gutters for 54 km, to a total length of 224 km.
- ✓ To improve the carrying capacity of nallas / canals desilting and increase the width and depth are proposed.

- ✓ To provide outfall structures at all outfalls (143 nos.).
- ✓ To construct RWH structures at all outfall locations and bore holes filled with filter media, at 30 m interval for drains of width more than 1m.
- ✓ Rehabilitation and strengthening of Visweswara pond and Perumal pond to hold water capacity of 47,754 m^3 and 32,090 m^3 respectively.

The total project cost including price variation, contingencies and road variation works out to Rs.149.00 Crores. Annual Maintenance cost for the Project works out to Rs.1.61 Crores.

The Project will be implemented in Three Phases and the total works to be executed for construction of street drains is proposed in mentioned below:

- The Phase – I is about 42.00 crores.
- The Phase- II is about 28.43 crores
- The Phase-III is about 78.57 crores.

- **Environmental Assessment**

The Project anticipates cutting of trees present adjacent to the drains, requires tree cutting permission from the District Collector / Highways / National Highways / Municipality. Though about 223 trees were present along the alignment, the alignments of the drains are proposed in such a way that only about 15 trees might be affected by the Project. No threat to fauna and no endangered species are present in the project area.

The Environmental Assessment (EA) was carried out as per the TNUIFSL Environmental and Social Management Framework (ESMF) and the Project is categorized as E-2 with fewer impacts than E-1 Projects.

Part of Project Area falls under the Category of CRZ I and CRZ II. No project activities are involved in the area classified in CRZ I and rehabilitation of existing drain for a length of 100 m fall under CRZ II for which clearances from DCZMA and TNCZMA is to be obtained before execution of the project.

In Phase I of the project the length of storm water drain proposed is 47.59 km, in which 2.885 km is proposed along National Highway and 6.716 km is proposed in State Highway. Prior to the start of the construction activities on the storm water drains necessary permission / clearance has to be obtained from the concerned Highway authority.

Baseline environmental monitoring was conducted to evaluate the pollution level at pre construction phase. Baseline environmental monitoring was conducted for five environmental components i.e., ambient air quality, surface water quality, ground water quality, noise level monitoring and soil quality monitoring.

Frequency of sample collection is one time grab sampling with standard procedure as per CPCB norms. The baseline monitoring was conducted by ABC Techno Labs India Private

Limited, Chennai. The baseline monitoring was done at three locations at the salient points of various project drains.

- **Environmental Regulatory Requirement**

A review of national, state, regional, and World Bank Environmental laws, rules, and regulations relevant to the proposed ISWM project indicates that in addition to the safeguard policies of the Bank and construction safety requirements, the project would require permission to cut about 15 trees that will be cut during the construction phase of the Project.

- **Baseline Environmental Profile**

The lithology of Cuddalore District is comprised of the soil types - Red Loam, Lateritic Soil, Black Soil, Sandy Coastal Alluvium and Red Sandy Soil and experiences a Tropical wet and dry climate. The district receives a normal rainfall 1206 mm from South West and North East monsoon. The Ambient Air Quality varies from 88.5 µg/m^3 (at Thirupapuliyur) to 102 µg/m^3 (at Manjakuppam). The Noise levels (56.4 dB(A) to 63.8 dB(A)) in the Municipality are generally below the permissible limits. Soil / sediment analysis reflects that the toxic element is present marginally above the permissible limits at some locations (Gedilam river – Lead as Pb, 9.62 mg/kg and SAR 13.6 and Kammiyam Pettai River - Lead as Pb, 7.13 mg/kg and SAR 5.87) and present below detection limit (BDL) in Capper Hills Canal. Quantities of Oil and Grease are found below detection limit in all the samples.

TDS and Total hardness as $CaCO_3$ are found higher than the acceptable limit in the ground water samples from Thirupapuliyur and Manjakuppam. Other parameters pH, Chlroide as Cl, Sulphate as SO_4, Flouride as F, Iron as Fe and lead as Pb are found below the acceptable limits. The ground water sample from Cuddalore OT showed all the parameters below the acceptable limits.

Two surface water samples showed very high TDS (Gedilam river – 17,633 mg/l and Kammiyam pettai river – 12,416 mg/l) and not suitable to consider as drinking water source.

- **Assessment of Impacts**

The Project during the Construction phase might lead to air, noise and water quality deterioration. The impacts will be health & safety impacts to the local communities, traffic diversion, utility shifting, back flow of water, solid waste dumping and disposal of excavated silt from the drains. The project might affect about 15 trees (7 Nos. in Phase I and 8 Nos. in Phase II)

- **Environmental Management Plan**

Various mitigation measures are proposed and the cost for the same is estimated in the Environmental Management Plan. The expected impacts are of small scale, temporary (only

during the construction phase) and site specific depending on the implementation of the Project and will not exceed the construction and major environmental norms. The EMP will also be part of the Contract document.

The project also proposes two rain water harvesting structures for every outfall location of the drain to recharge the ground water. Coarse screens are proposed to prevent the entry of the solid waste into the drains and traps to trap the silt. Public awareness programme is also proposed to be carried out by the Municipality to minimize the solid waste deposits in the drains. To prevent the backflow, the invert level of the branch drains are proposed at a level higher than the MFL of the receiving drains.

Implementation arrangement measures proposed will be implemented by the Contractor and monitored by the Municipality. In addition to the cost for execution of the project, environmental management cost is also budgeted to safeguard the environment. This cost includes compensatory afforestation, environmental monitoring, dust suppression, temporary tree protection, and traffic arrangement facilities.

Social Impact Assessment

In Phase I of the works, there is no land acquisition and no social impacts to PAPs, as per ESMF this **Phase I is categorized as S3**.

In order to redress the grievance raised by any affected person from project implementation, project level Grievance Redressal Committee (GRC) shall be established as a grievance redressal mechanism.

A budget of about Rs. 5.15 lakhs is proposed for the above management measures during construction phase. During Operational phase the cost for management measures is budgeted at Rs. 21.84 lakhs / annum.

1. ENVIRONMENTAL IMPACT ASSESSMENT REPORT

1.1. Introduction

The Government of India has received finance from the International Bank for Reconstruction and Development (IBRD) in the form of a loan, towards the cost of Tamil Nadu Sustainable Urban Development Project (TNSUDP). GOI intends to apply a portion of the funds to eligible payments under the contract, for which the Tamil Nadu Urban Infrastructure Financial Services Limited (TNUIFSL) entrusted proposals to provide Consultancy assignment for preparation of Detailed Project Report for providing Storm Water Drains to Cuddalore Municipality.

On the request of Cuddalore Municipality, Tenders were floated by TNUIFSL to select the consultant to prepare the DPR. In the process, M/s Shah Technical Consultants (P) Ltd., have been awarded the Consultancy work by TNUIFSL.

1.2. Objective of the Study

The objective of the assignment is

- to study, analyse, design and prepare separate DPR for Cuddalore Municipality for providing a effective storm water drainage system for the area by undertaking a technical, financial, economic, environmental and social study
- to prepare a prioritized capital investment plan, detailed designs, drawings, cost estimates and bidding documents for planning and implementation of such proposal.

Based on the information's furnished in the TOR, the consultant is expected to study and include the impacts and mitigation measures of the on-going and proposed storm water drainage projects in and around the areas in the Detailed Project Report. The proposed SWD network in the areas shall seamlessly synchronize with the existing network in the area, if any. It is expected that activities shall be carried out concurrently by the consultant in preparation of DPR both at site and design office.

1.3. Project Location

Cuddalore is a fast growing industrial city and headquarter of Cuddalore district in the Tamil Nadu state and is Located south of Pondicherry on the coast of Bay of Bengal. Cuddalore has a large number of industries which employ a great deal of the city's population. Cuddalore is known for its picturesque beaches, particularly Silver Beach. Cuddalore was the Capital of the English Possessions on the Coromandel Coast from 1748 to 1752.

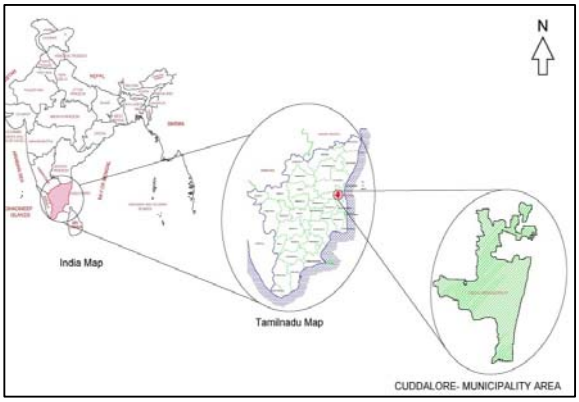


Figure 1 : Cuddalore Municipality Area

Cuddalore is located at 11.75°N 79.75°E. It has an average elevation of 6 m, as shown in No. STC/CUD/010. The land is completely flat with large deposits of black and alluvial soil inland and coarse sand near the seashore. The sandstone deposits in the town are popular. The River Thenpennai runs north of the town, while Gedilam river runs across it. The total extent of the Town is about 27.69 Sq.Km.

There are two large divisions in the town of Cuddalore, namely the Old Town, and the New Town (Thirupathiripuliyur). The Gedilam River flows through the town and separates the Old Town from the new one.

The Municipality is divided in to 45 Wards its ward wise population as per 2011 census is 1,73,636.

1.4. Project Description

Cuddalore Municipality has a total area of 27.69 sq.km and has a total road length of about 326 km.

The town is covered by natural and manmade drains. Some streets have drains on both the sides and some streets have drains on one side and some streets do not have any drains / gutters.

About 93 km of roads have drains. The total length of drains is about 126 km (including drains on both the sides of the roads)

About 28.50% of the roads were covered by storm water drains.

The total length of natural drains, nalla and rivers is about 32 km.

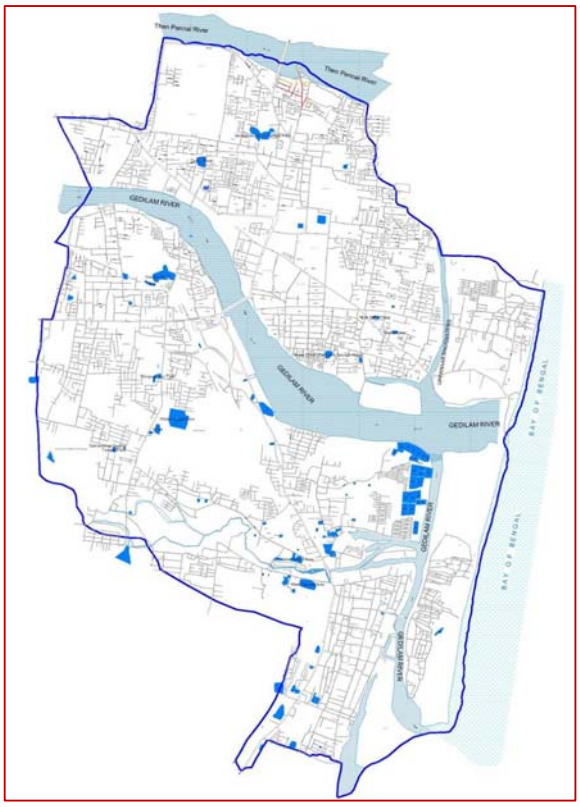


Figure 2 : Drainage System – Natural Water Ways

The details of the existing storm water drainage system – natural water ways is shown in the figure.

There are 2 major rivers viz., River Thenpennai and Gedilam. The Thenpennaiyar flows in the northern side of project area, flowing from West to East, abutting the boundary. The length of the river within the project area is about 2.4 km. The width of the river varies from 240m to 600 m. the bed level varies from -1.40 m to -3.45 m (MSL).

The Gedilam river almost flows in the middle of the project area, from West to East, abutting the boundary. The length of the river within the project area is about 3.48 km. The width of the river varies from, about 100m to 300 m. the bed level varies from -3.50 m to -14.45 m (MSL).

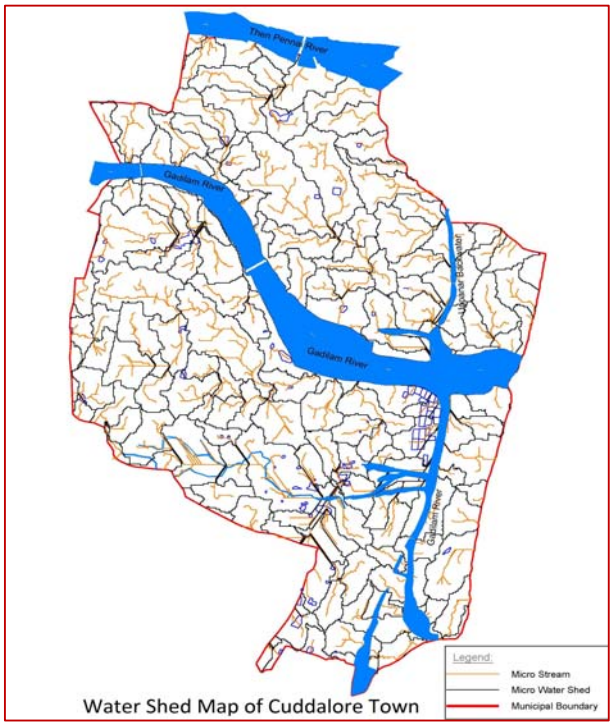


Figure 3 : Watershed map of Project Area

The Uppanr odai is very near to sea connecting River Gedilam and Thenpennaiyar. It contains only back waters of Bay of Bengal. The length of the odai within the project area is about 1.85 km. The width of the odai varies from, about 40 m to 240 m. the bed level varies from -2.40 m to -3.50 m.

The storm water due to precipitation in the project area goes to the above water ways. Also some water bodies (ponds) located in the project area. The rain water that collected in and around these water bodies flow into these ponds. Since they are small, during heavy rains, the capacities of the ponds are not sufficient to hold the storm water. Therefore the over flowing water will flow in to the storm drains and finally will reach to the nearby rivers. The water shed map of Cuddalore is shown above.

Underground Sewerage system (UGSS) has been provided in the town 33 wards out of 45 wards by the TWAD Board. In absence of UGSS, sullage being discharged into the SWD and finally disposing off into the nearby water bodies without treatment, which is against the pollution control board norms.

The SWD collection system in Cuddalore Municipality has the following basic problems which are the reasons for over flow and flooding, during heavy rains.

- Deposition of grit
- Blockages in System
- Surcharged sewer
- Improper outfall arrangement
- Improper inlet arrangements
- Inadequate vent road culvert
- Improper sloping arrangements
- Improper network arrangements

- The width and depth of the culverts in some areas is lesser than the width and depth of the main drains.
- Most of the drains out falls are located in the water ways. But the out fall arrangements are not properly constructed with required gradient. Therefore the water stagnation occurs in the terminal reaches of the drainage system.

Following photographs from the Project area depict the above problems in the present storm water drainage system.

Bharathi Road – Judge Bungalow Area – Katcha drains	Beach road – Cover slab broken to allow rain water in recent floods
Beach road – Broken cover slab & Water line cross the Drain	Out fall drain entering into water way – No proper structure
Blind school Area – Culvert size is smaller than drain size	Blind school Area – Out fall located near pond – dumped with garbage

Culvert size smaller than drain. Drain is katcha. No proper gradient.	OT Main Road – Water bodies - Siltup with dense bushes
Solid waste deposit into SWDs	Deposition of grit
Blockages in System	Surcharged sewage

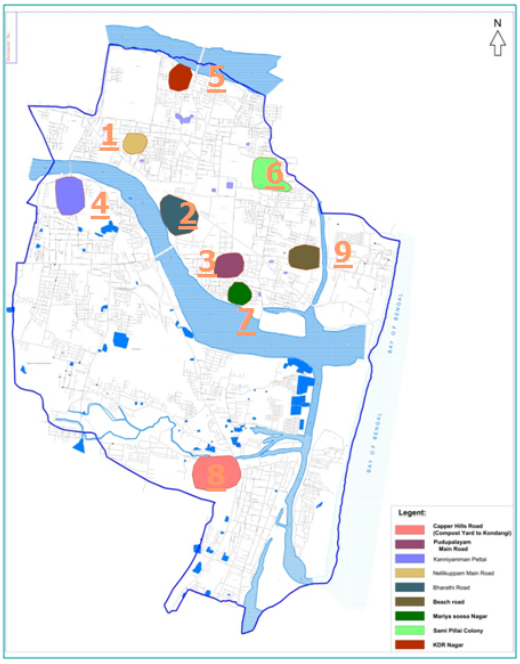
1.4.1 Management measures proposed

Issue	Reason	Management measure
Deposition of Grit	Drain below road level	Design the top of the drain above the road level and provide catch pits.
Blockages in the system	Poor maintenance & dumping of solid waste	Providing cover slab, fencing at vulnerable locations to avoid solid waste dumping and provide sufficient O&M Personnel
Surcharged Sewer	Insufficient slope and blockages	Design the drains with proper slope
Improper outfall arrangement	Improper design & execution	Design and execute with proper arrangements with rain harvesting structures
Improper inlet arrangement	Improper design and execution	Design and execute with proper arrangement like catch pit, gratings etc.,
Inadequate vent road culvert	Improper design	Rehabilitation and redesign of the culverts to match the size of the drains.

Issue	Reason	Management measure
Improper sloping arrangements	Construction by various agencies in different period of time	Provide proper slope and complete the construction of a stretch upto the outfall by one agency.
Improper network arrangements	Construction by various agencies in different period of time	Design the system as a whole in comprehensive manner without discontinuity and provide logical disposal points

1.5. Flood Prone Area

During the field visit and detailed interactions with the local body officials and people, it has been concluded that following areas are prone to flooding. These areas are listed below:



Sl. No	Description	Wards
1	Nellikuppam Main Road	2,3 & 4
2	Bharathy Road	21
3	Beach Road	13 & 14
4	Kammiyam Pettai	23
5	Keshavan Thottam	6& 7
6	Mariyaasoosai Nagar	17
7	Pudupalayam Main Road	18
8	Capper Hills Road (Compost Yard to Kondangi) Border of Railway line	41,42 & 45 (OT)
9	Samipillai Nagar	12

Figure 4 : Flood Prone Areas of Cuddalore Municipality

Main causes of flood in these area is enumerated below

- Discharge from the Upstream Catchment and water bodies like capper hill
- Encroachment over storm water drains & water ways
- High tide in sea prevents the free flow of storm water in outfall
- Culverts vent not sufficient in carries the free flow of storm during heavy rainfall
- Sewage connections to the SW drains
- Outfalls being occupied by the encroachments

1.6. Need for the Project

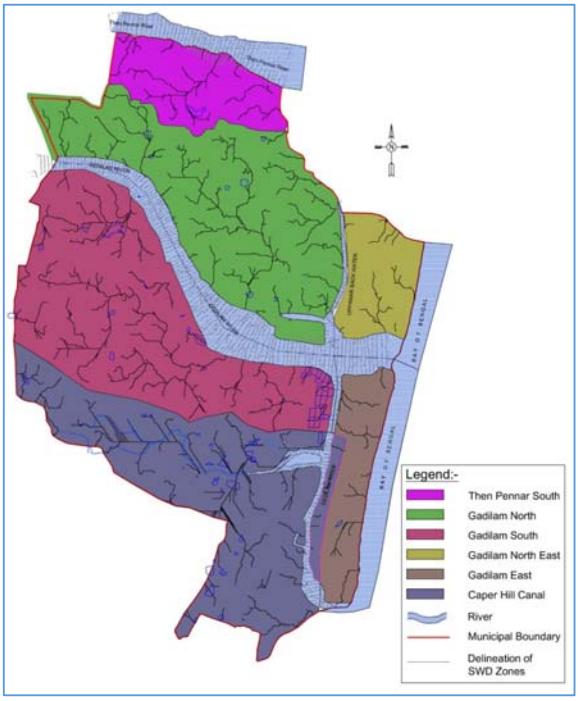
Tsunami waves that followed the 2004 Indian COcean Earthquake near Sumatra hit the Eastern Coast of India on 26th December 2004 at 8:32 Hours, resulting in 572 casualties. Several fishing hamlets disappeared, while Silver Beach and the historically important Cuddalore port were devastated. Fort St. David survived without damage. In 2012, Cyclone Thane caused widespread damage to crops and buildings.

In year 2015, Cuddalore continued to receive good rains, recording 144.3 mm in 24 hours on 23rd November, 2015. On December 2 as well, the town received three-figure rainfall, recording a whopping 134.8 mm. Over 60,000 hectares of farmland inundated and nearly 30,000 people had to be evacuated to relief camps. A damage of nearly 200 crores was reported to public facilities due to flooding.

Due to the frequent and regular flooding Cuddalore is affected with loss of productivity, loss of livelihood, loss of properties, disruption of normal life, increased risk of water borne diseases due to unhygienic environment, damage to the roads etc., To alleviate the problems caused due to flooding a proper storm water drainage system to collect, convey and dispose the rain water is required. Accordingly the following proposals were made.

1.7. Summary of Proposals

Based on the topography the Project area is divided into four drainage catchments - River Thenpennai basin, North of Gedilam basin, South of Gedilam basin & Capper hill Canal basin Using GIS tools, DEM of the project area is developed. Further using the DEM, the flow pattern in the project area is identified. Based on the drainage pattern, storm water zones are demarcated such that the flow in the each zone to reach the disposal point by gravity without necessity of pumping. For the design purpose, the zones are further subdivided into macro and micro zones.



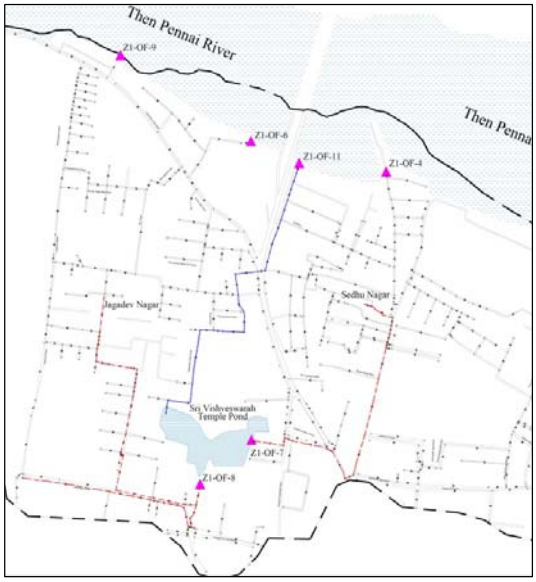
Rainfall data has been obtained from Indian Meteorological Department (IMD) for the past 3 decades. IDF curves have been developed for various return periods. The adequacy of the proposed sections is checked for various return periods. The nullahs are designed and proposed for a five year return period and the street drains are designed and proposed for a two year return period.

The existing drains are retained only if they are physically fit and hydraulically adequate. Rehabilitation of drains are suggested which are hydraulically adequate and moderately damaged.

1.7.1. Linking of water bodies

Linking of water bodies has certain advantages and will prevent flooding and conserve water. Considering the advantages the drains are connected to the water bodies wherever it is feasible. Accordingly the drains that collect storm water are connected to the two water bodies – Vishwewara temple pond and Perumal pond (Tortoise pond)

Linking of drains to the Vishweswara temple pond:



The flow from the catchment area (about 3.37 ha) between Sethu Nagar and Vishweswara Sivan kovil and the flow from the catchment area (about 4.69 ha) between Jagadev nagar and Vishweswara sivan kovil is conveyed to Vishweswara Temple pond by a drain length of about 760 m. The surplus from the Vishweswara temple pond is conveyed to Thenpennai river by RCC drain for a length of about 1600 m. New drain has been proposed since the existing masonry drain is in dilapidated condition.

At present the pond is polluted by discharge of sewage and the water is not used for any purpose. Once the sewerage system is fully functional with all houses are connected to the sewerage system, this pollution will cease. Over a period of time, conveying the rain water to the pond will improve the quality of the water in the pond. Also improvement works are suggested including strengthening the bund with stone cladding.

The area of Vishweswara temple pond is about 17,737 m^2 and the volume of water it could hold is about 26,607 m^3. The pond has an average depth of 1.5 m.

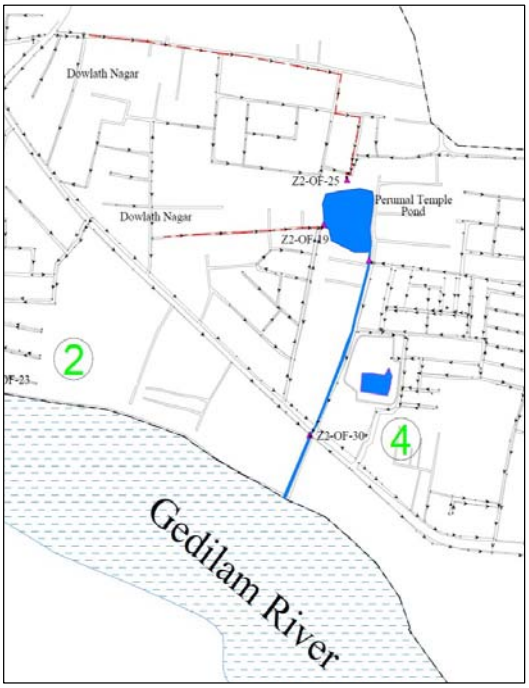
Rehabilitation of this pond is suggested to hold water for a volume of 47,754 m^3 by deepening of the pond from 1.5 m to 2.1 m and also increasing the bund to 0.5 m above GL. The bund of the pond is strengthen by gravel packing and tree plantation also proposed in the rehabilitation work.

Linking of drains to Perumal pond:

The drains that carry the flow from the catchment area (about 9.274 ha) between Dowlath nagar and Gandhi nagar is discharged into Perumal pond. Similarly the drains that carry the flow from the catchment area (about 3.576 ha) between Dowlath nagar and Dhandapani nagar is also discharged into Perumal pond. The length of drain from Gandhi nagar to

Perumal pond is about 581 m and the length of drain from Dhandapani nagar to Perumal pond is about 300 m.

The surplus from the Perumal pond is conveyed to the Gedilam river (near Blind School road) by a existing cement concrete channel of length 450 m.



At present the pond is polluted by the discharge of sewage and the water is not used for any purpose. Once the sewerage system is fully functional with all houses are connected to the sewerage system, this pollution will cease. Over a period of time, conveying the rain water to the pond will improve the quality of the water in the pond. Also improvement works are suggested including strengthening the bund with stone cladding.

The area of Perumal temple pond is about 8,437 sq.m and the volume of water it could hold is about 16,869 cum. The pond has an average depth of 2.0 m.

Rehabilitation of this pond is suggested to hold water for a volume of 320,90 m^3 by deepening of the pond from 2.0 m to 3.6 m and also increasing the bund to 0.5 m above GL. The bund of the pond is strengthen by gravel packing and tree plantation also proposed in the rehabilitation work.

The street drains area divided into Primary, Secondary and Tertiary drains and grouped as micro drains. These micro drains are linked to macro drains i.e. nearby Irrigation channel / Nallahs / rivers and finally storm water is discharged in to the Bay of Bengal.

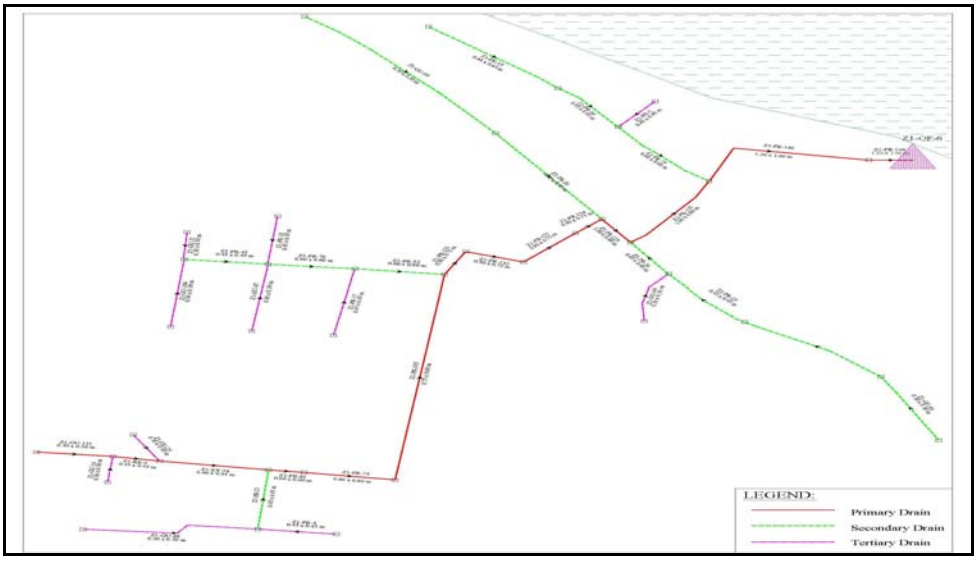
The details of Micro and Macro drains are as below

Micro Drains

Sl. No.	Name of the Zone	Primary Drain		Secondary Drain		Tertiary Drain		Total Length (km)
		Size	Length (km)	Size	Length (km)	Size	Length (km)	
1	Zone - 1	0.4m x 0.3m to 2.2m x 1.5m	10.02	0.3m x 0.3m to 1.5m x 1.5m	5.94	0.3m x 0.3m to 0.9m x 0.6m	9.65	25.61
2	Zone - 2	0.3m x 0.3m to 2.2m x 1.6m	26.27	0.3m x 0.3m to 2.2m x 1.1m	14.93	0.3m x 0.3m to 1.2m x 0.9m	45.72	86.92
3	Zone - 3	0.3m x 0.3m to 1.5m x 1.5m	18.02	0.3m x 0.3m to 1.5m x 1.2m	10.81	0.3m x 0.3m to 0.9m x 0.6m	31.23	60.06

Sl. No.	Name of the Zone	Primary Drain		Secondary Drain		Tertiary Drain		Total Length (km)
		Size	Length (km)	Size	Length (km)	Size	Length (km)	
4	Zone - 4	0.3m x 0.3m to 1.6m x 1.1m	16.69	0.3m x 0.3m to 1.5m x 1.2m	16.26	0.3m x 0.3m to 0.8m x 0.6m	18.49	51.44

Typical flow diagram of street drains from start of the drain to its outfall is given below.



Macro Drains

Sl. No.	River / Nallah /Channels	No. of Sub Catchment	Area of Catchment (Sq. km)	Disposal Point
1	Gedilam River	103	10.167	Bay of Bengal
2	Gedilam River Branch	41	2.113	Bay of Bengal
3	Thenpennai River	16	2.736	Bay of Bengal
4	Uppanaar Backwater	25	2.05	Bay of Bengal
5	Chinna vaaikkaal Irrigation Channel	4	0.984	Gedilam River
6	Vandipalayam Irrigation channel	23	3.737	Gedilam River
7	Kondangi Tank Surplus Channel -1	18	1.994	Uppanaar Backwater
8	Kondangi Tank Surplus Channel -2	9	0.762	Kondangi Surplus Channel 1
9	Vettukulam Irrigation channel	4	0.371	Kondangi Surplus Channel 2
10	Ponnaiyankuppam Irrigation Channel	3	0.219	Kondangi Surplus Channel 2
11	Capper hill Odai	5	0.282	Kondangi Surplus Channel 1
12	Capper hill Nallah Branch	5	0.418	Gedilam River Branch
	Total	**256**	**27.68**	

The following factors were considered on the proposals for drains:

- New storm drains are proposed in uncovered areas.
- In undeveloped areas / sparsely populated areas, where the minimum road network exists, the drains are sized by duly considering the future flow from these undeveloped areas on the upstream side.
- Minimum of 0.45 m x 0.45 m section is proposed for new drains. In initial reaches where the flow is less and thus if size required is less than 0.45 m x 0.45 m then kerbs and gutters are proposed.
- RCC covered drains are proposed in all bus route roads and drains having more than 1.2 m width.
- All the proposed drains are to be constructed using RCC M25 concrete.
- Kutcha drains are replaced with new RCC drains.
- In newly added villages and undeveloped areas, Gutter and gully is proposed. If road width is less than 10m, single side drains are proposed. Two side drains are proposed for roads having more than 10m width.
- About 105 km length of drains were provided in the town and out of which about 68 km length of drains were observed as inadequate and need replacement.
- In addition to the replaced drains, additional length of 65 km length of drains are proposed.
- New drain has been proposed to convey the surplus water from Visweswara temple pond to River Thenpennai
- The total length of drains thus proposed is about 170 km. In addition to the drains kerbs and gutters are proposed for a length of 54 km.
- Provision for fencing to prevent depositions of solid wastes has been made in the proposal.
- The total cost for both the works is estimated at a total base Cost of Rs.136.25 Crores
- Improvements & Rehabilitation to nallah and odai by widening within the RoW and deepening by desilting, for a length of about 17.5 km is proposed at a base cost of Rs.25.35 Crores.
- The total project cost including price variation, contingencies and road variation works out to Rs.149.00 Crores. Annual Maintenance cost for the Project works out to Rs.1.61 Crores.

1.8. Project Cost & Phasing

Lead statement has been obtained from the Municipality and the Rate analysis have been prepared using latest Schedule of Rates (PWD / TWAD / Market Rates (for items not available in Schedule of Rates.

Table 1 : General Abstract of cost estimate

Sl. No.	Name of the Catchment	Project Cost (Base Cost Rs. Crores)
1.	Zone I - River Thenpennai	12.66
2.	Zone II - Gedilam North	45.94
3.	Zone III - Gedilam South	48.69
4.	Zone IV - Capper Hill	28.96
	Total Estimated Project Cost	**136.25**

Phasing of Project

The works proposed above are planned to be carried out in three phases as below:

- Phase I – Providing drainage facilities in flood prone area at a cost of Rs. 42.00 Crores
- Phase II – Improvements to channels including widening and lining at a cost of Rs. 28.43 Crores
- Phase III – Providing street drains to all the four zones at a cost of Rs. 78.57 Crores

1.9. Annual O&M Cost

For proper operation and maintenance of the storm water drainage system, a team consisting of junior engineer / supervisor, fitters / plumbers and other labourers in the cadre of mazdoors to assist in cleaning the drains, are required.

Also the vehicles, cleaning equipments, tools and machineries, that have been procured, have to be maintained properly, to keep them in working condition. The O&M cost covers the salary for the maintenance staff and maintenance of tools and machineries etc., As such the Annual O&M cost for the scheme works out to Rs.1.61 Crores.

1.10. Analysis of Alternatives

Selection of alignment:

The alignments of the drains are selected in such a way that it least affect the existing structures and trees present in the project area. Provision made in the estimate for shifting of the existing service utilities. Also the alignment is proposed based on the topography of the area and location of outfall in the nearby Nallahs / water bodies.

Right of Way of Irrigation Channels:

To carry the designed storm water flow, the channel sections are modified by desilting and widening of the channel. Since these sections are modified within the RoW of the channel portion, there is no issue of land acquisition arise in these areas.

2. APPLICABILITY OF ENVIRONMENTAL REGULATIONS

2.1. Regulatory Framework – Environment

The environmental safeguards framework aims at incorporating environmental considerations into the project design and development process and makes the project as a whole sustainable. The objective is that all the environmental issues and impacts likely from the project are identified upfront, adequately addressed in the project design and mitigated during implementation so as to ensure compliance to the applicable environmental legislations and regulations.

The National and State level environmental laws and the Operational Policies of The World Bank are applicable to the TNUIFSL financed projects. The key environmental laws applicable to the Cuddalore Storm Drainage project are:

2.1.1. *National/State Level*

- Water (Prevention and Control of Pollution) Act, 1974
- Water (Prevention and Control of Pollution) Cess Act, 1977
- Air (Prevention and Control of Pollution) Act, 1981 and Tamil Nadu Air (Prevention and Control of Pollution) Rules,1983
- Environment (Protection) Act, 1986
- Forest (Conservation) Act, 1980
- Coastal Regulation Zone (CRZ) Notification, 2011
- Chennai Metropolitan Area Ground Water (Regulation) Amendment Act, 2002
- Tamil Nadu Forest Act 1882 and Tamil Nadu Timber Transit Rules, 1968

2.1.2. *World Bank Operational Policies*

- ✓ OP 4.01 Environmental Assessment
- ✓ OP 4.04 Natural Habitats
- ✓ OP 4.11 Physical Cultural Resources
- ✓ OP 4.36 Forests

The relevance of applicable environmental regulations to the project is given in Table 2.

Table 2 : Relevance of Applicable Environmental Regulations to Cuddalore Storm Water Drainage Project

Sl. No.	Acts	Relevance to the Project
	NATIONAL	
1	Water (Prevention And Control of Pollution) Act, 1974 and Tamil Nadu Water (Prevention And Control of Pollution) Rules, 1974.	These laws seek to control pollution of water and enhance the quality of water. Under this law, it is mandatory to obtain consent for discharge of effluents and pay consent fees to Tamil Nadu State Pollution Control Board (TNPCB) for any municipal projects causing water pollution.
2	The Water (Prevention And Control of Pollution) Cess Act, 1977	This Act provides for levy and collection of cess by local authorities on water consumed by

Sl. No.	Acts	Relevance to the Project
		persons or industries to augment resources for Pollution Control Boards.
3	Forest (Conservation) Act, 1980	Forest (Conservation) Act, 1980 was enacted to halt rapid deforestation and governments cannot de-reserve forest land or direct that it be used for non-forest purposes. Municipal projects with activities falling in reserved forest areas need a clearance from MoEFCC.
4	Air (Prevention and Control of Pollution) Act 1981 and Tamil Nadu Air (Prevention of Control of Pollution) Rules 1983	These laws address the prevention and control of air pollution. Under section 21 of this Act, it is mandatory to obtain consent from Pollution Control Board to establish or operate any industrial operation. Activities involving emission of pollutants like establishing batch mixing plants require consent from TNPCB.
5	Environment (Protection) Act, 1986	Popularly known as EP Act, it is an umbrella legislation that supplements existing environmental regulations. This law essentially links pollution and natural resource issues. Empowered by the EP Act, the Ministry of Environment, Forests and Climate Change (MoEFCC), Government of India has issued various notifications such as Hazardous Wastes (Management & Handling) Rules, 1989; Manufacture, Storage and Import of Hazardous Chemicals Rules, 1989; Noise Pollution (Regulation and Control) Rules, 2000; Environmental Impact Assessment Notification, 2006 etc.
6	The Noise Pollution (Regulation and Control) Rules, 2000	The ambient air quality standards in respect of noise for different areas/zones namely industrial, commercial, residential or silence areas/zones are specified in the Schedule of these rules. The noise levels in any area/zone shall not exceed the ambient air quality standards in respect of noise as specified in the Schedule.
7	EIA Notification, dt. 2006 (S.O. 1533 (E), dt.14/09/2006)	The notification specifies that prior environmental clearance is required for the projects listed in the schedule of the notification before any construction work, or preparation of land by the project management except for securing the land, is started on the project or activity. The Schedule of the notification lists eight broad categories of projects that require prior environmental clearance. These projects are categorized in to Category 'A' and category 'B' based on the magnitude and environmental impacts of the project. TNUDF projects falling under any of these categories will have to obtain environmental clearance from the authority as applicable.
8	Coastal Regulation Zone (CRZ) Notification, 2011 (S.O.19(E), dt. 06/01/2011)	This notification under Environment (Protection) Act, 1986 supplements the law on site clearance by declaring certain zones as CRZ and regulates

Sl. No.	Acts	Relevance to the Project
		activities in these zones. The CRZ Notification, 2011 clearly lists out the areas that fall within the categories of I, II, III and IV of CRZ-I and the permissible and non-permissible activities in each zone. Projects attracting this notification shall obtain CRZ clearance for implementation from the authority as required. The part of Project Area falls under the Category of CRZ I and CRZ II. No project activities are involved in the area classified in CRZ I and rehabilitation of existing drain for a length of 100 m fall under CRZ II for which clearances from DCZMA and TNCZMA is to be obtained before execution of the project.
9	National Action Plan on Climate Change	India is faced with the challenge of sustaining its rapid economic growth while dealing with the global threat of climate change. India, in 2008, has set up National Action plan on climate change (NAPCC) which outlined policies aimed at sustainable growth and dealing with climate change concerns effectively.
	State Level	
10	Chennai Metropolitan Area Ground water (Regulation) Amendment Act, 2002	This amendment to the original act was made to impose provision of rainwater harvesting in every building either private or government to augment ground water storage in such manner as may be prescribed. The act also mentions that water bodies, including ponds, lakes, tanks and the like, whether public or private should be used only for the purpose of storage of water and not for any other purposes. These provisions are also included in the Panchayats Act and the Municipal Act.
11	Tamil Nadu Forest Act 1882 and Tamil Nadu Timber Transit Rules, 1968	No person shall move timber notified as Scheduled Timber under the Tamil Nadu Forest Act 1882 into or from or within the State by land, water or air unless such timber is accompanied by a permit issued by the Tamil Nadu Forest Department. Black wood, Red Sanders, Rose wood, Sandal wood, and Teak wood are the tree species notified as Scheduled Timber under the Tamil Nadu Forest Act 1882. Further, for cutting and transportation of non-scheduled trees, a prior clearance is required from District Collector and Tamil Nadu State Forest Department. Since the project envisages cutting of non-schedule trees on both sides of the Secondary drains, requires permit from District Collector and forest department for cutting of trees and their transportation.
	Operational Policies And Directives Of The World Bank	
12	OP / BP 4.01 - Environmental Assessment	Operational Policy 4.01 (OP 4.01) is one of the ten safeguard policies of the World Bank, which provides the Environmental Assessment (EA) guidance for the lending operations. The OP 4.01 requires the borrower to screen projects

Sl. No.	Acts	Relevance to the Project
		upstream in the project cycle for potential impacts.
13	OP: 4.11 Physical Cultural Resources	The World Bank's Operational Policy 4.11 aims at preserving and avoiding the elimination of structures/ natural features and landscapes having archaeological (prehistoric), paleontological, historical, religious and unique natural values. Wherever, projects involve physical cultural resources or in case of any chance finds, suitable mitigation / management plan will be prepared within the Environmental Assessment and implemented as part of the project.
14	OP: 4.04 Natural Habitats	Operational Policy 4.04 sets out the World Bank's policy on supporting and emphasizing the precautionary approach to natural resource management, takes into account the conservation of biodiversity, and ensure opportunities for environmentally sustainable development. As per this policy, projects that involve significant conversion or degradation of critical natural habitats are not supported by the Bank.
15	OP: 4.36 Forests	Forest Policy (OP/BP 4.36) aims to reduce deforestation, enhance the environmental contribution of forested areas, promote afforestation, reduce poverty, and encourage economic development for protection of forests through consideration of forest related impacts of all investment operations, ensuring restrictions for operations affecting critical forest conservation areas, and improving commercial forest practice through use of modern certification systems.

2.2. Environmental Categorization of Projects as per ESMF of TNUIFSL

The TNUIFSL has evolved with the Environmental and Social Management Framework (ESMF) to recognize the environmental and social issues that can be raised in urban infrastructure projects. The ESMF provides an overall framework to TNUIFSL in identification, assessment and management of environmental and social concerns at the sub project level. As per the TNUIFSL's Environmental and Social Management Framework (ESMF), depending on location and the nature of project activities will have varying impacts on urban environment. The rigor of environmental assessment required to identify and mitigate the impacts largely depends upon the complexities of project activities. To facilitate effective screening, TNUDF has categorized the projects in to different categories – E1, E2 and E3 linked to severity of impacts and regulatory requirements. Description of Environmental categories E1, E2 and E3 are presented in Table 3. As per the initial environmental screening, the proposed project is categorized as "E2-Category", having moderate environmental issues. Hence, it requires project specific environmental assessment.

Table 3 : Description of Environmental Categories

Environmental Categories	Description of Environmental Categories
E-1	Projects with major environmental impacts thus necessitating Environmental Assessment Report (EAR). A proposed project is classified as E1 if it is likely to affect sensitive environmental components (SEC) and those projects/activities, which require environmental clearance as per the EIA notification published by Ministry of Environment and Forests. The E -1 Category is similar to the Environmental Category A of the World Bank Safeguard Policy.
E-2	A project is categorized as E2, if its potential adverse environmental impacts are less adverse than those of E1 projects. These impacts are mostly generic impacts in nature and in most cases mitigation can be designed more readily than for E1 projects. E - 2 Category as per ECSMF is similar to the Environmental Category B of World Bank Safeguard Policy.
E-3	No environmental issues are expected in E-3 projects and can be termed 'environmentally benign'. Hence no environmental assessment is required for an E3 project beyond screening. E- 3 Category is similar to the Environmental Category C of the World Bank Safeguard Policy.

Source: Environmental Climate Change and Social Management Framework, TNUIFSL, 2015

2.3. Screening and Classification of the Project

The Screening process for the planned project is designed to appraise at an early stage in order to determine its relevance in terms of environmental and social aspects and risks associated in the implementation of the project.

Based on the assessment of project activities and their anticipated impacts, the project has been categorized as “Category E- 2 Project” and requires a project specific EIA and EMP. The filled in proforma is given at Annexure 1.

As part of the preliminary appraisal, a Screening Form has been used to assess the environmental and climate change relevance due to implementation of the proposed project.

2.4. Clearances to be obtained from other departments

2.4.1. *Coastal Regulation Zone Classification and Permissions*

As per the Coastal Zone Management Plan of Tamil Nadu (June 1996), part of the Project Area falls under the Category of CRZ I and CRZ II (Refer Coastal Zone Management Plan provided in Annexure V). No project activities are involved in the area classified in CRZ I. As per Para 3 (iv) (c) and Para 3 (v) (b) of Coastal Regulation Zone Notification, Ministry of Environment and Forests dated 6th January 2011, the activities related to Construction of Storm water drains are permissible in areas falling under CRZ II. However, as per Para 4.2 of tthe CRZ Notification, clearance is to be obtained from State Coastal Zone Management Authority for execution of the works.

Out of 47.59 km length of storm water drain proposed in Phase I, Rehabilitation of existing storm water drain for a length of 100 m is to be carried out in CRZ II. In Phase II, improvisation of Channels for a length of 3.736 km and Rehabilitation / Renewal / new construction of storm water drain under Phase III for a length of 2.0 km fall under CRZ II [Refer Annexure V(I)]. For these works which fall under CRZ II, clearance is to be obtained from the District Coastal Zone Management Authority (DCZMA), District Environmental Engineer, Tamil Nadu Pollution Control Board, Cuddalore. After obtaining concurrence from the DCZMA, the same has to be submitted (with minutes of meeting of DCZMA) to Tamil Nadu Coastal Zone Management Authority, Department of Environment, Govt. of Tamil Nadu for obtaining clearance from TNCZMA for execution of the work.

2.4.2. *Permissions from National and State Highway Department*

In Phase I of the project the length of storm water drain proposed is 47.59 km, in which 2.885 km is proposed along National Highway and 6.716 km is proposed in State Highway. The details are given below.

2.4.2 (A) National Highway

(a) Drains along National Highway

Sl. No.	Name of the Road	Length of Drain in "m"
1	Sivanandapuram Imperial Road	1616
2	Bharathi Road	1269
	Total	2885

(b) Culvert crossing in National Highway

Sl. No.	Name of the Road	Chainage
1	Bharathi Road	
2	Bharathi Road	
3	Bharathi Road	
4	Sivanandapuram Imperial Road	
	Total	

2.4.2 (B) State Highway

(a) Drains along State Highway

Sl. No.	Name of the Road	Length of Drain in "m"
1	Nellikuppam Road	2359
2	Beach Road	987
3	Pondy Road	2040
4	Gundu Salai	843
5	Pudupalayam Road	487
	Total	6716

(b) Culvert crossing in State Highway

Sl. No.	Name of the Road	Chainage
1	Kammiyampettai – Gundu salai Road (via) Semmandalam	km 3 / 952
2	Kammiyampettai – Gundusalai Road (via) Semmandalam	km 3 / 733
3	Cuddalore – Chittoor Road	km 0 / 945
4	Cuddalore – Chittoor Road	km 0 / 654
5	Cuddalore – Chittoor Road	km 0 / 072
6	Pudupalayam Main Road	Km 0 / 350

Prior to the start of the construction activities on the storm water drains as per the aforementioned table, necessary permission / clearance has to be obtained from the concerned Highway authority.

2.4.3. *Permissions from Public Works Department*

The works related to Channels comes under the control of Public Works Department will be carried out in Phase II and hence no permission is required at this stage.

2.4.4. *Clearances required*

The following clearances are required before construction and during construction stages of the Project:

- Chief Engineer, State Highways, Guindy, Chennai – for obtaining permission for the works to be carried out on State Highways.
- Superintending Engineer, Public Works Department (PWD), Cuddalore – for obtaining permission for the works to be carried out on Nallahs and rivers under PWD control
- Collector, Cuddalore District, Cuddalore – for obtaining permission to cut the trees during execution.
- Superintendent of Police, Cuddalore District, Cuddalore – for obtaining permission to divert the traffic / to declare one way traffic during the construction stage.
- Respective Regional Head for shifting of utilities like Electrical Post, Telephone Cables etc.
- Tamil Nadu Pollution Control Board – for installation of Batching Plant
- State Coastal Zone Management Authority – for construction of drain falls under CRZ

All the clearances are to be obtained by the Cuddalore Municipality and hand over the site to the Contractor for construction.

3. Description of Physical Environment

3.1. Geography and Topography

Cuddalore is located at 11.75°N 79.75°E. It has an average ground elevation of 6 m with reference to MSL. The land is almost flat with large deposits of black and alluvial soil inland and coarse sand near the seashore. The sandstone deposits in the town are popular. The Pennaiyar River runs north of the town, while Gedilam River runs across it. The total extent of the town is about 27.68 sq.km.

Land use: The Land use of Cuddalore Town is presented in the map below and the major land user observed is Built up – Urban.

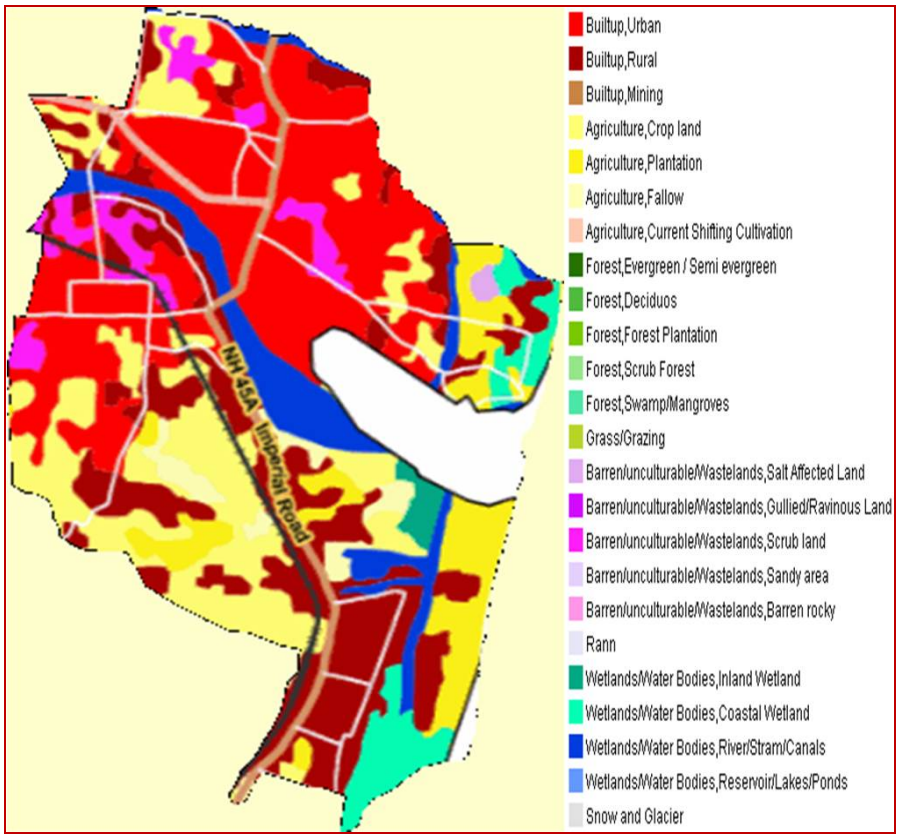
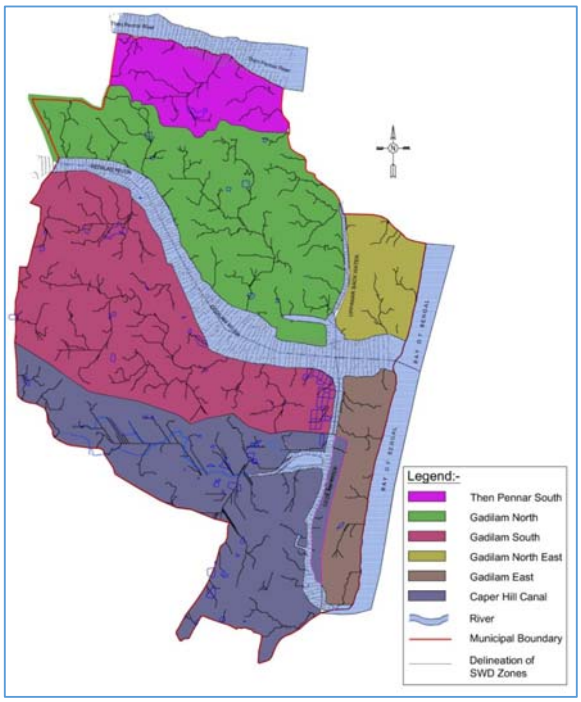


Figure 5 : Land use of Cuddalore Municipality

The Cuddalore town has been divided into 6-storm water drainage zones (catchments) as below.

1. River Thenpennai basin -Watershed – I
2. Gedilam Basin – North - Watershed – II
3. Gedilam Basin – South - Watershed – III
4. Gedilam Basin - North East - Watershed – IV
5. Gedilam Basin - South East -Watershed – V
6. Capper hill Canal Basin - Watershed – VI

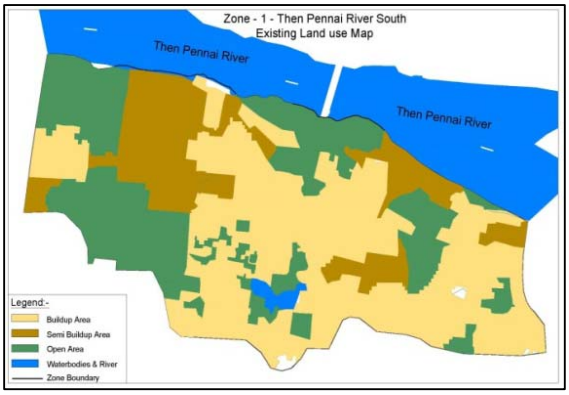
These catchments have different characteristics of their own having different types and land use pattern that affect the runoff. They have different soil characteristics, different permeability and flood absorption characteristics.



The Gedilam Northeast and Southeast catchments lie between Gedilam River branch/Uppanaar Odai and Bay of Bengal, almost island like area. It was formed as Tsunami settlement area, for accommodating the fisher men who were badly affected by Tsunami storm during 2004. These catchments are not considered owing to narrow lanes, also most of the storm water is being absorbed by the sandy soil and after saturation, and it will get drained naturally into Uppanaar odai (backwater) / Gedilam River branch or Bay of Bengal.

(a) River Thenpennai Basin - Watershed – Zone-I

This water shed is on the Northern part of Cuddalore Town area and it is the smallest among the other watersheds. It is surrounded by water shed of Gedilam in the south and River Thenpennai the north and has a catchment area of 2.736 sq.km and is divided into 16 numbers of water shed based on the direction of flow as well as final disposal point. The storm water collected through street drains are discharged into river for final disposal.

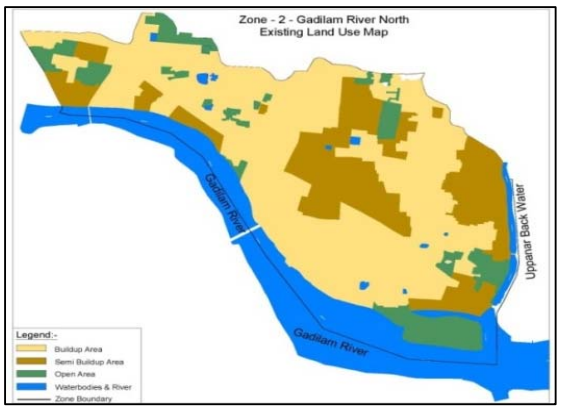


The total catchment area is 2.736 sq.km, out of which 0.893 sq.km of Residential area with high population density, 0.355 sq.km of Residential with low population density, 0.604 sq.km of Parks and open areas and 0.866 sq.km of water bodies including river Thenpennai.

(b) Gedilam River Basin–North – Watershed - Zone II

This water shed is on the Northern side of Gedilam River. It is surrounded by watershed of Thenpennai in the north and River Gedilam in the south and has a catchment area of 7.09 sq.km and is divided into 46 numbers of watershed based on the direction of flow as well as

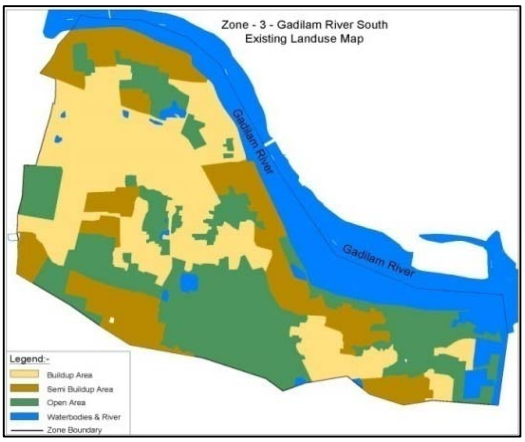
final disposal point. The storm water collected through street drains are discharged into Gedilam river and Uppanaar Backwater for final disposal.



The total catchment area is 7.090 sq.km, out of which 3.809 sq.km of Residential with high density, 1.556 sq.km of Residential with low density, 0.709 sq.km of Parks and open areas and 1.016 sq.km of water bodies. In addition to this catchment area, catchment area of Gedilam River is 2.049 sq.km.

(c) Gedilam River Basin–South – Watershed – Zone III

This water shed is on the Southern side of Gedilam River. It is surrounded by watershed of Capper Hill Canal basin in the south and River Gedilam in the North, has a catchment area of 7.837 sq.km, and is divided into 45 numbers of watershed based on the direction of flow as well as final disposal point. Chinna Vaaikkaal and Vandi Paalayam Irrigation Channel are the major channel flowing in this basin. The storm water collected through street drains are discharged into Chinna Vaaikkaal, Vandi Paalayam Channel and finally to Gedilam river and Uppanaar Backwater for final disposal. The RL of Chinna Vaaikkaal at starting point Municipal Boundary and at end of Gedilam River is 3.310 m and 0 m respectively. Similarly, the RL of Vandi Paalayam Irrigation Channel at starting point Municipal Boundary and at end of Gedilam River is 2.930 m and -1.170 m respectively.

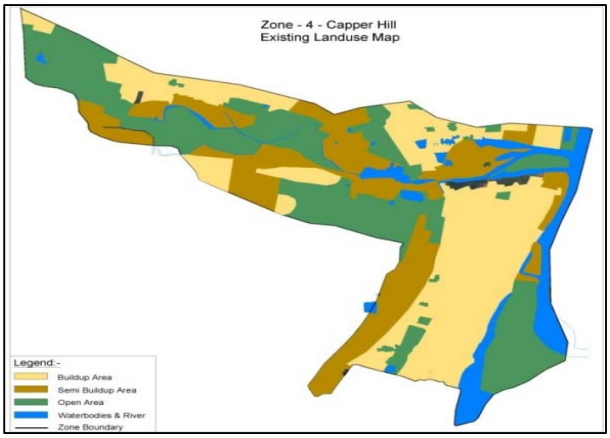


The total catchment area is 7.837 sq.km, out of which 2.467 sq.km of Residential with high density, 1.801 sq.km of Residential with low density, 1.751 sq.km of Parks and open areas and 1.818 sq.km of water bodies.

(d) Capper Hill Canal Basin – Watershed – Zone IV

This water shed is on the South of Cuddalore Municipal Town. It is surrounded by watershed of Gedilam River basin (South Zone) in the North and SIPCOT area in the South, has a catchment area of 6.317 sq.km, and is divided into 65 numbers of watershed based on the direction of flow as well as final disposal point. Kondangi Surplus Channel 1 & 2, Vettukulam

Irrigation Channel, Ponnaiyan Kuppam Irrigation Channel, and Capper Hill Odai are the major channel flowing in this basin. The storm water collected through street drains are discharged into these Channels and finally to Uppanaar Backwater for final disposal. The RL of start and end of various channels are as below:



Sl. No.	Name of the Channel	RL of Start Point	RL of End Point
1	Kondangi Surplus Channel 1	0.483	-1.42
2	Kondangi Surplus Channel 2	1.074	0.677
3	Vettukulam Irrigation Channel	0.720	0.060
4	Ponniyan Kuppam Irrigation Channel	0.323	-0.142
5	Capper Hill Odai	4.019	-0.600

The total catchment area is 6.137 sq.km, out of which 2.038 sq.km of Residential with high density, 1.061 sq.km of Residential with low density, 1.707 sq.km of Parks and open areas and 1.511 sq.km of water bodies.

3.2. Climatic Conditions

Cuddalore experiences a Tropical wet and dry climate. The district receives a normal rainfall 1206 mm from South West and North East monsoon. Month wise historical average high, average low and average rainfall of Cuddalore district is furnished below:

Table 4: Month wise temperature average high, average low and average rainfall

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Average high °C	28.1	29.2	31.1	33.2	36.1	37	35.5	34.6	34	31.7	29.1	28	32.3
Average low °C	20.8	21.2	23	25.8	27.1	27	26.1	25.4	25.1	24.3	22.8	21.5	24.18
Average rainfall mm	30	13	11	16	46	38	85	144	121	247	329	172	1252

3.3. Soil Lithology

The lithology of Cuddalore District is comprised of the soil types - Red Loam, Lateritic Soil, Black Soil, Sandy Coastal Alluvium and Red Sandy Soil.

3.4. Socio Economic Background

Cuddalore district has industrial parks and many industries like Thermal Power Station, Neyvelli, M.R.Krishnamoorthy Co-op, Sugar Mill E.I.D, Parry, Ambika Sugar Mill, TANFAC, National Cotton Mill, SPIC Pharma Chemicals, Thiru Arooran Sugar Mills, Neycer (I) Ltd.,

Tagros Chemicals (I) Ltd., Asian Paints (I) Ltd., STCMS Electric Company Ltd., Shasun Drugs & Chemicals Ltd., Bayer Material Science(P) Ltd., Askema Peroxides India (P) Ltd., Saravana Insulators Ltd., Calariant Chemicals Ltd., Chemplast Sunmar Ltd., Pandian Chemicals Ltd., Lotte (I) Corporation Ltd.,

According to 2011 census, Cuddalore town had a population of 173,636 with a sex-ratio of 1,026 females for every 1,000 males, much above the national average of 929. A total of 17,403 were under the age of six, constituting 8,869 males and 8,534 females. Scheduled Castes and Scheduled Tribes accounted for 13.22% and .3% of the population respectively. The average literacy of the city was 78.92%, compared to the national average of 72.99%. The city had a total of 42174 households. There were a total of 62,115 workers, comprising 561 cultivators, 1,856 main agricultural labourers, 1,464 in house hold industries, 48,337 other workers, 9,897 marginal workers, 139 marginal cultivators, 952 marginal agricultural labourers, 771 marginal workers in household industries and 8,035 other marginal workers

3.5. Ground Water

The Lower Vellar watershed in Cuddalore District, Tamil Nadu, is characterized by coastal Tertiary Sedimentary rocks overlain by Quaternary Alluvium.

The freshwater occurs in the Quaternary Alluvium and underlying Cuddalore Sandstones of Tertiary Age, which are being tapped up to the depth of 250 to 300 m. The quality of groundwater is in general potable, except for the coastal tract where saline groundwater occurs in the Quaternary Alluvium and freshwater aquifers are only in the underlying Cuddalore Sandstones. Cuddalore formation holds a lignite bed.

The aquifer system in the area to the depth of 250 to 300 m comprises four aquifers, two overlying the lignite bed, and the other two underlying it.

Depth of water table during Pre-monsoon varies between 10 to 20 m bgl for the unconfined aquifers and 20 to 60 m bgl for deeper aquifers (m bgl : m below ground level).

Biological Environment

Flora

Common flora found in the project area are Tamarind, Neem Tree, Palmyra Palm, Peeple Tree, Coconut Tree, Wild date palm, Rain Tree, Ravenna grass, Banana Plant, Knotgrass, Swollen finger Grass, Daobha, Water Hyacinth, Water lily, Castor Oil Plant, Erakku Plan, Papaya.

No endangered plants are found in the Project area. Along the natural channels, canals, nallahs wild grasses and weeds are found. Due to the proposals made in this project, no major impact on Flora is envisaged.

Fauna

Fauna found in the project area includes mice, squirrels, pigeon, crow, sparrow, duck, eagle, parrot, snakes etc., Domestic animals like cow, buffalo, goat, dogs, cats, pigs. Frog, water insects are found in the storm water drains. Small fishes are found in the rivers near the mouth. The proposals made in this project do not have any adverse impact on the Fauna. Fish deaths in the process of desilting during the construction phase are temporary of nature and could be avoided by planning the desilting in batches and by earthen barriers.

3.6. Land cover & Forests

The land cover, including forest cover in hectares in Cuddalore district is furnished below:

Table 5: Land cover, including forest cover in hectares

Category	Area in Hectares
Forests	1415
Barren & Uncultivable land	14623
Land put to Non Agricultural use	58794
Cultivable Waste	6034
Permanent Pastures & other Grazing Land	604
Land Under Miscellaneous Tree Crops & groves not included in Net Area Sown	14050
Current Fallow Lands	34371
Other Fallow Lands	22333
Net Area Sown	215559
Total Geographical Area	**367781**

As the storm water drains proposed does not pass through any forest area, forest land diversion is not required.

Since there is no industries present within the project vicinity, possibility of pollution due to such industries are not there.

Agriculture

Total cultivated area in the district is about 3,25,355 hectares. Paddy is cultivated in 1,27,485 hectares. Balance area is cultivated with millets, vegetables, fruits, flowers and cash crops like sugar cane etc.

Archaeological, historical, tourism etc.

Cuddalore district houses many temples of historical and archaeological importance like Sri Nataraja temple at Chidambaram, Sri Hayagrivar temple at Thiruvanthipuram, Padaleeswarar temple at Cuddalore etc. The famous tourist spot Pichavaram mangrove forests is located in Cuddalore district. Annamalai University is located at Chidambaram in Cuddalore District.

3.7. Environmental Sanitation

Cuddalore has UGD system for a part of the town. So, the sullage and the sewage are let into the drains without any treatment causing environmental hazards. Also the solid waste is thrown into the drains, causing blockage of the drains causing overflows.

Flooding / inundation during heavy rains cause hindrances to the citizens of the town and tourists and affect the business. Lack of proper drainage system causes unhygienic situation causing various water and vector borne diseases.

Surcharge in drains, Old Town, Boat Road	Soorapanaiken Chavadi Road
Solid Waste disposal,Chidambaram Road,Vettukulam Channel	Silt formation in drains, Chidambaram Road.JPG
Insufficient Culvert Size, Ramanathan Nagar, Chinna Vaaikaal	Improper Drain Connectivity in outfall locations, Cummingpet

As the UGD system is not implemented in the entire Municipality and even in the implemented areas all the households are not connected to the sewerage system. This

eventually lead to the discharge of sullage into the drains. Though the Municipality is implementing a solid waste management system, many Public choose to dispose the solid waste into the drains. Due to this the drains are surcharged, polluted and not functioning properly. To avoid this it is recommended to implement the UGD system for the entire Municipality with maximum household coverage, to perform IEC activities to sensitise the public on importance of drains and the ill effects of dumping solid wastes into the drains and to cover and fence the drains at locations vulnerable for solid waste dumping.

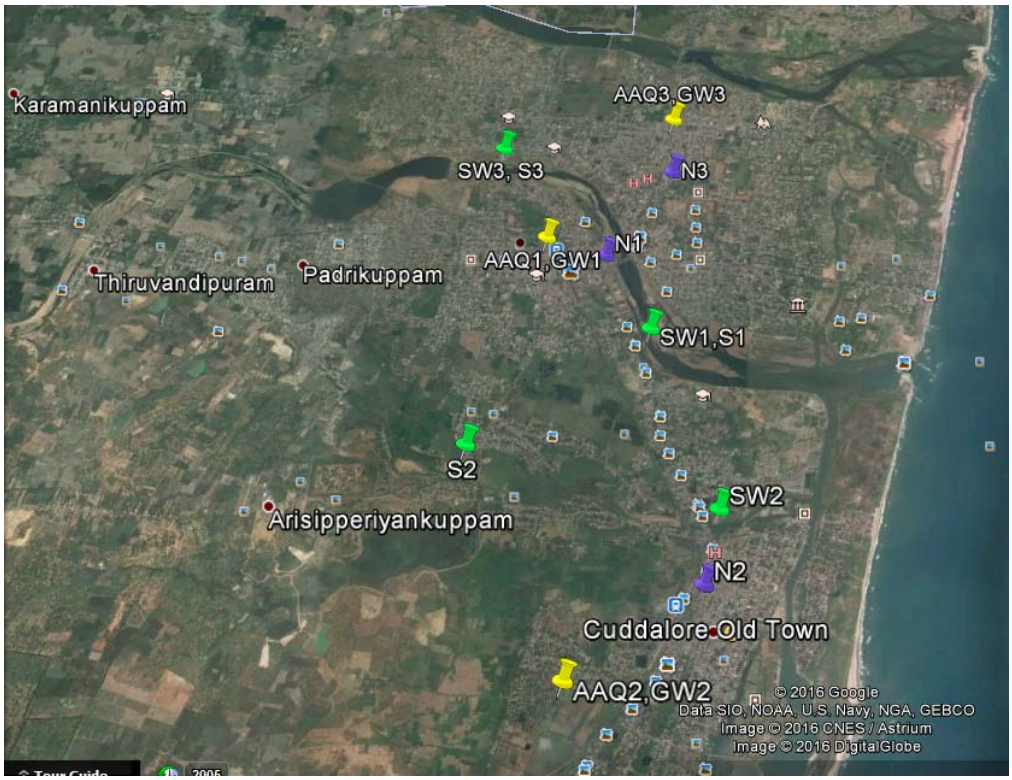
3.8. Baseline Environmental Status

Baseline environmental monitoring was conducted for five environmental parameters i.e., ambient air quality, surface water quality, ground water quality, noise level monitoring and soil / silt quality monitoring at three locations on 20.05.2016 and 21.06.2016. The locations are identified considering the sensitivity (environmental, economical, social) of the location, pollution possibilities and disposal locations. These locations are selected considering the location of outfall of the micro and macro drains, land use pattern like residential, agricultural and commercial area etc. The samples and the parameters were tested as per ESMF Guidelines of TNUIFSL – Volume II – March 2015 in Environmental Monitoring Plan furnished in Page No.46. The locations and the parameters sampled are furnished in the below table:

Table 6: Locations of sample collection for testing of Air, Soil Water

S. No.	Parameter	Location	Location Code
1.	Ambient Air Quality	Thirupapuliyur	AAQ1
2.	Ambient Air Quality	Cuddalore OT	AAQ2
3.	Ambient Air Quality	Manjakuppam	AAQ3
4.	Noise level	Thirupapuliyur	N1
5.	Noise level	Cuddalore OT	N2
6.	Noise level	Manjakuppam	N3
7.	Soil/silt	Gedilam River	S1
8.	Soil/silt	Capper Hills Canal	S2
9.	Soil/silt	Kammiyam Pettai River	S3
10.	Ground Water	Thirupapuliyur	GW1
11.	Ground Water	Cuddalore OT	GW2
12.	Ground Water	Manjakuppam	GW3
13.	Surface Water	Gedilam River	SW1
14.	Surface Water	Enaikaran Thottam	SW2
15.	Surface Water	Kammiyam Pettai River	SW3

GPS Locations of the Sampling points are shown in the satellite imagery below:



The results of the analysis of the above parameters are furnished below:

3.8.1. Ambient Air Quality

The values of Ambient Air Quality parameters (SPM, RPM, SO_2, NO_2, Pb and CO) at all the three sampling locations are found be lesser than the permissible limits as per the Standards. The test results are given in the table below:

Table 7 : Air Quality Test results at 3 locations

S. No.	Parameters	AAQ 1	AAQ 2	AAQ 3	Standards*
1.	SPM -Suspended Particulate Matter, µg/m^3	102	82.4	88.5	Not Specified
2.	RPM-Particulate Matter size less than 10- µm (PM_{10}), µg/m^3	49.6	41.7	47.6	100
3.	Sulphur Dioxide (SO_2), µg/m^3	7.8	6.6	6.9	80
4.	Nitrogen Dioxide (NO_2), µg/m^3	16.8	12.2	13.8	80
5.	Lead (Pb), µg/m^3	BDL (<0.1)	BDL (<0.1)	BDL (<0.1)	1
6.	Carbon Monoxide (CO), mg/m^3	(BDL<0.1)	(BDL<0.1)	(BDL<0.1)	2

* National Air Quality Standards prescribed by Ministry of Environment and Forests, Government of India vide Gazette Notifications GSR 826 (E) dated 18.11.2009

3.8.2. Noise Level Monitoring

The values of Noise level measured during the day and at the night at the three sampling locations are furnished in the above table. The areas falls under residential / mixed residential

/ commercial area. The noise levels measured in these areas are found marginally higher than the permissible limits.

Table 8 : Noise Test results at 3 locations

Location Code	Sample location	Lday [dB(A)]	Lnight [dB(A)]	Leq [dB(A)]	Standards*	
					Lday [dB(A)]	Lnight [dB(A)]
N1	Thirupapuliyur	63.8	49.2	62.1	65	55
N2	Cuddalore OT	58.6	46.8	56.9	55	45
N3	Manjakuppam	56.4	45.3	54.8	55	45

*The Noise Pollution (Regulation and Control) Rules, 2000 and subsequently amended on 11.01.2010 under the Environment (Protection) Act, 1986

3.8.3. Soil /silt Analysis:

Samples for soil/silt Analysis were collected from Gedilam River, Capper Hills Canal and Kammiyam Pettai River. The results of the analysis are furnished in the above table. Small quantities of lead is found in Gedilam and Kammiyam Pettai river and lead quantity could not be detected in Capper Hills canal sample. Similarly SAR is found in marginal quantity in Gedilam River and Kammiyam Pettai River and in very less quantity in Capper Hills canal. The quantities of Oil & Grease in all the three samples are found below detectable levels. Since there is no industries are present in these areas, only the above parameters were monitored and possibilities for other hazardous materials are not there in these areas.

Table 9 : Soil Test results at 3 locations

Sl. No.	Parameters	Test Methods	S1- Gedilam River	S2-Capper Hills Canal	S3-Kammiyam Pettai River
1	Lead as Pb, mg/Kg	EPA 3050 B	9.62	BDL(<5)	7.13
2	Sodium Absorption Ratio (SAR)	IS 11624:1986 By Calculation	13.6	1.62	5.87
3	Oil & Grease, mg/Kg	EPA 9071 B	BDL(<10)	BDL(<10)	BDL(<10)

3.8.4. Ground Water Quality

Samples were collected from Manjakuppam, Cuddalore OT and Thirupapuliyur for Ground Water Quality analysis. Presently the water from these sources are used for domestic / drinking purposes. The results of the above analysis are presented in the above table.

GW1 – Can be considered for potable use, in the absence of alternate source.

GW2 – Fit for use as a drinking water source.

GW3 – Can be considered for potable use, in the absence of alternate source.

TDS is found to be in higher quantity in Manjakuppam and Thirupapuliyur Samples and $CaCO_3$ is found marginally higher in the two samples. In the sample from Cuddalore OT values of all the quality parameters were found to be below permissible limits. No industries are present in the area.

Table 10 : Ground Water Quality Results at 3 locations

S. No	PARAMETER	UNIT	RESULTS GW1	RESULTS GW2	RESULTS GW3	Acceptable Limit*
1.	pH at 25 °C	-	7.67	7.55	7.12	6.5 – 8.5
2.	Total dissolved solids	mg/l	805	384	991	500
3.	Total Hardness as $CaCO_3$	mg/l	340	140	310	200
4.	Chloride as Cl^-	mg/l	154	89	243	250
5.	Sulphate as SO_4	mg/l	88	55	134	200
6.	Fluoride as F	mg/l	0.39	0.31	0.47	1
7.	Iron as Fe	mg/l	BDL(<0.05)	BDL(<0.05)	BDL(<0.05)	0.30
8.	Lead as Pb	mg/l	BDL(<0.01)	BDL(<0.01)	BDL(<0.01)	0.01

*Acceptable Limit as per IS 10500:2012

3.8.5. Surface Water Quality

Surface water samples were collected from Kammiyam Pettai River, Enaikaran Thottam and in Gedilam River. The results of the analysis of the samples are furnished in the above table. The results were compared with Schedule VI - General Standards for Discharge of Environmental Pollutants - Part A by CPCB - The Environmental (Protection) Rules, 1986 for Marine Coastal Areas.

Table 11: Surface Water Quality at 3 locations

S. No	PARAMETER	UNIT	RESULTS SW1	RESULTS SW2	RESULTS SW3	Acceptable Limit*
1.	pH at 25 °C	-	8.25	6.47	8.30	6.5 – 8.5
2.	Total Dissolved Solids	mg/l	17633	136	12416	500
3.	Oil & Grease	mg/l	BDL(<4)	BDL(<4)	BDL(<4)	Not Specified
4.	Dissolved Oxygen	mg/l	5.7	6.5	5.3	>6
5.	Chemical Oxygen Demand	mg/l	48	15.8	62	Not Specified
6.	Biochemical Oxygen Demand at 27°C for 3 days	mg/l	7.6	BDL(<2)	8.6	2
7.	Lead as Pb	mg/l	BDL(<0.05)	BDL(<0.05)	BDL(<0.05)	0.1
8.	Anionic Surfactants as MBAS	mg/l	BDL (<0.025)	BDL (<0.025)	BDL (<0.025)	0.20

*Acceptable Limit as per IS 2296: 1982 – Class A (Surface Water as drinking water source)
BDL – Below Detection Limit.

The values of all tested parameters (excluding TDS) were found to be below permissible limits in the samples of Kammiyam Pettai River ad Gedilam River. The TDS of these samples were found to be 12,416 mg/l and 17,633 mg/l respectively, which is very high when compared to the rejection limit of 2000 mg/l for drinking water. The values of all tested parameters were found to be below permissible limits in the Enakikaran Thottam Sample.

SW1 – Unfit for consideration as a source of drinking water as per IS:2296-1982.

SW2 – Fit for use as a drinking water source after conventional treatment and disinfection.

SW3 – Unfit for consideration as a source of drinking water as per IS:2296-1982.

Complete analysis reports of the above parameters and photos of sampling locations are furnished in the Annexure 3.

3.8.6. Major Channels / Nallahs in the Project area

Following are the major channels / Nallahs maintained by PWD. These channels carrying the storm water runoff from the catchment area and disposing to the River Gedilam and Thenpennai.

1. Chinna Vaaikkaal
2. Vandipaalayam Irrigation Channel
3. Kondangi Surplus Channel 1
4. Kondangi Surplus Channel 2
5. Vettukulam Irrigation Channel
6. Ponniyan kuppam Irrigation Channel
7. Capper Hill Odai
8. B Canal / Uppanaar Backwater

4. ENVIRONMENTAL IMPACT IDENTIFICATION, PREDICTION, ASSESSMENT AND MITIGATION MEASURES

4.1. Introduction

The environmental impacts caused due to the urban infrastructure projects can be categorized as primary (direct) and secondary (indirect) impacts. Primary impacts are those which are caused directly by the project whereas the secondary impacts are those which are induced and typically include the associated investments and changing patterns of social and economic activities due to the proposed action.

The impacts of the project activities on the environment are identified, predicted and assessed in the following sections. The impacts identified are a result of the screening and scoping exercise carried out for the project which has assisted in identifying the key environmental parameters getting affected due to the project.

4.2. Prediction of Impacts

4.2.1. *Impacts on Physical Environment*

4.2.1.1. Impacts on Topography

The major activities under the proposed project would consist of earth work excavation in areas not provided with the storm water drains, construction of new drains/ rehabilitation of existing damaged drains and other related structures. These activities will not have any significant impact on the topography of the project area. Excess soil, if any, generated during excavation will be utilized for landscaping or filling up of low lying areas to be identified and approved by the local body. During excavation, appropriate safety measures as recommended in the EMP will be adopted to ensure the safety of the workers and the local residents.

4.2.1.2. Impacts on Climate

There will be temporary and insignificant extent of impact on ambient air, noise and soil quality in the project region due to proposed improvement of SWD. However, this will not leads to any major changes in climatic conditions of the project region. Further by adopting suitable mitigation measures, these temporary impacts on air, noise and soil shall be minimized.

4.2.1.3. Impacts on Ambient Air Quality

Construction Phase

Impacts on ambient air quality due to the proposed project activities are expected during the construction phase of the project. These impacts are primarily attributed to various construction activities of the project and associated generation of air pollutants such as dust, vehicular emissions, emissions from the DG set etc.

The dust levels in the construction areas are expected to be increased. Similarly, the trenching work for construction of new drains will generate considerable dust pollution. The SPM standards, however, are not expected to be violated in interior areas as the background levels are very low and the particulates tend to settle during low wind and stable conditions. Since heavy machineries used for the project will be minimum, impacts on ambient air quality due to vehicular emissions will also be insignificant.

It is also to be noted that these impacts are temporary in nature and will have moderate impacts on the settlements along the proposed drainage alignment. However, to minimize these minor air quality impacts on the ambient air quality, measures such as periodic watering during construction, dust hoods for equipment, stockpiling of earth, sand, aggregates and other construction materials in designated areas, covering of tarpaulins for vehicles carrying construction materials and ensuring machineries fitted with air pollution control devices will be implemented.

Operation Phase

No component of the proposed project is a source of air pollution, during operation and hence no impacts on air quality are anticipated during the operation phase of the project.

4.2.1.4. Impacts on Ambient Noise Levels

Construction Phase

The major sources of noise pollution from the proposed project are the construction activities, movement of vehicles and operation of construction equipment and DG sets etc. The sensitive receptors present in the project region will be affected. The noise likely to be generated during excavation, loading and transportation of material will be in the range of 90 to 105 dB (A) and this will occur only when all the equipment operate together and simultaneously. This however, is a remote possibility. The workers in general are likely to be exposed to an equivalent noise level of 80 to 90 dB (A) in an 8-hour shift, for which all statutory precautions should be taken into consideration. However, careful planning of machinery selection, operations and scheduling of operations can reduce these levels. The noise impact is temporary and reversible by mitigation measures.

Considering the onsite noise levels, it is recommended to provide Personal Protective Equipment (PPE) such as ear muffs, ear plugs etc. to the construction workers. Honking of vehicles shall be prohibited at sensitive receptor locations. Noise levels from construction equipment will be minimized by using vehicle silencers, fitting jackhammers with noise-reducing mufflers, and portable street barriers near the sensitive receptors. Sound levels not exceeding 80 decibels (dBA) when measured at a distance of 10m or more from the vehicles will be maintained.

Operation Phase

No impact is anticipated on noise level, since no components of the project will generate noise during operation phase.

4.2.2. *Impacts on Water Environment*

4.2.2.1. Impacts on Hydrology

Impacts on Surface Water Resources

Construction Phase

There will be no significant impact on the surface water resource, only flow rate of the water will get altered during construction phase. There is minor chance for water contamination due to spillage of construction materials during rehabilitation of existing drains. These impacts are only for short period. As far as possible, construction work shall be scheduled during non-monsoon seasons to avoid the inundation and damage to neighboring properties. In perennial channels, diversion of sullage through alternative routes or by pumping shall be made to maintain the free flow of water. At no point water flow should be choked completely. Remains of construction materials, debris and waste generated from construction activity shall be disposed to nearby approved landfill sites or at the locations as suggested by the authorized engineer of the local body.

The runoff water should be led to identified low lying natural ground water recharge area. This will avoid the depletion of ground water level in the particular region. To achieve this, some additional cost is envisaged for elevation correction of the drain, pumping of drain water to nearby lakes, etc.

Operation Phase

During operation phase, impact of surface water resources is insignificant. Proper care should be taken to avoid the hindrance of water flow in the project drains by avoiding silting of drains. Periodic removal of weeds, solid waste and debris should be done. Water quality monitoring shall be carried out as per the Environmental Monitoring Plan to ensure the water free from sewage, sullage and other contaminations. Ward wise awareness program should be conducted in the project drain regions. Sign boards, wall painting should be installed/ depicted in the vantage points of the areas. Institutional level and community level awareness programs are very effective in this regard.

Impacts on Ground Water Resources

Construction Phase

Ground water will be extracted for construction activities of the project during the construction phase, which may lead to an insignificant reduction in ground water availability of the project area.

Operation Phase

Construction of rain water harvesting structures at the outfalls will increase the ground water potential in the project region.

4.2.2.2. Impact on Water Quality

Impacts on Surface Water Quality

Construction Phase:

No pollution causing activities are proposed along the drains. However, during construction of the storm water drain care shall be taken to avoid dumping of construction debris, accidental spill of hazardous materials etc. into the canal. The construction activities should not be taken up during the monsoon season. Runoff from construction sites during rainy season may pollute the surface drain by increasing turbidity level. No washing or cleaning of construction equipment and material carrying vehicles in drain water. Filling of drain by earth material to ease the construction activity should be strictly avoided.

Operation Phase:

To enhance the drain water quality, it is necessary to divert/avoid the sewage water entering into the drain. Cuddalore Municipal Corporation should take necessary measure to avoid the sewage intrusion into the drain by making UGD connection mandatory for all households within the Municipal Corporation limits. Cuddalore Municipal Corporation also ensures to have separate ETP, if any industries develop in around project area and monitor water quality parameters downstream of the industries to assess the impact on surface water quality.. To enhance the drain water quality, regular maintenance should be considered by de-silting the drain prior to monsoon, clearing of vegetation along the drain, immediate repairing of damaged structures and conducting awareness program to the people residing next to project drains.

Impacts on Ground Water Quality

Construction Phase:

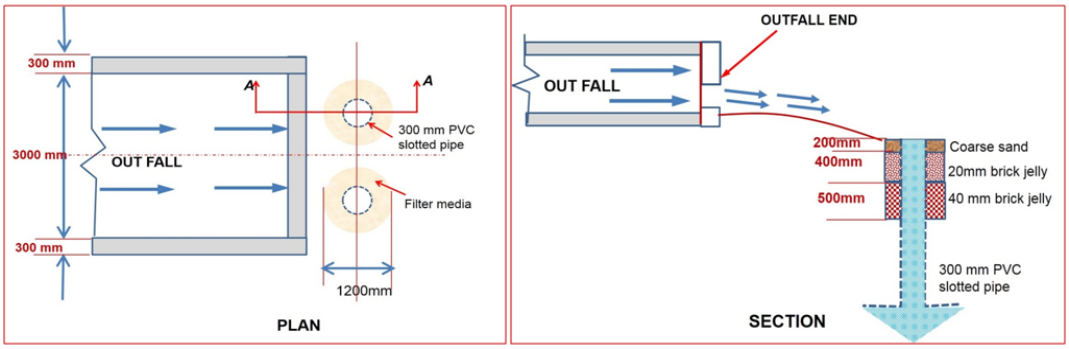
No ground water polluting activities are envisaged during the construction or operation phase of the project. However, ground water will be extracted during the construction phase of the project for construction activities, which may lead to an insignificant reduction in ground water availability and quality.

Operation Phase:

Construction of rain water harvesting structures at the outfalls will increase the ground water potential in the project region.

Disposal arrangement with Rain Water Harvesting

Disposal of storm water drainage into the water bodies is done through outfall arrangement. This is designed with utmost care to prevent solid waste and silt entering into the water bodies and rain water harvesting structure is integrated with the outfall arrangement to recharge the ground water table and to improve the water quality. Accordingly outfall for drains of width 3m and above will be connected to two rain water harvesting structures and outfall for drain less than 3m will be connected to one rain water harvesting structures. Wherever the width of the storm water drain is more than 1m, bore holes will be proposed at 30 m interval and is filled with stones as filter media. Typical disposal arrangement with rain water harvesting structure is shown below:



4.2.3. *Impacts on Land Environment*

4.2.3.1. Impacts on Land Use

No project activity induced change in land use in the project area is expected. Land acquisition is not envisaged for the proposed project and it does not involve any sensitive archaeological monuments or cultural or religious structures.

4.2.3.2. Impacts on Soil Characteristics

Construction Phase

The impact on soil due to the proposed project will be in terms of loss of topsoil due to construction activities, extraction of soil from the borrow areas and soil erosion; and contamination and loss of top soil due to entering of Storm water and Sewage water during rainy season. Since no new borrow pits and quarries are envisaged for the proposed construction activities, no significant impacts are anticipated due to the project. Pollution would take place to a negligible extent due to spillage of construction material, oil, fuel and grease around the construction sites. Care should be taken to minimize spillages of

construction materials. To arrest the erosion of top soil to storm water drain silt traps should be installed temporarily.

Operation Phase

During operation phase, periodical de-siltation should be carried out prior to the onset of monsoon season. De-silted soil should be dumped into municipality approved landfill site. Periodical site inspection has to be conducted by the municipal corporation officials to ensure no construction waste or debris shall be dumped in the vicinity of the drain.

4.2.4. *Impacts on Biological Environment*

No forest areas, wild life sanctuaries or protected areas are present in the project influence area. The other ecological impacts of the project are discussed in the following sections.

4.2.4.1. Impacts on Terrestrial Ecology

The impacts on terrestrial ecology are due to canalization of the storm runoff to the final point of disposal through properly aligned drains and diversion of sullage and sewage from the domestic sources to the proper sewerage network. This will be accompanied with some civil works like earthwork excavation, construction of properly aligned channels having the designed & required cross sections with approach culverts, landscapes, fencing the boundaries and other safety measures. Construction of drains will not have any influence on the terrestrial ecology of the existing environment. However, these actions will influence indirectly in upgrading the environmental hygiene to a considerable extent and positive impact on the terrestrial environment.

4.2.4.2. Details of Trees to be affected

There are about 223 trees present along the drains. Of which about 102 trees are present on the major roads and about 121 trees are present on other than major roads. The alignment of the drains are proposed in such a way that it least affects the trees. Though about 223 trees are present, the alignment of the drains are planned in such a way that it is estimated that only about **15 trees** might be affected by the construction of drains. The details of trees to be affected are furnished in the below table.

Table 12: Details of trees along the alignment of drains

S. No.	Description	No. of Trees
1.	*Highly vulnerable trees lying on the proposed alignment of the drains*	*5*
2.	*Moderate vulnerable trees lying in between the vicinity and 0.5 m distance of the proposed storm water drains*	*10*
3.	**Not** vulnerable trees lying in between the vicinity and the proposed storm water drain	208
	Total trees lying nearby the proposed drain	**223**

Table 13: Phase wise details of trees affected and its locations

Phase I

Sl. No.	Road / Street Name	Type of Drain	No. of Trees
1	Pondy Road	Primary Drain	1
2	Nellikuppam Main Road	Primary Drain	2
3	Bharathi Road	Primary Drain	1
4	St. Joseph Avenue Road	Primary Drain	1
5	Anna Nagar	Territory Drain	1
6	KK Nagar Road	Secondary Drain	1
		Sub Total	**7**

Phase III

Sl. No.	Road / Street Name	Type of Drain	No. of Trees
1	SSR Nagar Road	Secondary Drain	1
2	Pounammbal Nagar Road	Secondary Drain	1
3	Govindasamy Nagar 1st Cross	Territory Drain	1
4	Sanjivarayan Koil Street	Territory Drain	2
5	Mosque Street	Secondary Drain	2
6	Sonagar Street	Secondary Drain	1
		Sub Total	**8**

Tamarind Tree, Neem Tree, Palmyra Palm, Mango Tree, Coconut Tree, Wild date palm, Rain Tree are the common tree species that are present along the proposed drains and are vulnerable. No endangered species are affected by the proposed drains.

4.2.4.3. Mitigation measures for loss of trees:

The compensatory afforestation at the rate of 10 trees for one tree felled will be carried out in the project region preferably in Vishweswara pond and Perumal pond rehabilitation works (70 Nos.) and also along the streets in the Cuddalore municipal area, in consultation with the forest department. Cuddalore Municipality has to identify the land space for balance tree plantation and complete the work prior to completion of project. Gardening and landscaping will be done at regular intervals which will enhance the overall aesthetics of the project region.

Tree species that could be considered for compensatory afforestation are lebbak tree, banyan tree, sacred fig tree, rain tree, Indian almond, mangium, subabul, pongam oil tree, Portia tree, mango tree, amla tree, jamun tree, tamarind tree, gulmohar and fountain tree.

4.2.4.4. Impacts on Aquatic Ecology

No impacts on aquatic biota during construction and operational phase, since no aquatic biota found in the project drains.

4.2.5. *Impacts on Socio – Economic Environment*

4.2.5.1. Social – land acquisition, accessibility and traffic congestion

Land acquisition is not expected for the project, because the construction is taken place in the existing channel area and new drains are proposed along the sides of roads and streets which are under Cuddalore Municipal corporation area only.

A beneficial impacts is that, the proposed project will generate proper drainage facilities and will avoid human hardships due to floods and inundation. Additional protection will increase hygiene and safety in the area. An increase in noise levels will not be expected. Access to houses, shops and others public utilities will be temporarily affected due to construction activity. There are no major possible adverse social effects of the proposed project. This work will not affect or diminish the use of green space for any recreational area. Due to de-silting of drains and making it free from solid waste will avoid flooding in the project region.
Hauling routes of construction materials and disposal of silt materials shall be predetermined in consultation with Traffic department. Tarpaulin will be covered for the vehicles carrying these materials. Transportation of materials shall be schedule in non-peak hours. Necessary alternative routes shall be identified in emergency cases. Proper traffic management plan should be prepared in consultation with traffic department. Operation of equipment and construction machineries shall not obstruct the free flow of traffic. Maintenance of haul roads shall be considered periodically till the completion of construction work.

Traffic Planning:

During the planning stage of works the following points should be noted:

- Intimation to the public living or shops available adjoining the construction site.
- Importance to be given to the needs of pedestrians
- Construction works should be undertaken in the minimum time, in minimum roads space without compromising road safety.
- Area specific execution should be practiced. For example avoid construction near religious places during the respective festivals and complete construction near educational institutions during holidays.
- Discuss with Traffic authorities to decide and implement if traffic diversion is required.

Traffic Management:

- Minimum Sideways / lateral clearance should be ensured before starting the execution.
- Proper barricading should be provided along with traffic cones. Barricading, traffic cones and other traffic controlling tools should be visible in day and night.
- For roads less than 5.5 m width, one way traffic could be suggested with proper information to the public. Heavy vehicles / public transport should not be allowed in the streets of width less than 3.3 m. In streets of width 2.5 m only car traffic shall be allowed.

- Traffic warning signs should be placed and should be clearly visible to the motorists. Speed of the vehicles shall be restricted as per the type of vehicles.
- For crossing major roads with heavy traffic, trenchless technology could be suggested. If open cut method is followed then proper refilling of trenches with layers, watering and ramming should be ensured.

4.2.5.2. Economic

The proposed project will not have economic impacts other than the costs of design, construction and maintenance on the corporation. There will be temporary as well as permanent increases in employment in response to this project. This project will minimally affect annual operational and maintenance costs. The structures built will require periodic long-term maintenance and renewal. Construction of this project will have a short-term positive economic impact through employment for the local people. Contactor should engage local workers for skilled and unskilled works for the construction of the drain.

4.2.6. *Solid Waste Management*

Anticipated Impacts during Construction Phase:

Various construction activities such as demolition of structures, cutting of earth and rock mass for developing storm water drain will yield considerable quantity of solid waste. Further, domestic waste will also be generated every day from workers camps. Contractor shall dispose these waste materials in the Municipal landfill site or at sites identified by the Municipal Engineer prior to the commissioning of the construction work. Improper disposal of these wastes may obstruct water flow resulting in reduction in water carrying capacity of the water body. Improper collection of waste from construction site may lead to traffic congestion and inconvenience for commuters. Unscientific disposal of domestic waste may cause filthy smell resulting in health problems in workers and local residents.

Anticipated Impacts during Operation Phase:

Health issues can arise due to improper management of solid waste in the project drains. Disposal of solid waste into drain will cause hindrance of flow as well as attracts domestic animals in to drain. This also reduces the durability and longevity of drain.

Mitigation Measures to be taken during Construction Phase:

Dumping of debris in or nearby water bodies shall be strictly avoided. Waste products must be collected, stored and taken to identified disposal sites as per prevailing disposal norms. Earth, stone or any other construction material should be properly disposed of so that the flow of water in cross drainage channels is not blocked. Construction waste and other materials should be cleared immediately after completing the work so that traffic can move without any constraint.

Domestic solid waste generated from workers camps shall be collected in waste bins and disposed as per the guidelines of Solid Waste Management Rules, 2016.

De-silted material should be dumped in Cuddalore Municipality approved landfill site. Cuddalore Municipality has to identify the landfill area for this purpose well in advance for speedy progress of the works. Methodology of collection, storing, transportation and disposal of de-silted material is as follows:

- Tarpaulin should be spread on the banks of the canals/drains to drain the leachate from the silt
- After drying, silt has to be transported in the vehicle spread with tarpaulin
- During transportation, the de-silt material should be covered by tarpaulin to avoid the fly
- De-silted material should be disposed only in Municipality approved landfill sites, since the silt material is highly contaminated with organic and inorganic residues and biological contaminants

Contractor should strictly adhere to other clauses and guidelines detailed out in the EMAP for debris disposal and waste disposal.

Provisions made at a cost of about Rs.17.72 lakhs for fencing the drains wherever necessary to prevent depositions of Solid Waste in the drainage.

4.2.7. *Flooding Impacts*

Three different agencies were involved in installation of Storm Water Drains in Cuddalore Town viz. Local body, State & National Highway and Public Works Department. Storm Water collected in the street drains are discharges into channels flows within the town limit.

The carrying capacity of these drains / channels are not adequate to drain the storm water during rainy days mostly due to accumulation of silt and garbage blocking the free flow of storm. Besides, the disposal points are not properly connected either to water way or water bodies.

This causes the inundation, back flooding over the roads. Due to this roads are damaged, besides causing inconvenience to the public till entire storm is drained off. In the year 2015, inundation and storm water stagnation in several pockets in the town were there from 9th November to 27th December, during field visit and reconnaissance survey, the team has noticed the water mark in compound wall of houses.

This has been studied and the existing drains are replaced with adequate size drains and culverts. In National Highways and State Highways minimum size of 2.0 m X 2.0 m box culverts are proposed and rest of the roads adequate size box culverts are proposed instead of existing pipe culverts. The disposals of drains are proposed till end of the waterways. Therefore the flooding hotspots identified earlier will be free from flooding in future.

The Micro Drains (street drains) are designed for 2 years return period and Macro Drains (Channels) are designed for 5 years return periods. The existing channel sections are modified by deepening and widening the channel to accommodate flow for 5 years return period. Since all the street drains are either connected to channels or rivers, the flow will be discharged finally to the river without causing flooding in the catchment area.

Mitigation Measures to be taken during Operation Phase:

All the water bodies in the town shall be declared as solid waste free zone. Proper sign boards shall be installed along the drain.

Awareness programs by means of street plays, distributing pamphlets / public notices should be conducted to educating the public in source segregation and keeping the primary drains catchment free of solid waste and debris, by engaging local NGOs.

A nominal fine shall be charged on the person who dumps the solid waste in the drain.

Periodical removal of silt material should be practiced prior to the monsoon season.

Silt and debris shall be collected in covered trucks and transported to the Municipal Solid Waste Disposal Site and shall be used as covering material for the waste being land filled.

Interaction of the project activities with environmental attributes and its potential impacts also expressed in terms of degree and nature of impacts during construction and operation phase is presented as Activity-Impact matrix in Table 14.

4.2.7.1. Social Impact

(a) General:

The Phase – I of Storm Water Drainage System Project for the Cuddalore Municipality is to be taken up under Tamil Nadu Sustainable Urban Development Project (TNSUDP) and Public Works Department (PWD). This project involves construction of integrated Storm Water Drainage System and modification of channels / nallas in the Project Area. The total length of the drains to be constructed under Phase –I is 59.24 Km.

This Project involves construction of new Storm Water Drains, Rehabilitation of existing / unsized / dilapidated Storm Water Drains and improvements to the existing channels. The Storm Water Drainage System Project has been proposed to be implemented along the roadsides and canals/nalla which do not involve acquisition of Private Lands or transfer of any Government Lands. The narrow streets and lanes are provided with one side drains in order to avoid Social Impacts.

The drainage system network will be implemented within the existing RoW of the road sections and there are no impacts to be affected. Temporary impacts like in the nature of loss of access to residences during the implementation will be addressed with ensuring implementation of the management measures in the EIA.

Since the construction of Storm Water Drains is in the road sides there is no private land acquisition and no social impacts to PAPs, as per ESMF this **project is categorized as S3**. If any unforeseen impacts encountered during implementation will be addressed in accordance with the principles of the ESMF adopted by TNUIFSL.

(b) Traffic Management

Minimum Sideways / lateral clearance should be ensured before starting the execution.

Proper barricading should be provided along with traffic cones. Barricading, traffic cones and other traffic controlling tools should be visible in day and night.

For roads less than 5.5 m width, one way traffic could be suggested with proper information to the public. Heavy vehicles / public transport should not be allowed in the streets of width less than 3.3 m. In streets of width 2.5 m only car traffic shall be allowed.

Traffic warning signs should be placed and should be clearly visible to the motorists. Speed of the vehicles shall be restricted as per the type of vehicles.

For crossing major roads with heavy traffic, trenchless technology could be suggested. If open cut method is followed then proper refilling of trenches with layers, watering and ramming should be ensured.

(c) Health and Safety

During construction stage, the Contractor will provide PPE to the labourers for their safety during construction. Due to implementation of this project this will reduce the attenuation of Storm water and improves public health status due to reduction in waterborne diseases.

Table 14 : Impact Identification Matrix

Sl. No.	Environmental Parameter	Project Activities		Potential Impacts	Degree of Impact	Nature of Impact
		Project Phase	Activity			
1.	Topography	Construction Phase	Construction of Storm water Drain	Minor changes in topography of construction sites due to excavation and filling of soil.	Minor	– ve, P
		Operation Phase	Nil	Nil	Nil	Nil
2.	Climate	Construction Phase	Cutting of trees and clearing of vegetation	Minor change in micro climate of the region	Minor	– ve, T
		Operation Phase	Landscaping of either side of the canal	Improvement in the microclimate of the project area	Minor	+ ve, P
3.	Soil Characteristics	Construction Phase	Excavation soil for construction of Storm water Drain.	Loss of top soil due to excavation and Soil erosion and contamination of top soil due to spillage of construction materials, fuels and grease.	Minor Minor	– ve, P – ve, T
		Operation Phase	Nil	Nil	Nil	Nil
4.	Hydrology	Construction Phase	RCC of the drain	It affects the flow rate during construction	Minor	– ve, T
		Operation Phase	Construction of rain water harvesting pits	Increases the infiltration of the ground water.	Minor	+ ve, P
5.	Ambient Air Quality	Construction Phase	Running of concrete mixing equipment, Vehicles and DG sets	Increased air pollution in terms of dust and emissions from vehicles and DG sets	Minor	– ve, T
		Operation Phase	Storm water is free from sewage contamination	Water is free of foul odour	Minor	+ ve, P
6.	Noise levels	Construction Phase	Running of concrete mixing equipment, Vehicles and DG sets	Increase in ambient noise levels	Minor	– ve, T
		Operation Phase	Nil	Nil	Nil	Nil
7.	Surface Water Resources	Construction Phase	Extraction of surface water for construction activities	Reduction in surface water availability	Minor	– ve, T
		Operation Phase	Nil	Nil	Nil	Nil
8.	Ground Water Resources	Construction Phase	Extraction of ground water for construction activities	Reduction in ground water availability	Minor	– ve, T
		Operation Phase	Construction rain water	Increase the infiltration of the ground water.	Major	+ ve, P

Sl. No.	Environmental Parameter	Project Activities		Potential Impacts	Degree of Impact	Nature of Impact
		Project Phase	Activity			
			harvesting pit			
9.	Surface Water Quality	Construction Phase	Construction of Storm water Drain	Pollution of drain water due to construction activities and spillage of construction materials, fuels etc.	Minor	– ve, T
		Operation Phase	Nil	Nil	Nil	Nil
10.	Ground Water Quality	Construction Phase	Extraction of ground water for construction activities	Reduction in ground water availability and subsequent impact on ground water quality	Minor	– ve, T
		Operation Phase	Construction of rain water harvesting pits	Infiltration of sewage and sullage contaminated water will be avoided	Major	+ve, P
11.	Terrestrial Ecology	Construction Phase	Construction of Storm water Drain	Felling of trees and clearing of vegetation	Major	- ve, P
		Operation Phase	Tree plantation and Landscaping of adjacent land	Aesthetic value and micro climate of the area will be improved.	Major	+ve, P
12.	Aquatic Ecology	Construction Phase	Nil	Nil	Nil	Nil
		Operation Phase	Nil	Nil	Nil	Nil
13.	Land Use	Construction Phase	Construction of labor camps	Change the land use of the adjacent drain land	Minor	– ve, T
		Operation Phase	Nil	Nil	Nil	Nil
14.	Agriculture	Construction Phase	Nil	Nil	Nil	Nil
		Operation Phase	Water is utilized for Agriculture purpose	Increase the crop production and reduce the ground water utilization.	Major	– ve, P
15.	Socio Economic Profile	Construction Phase	Labor for construction	Employment for the local people	Major	+ ve, T
		Operation Phase	Construction of canal with proper design	Help to reduce the spreading of waterborne disease	Major	+ ve, P
16.	Public Health	Construction Phase	Nil	Nil	Nil	Nil
		Operation Phase	Reduce the attenuation of Storm water.	Improvement of public health status due to reduction in waterborne diseases	Major	+ ve, P

5. ENVIRONMENTAL MANAGEMENT PLAN

5.1. Introduction

The proposed storm water drainage project would not cause any significant irreversible environmental impacts in the project influence area. During the construction phase, temporary negative impacts of the project would be the pollution of Air, Water and Noise. Over a period of time silt accumulation would occur in the drains causing temporary local flooding. This could be eliminated by ensuring regular desilting of the drains, especially prior to the onset of monsoon.

Even though the impacts are not very severe, care has to be taken to ensure that the ambient environmental conditions do not deteriorate beyond the prescribed standards. In order to address the predicted impacts, various mitigation measures, monitoring actions and a reporting schedule are suggested in this Section in the form of an Environmental Management Plan (EMP). The EMAP is a plan of action for avoidance, mitigation and management of the negative impacts of the project. Environmental enhancement is also an important component of EMAP.

The EMP includes a list of all project-related activities and impacts and their mitigation measures at different stages of project, namely, pre-construction phase, construction phase and operation Phase, Environmental monitoring plan and a clear reporting schedule. The EMAP sets a time frame to all proposed mitigation and monitoring actions with specific responsibility assigned to the proponents, the contractors and the regulatory agencies to implement the project and follow-up actions defined.

5.2. Environmental Measures for the impacts due project activities

Environmental Impact Identification, Prediction, Assessment and Mitigation measures are discussed in detail in Chapter 3. The extract of the chapter is given table below

Sl. No.	Prediction of Impacts	Mitigation Measures
1	**Impact on Physical Environment**	
1.1	*Impact on Topography*	
	No significant impact on topography.	Excess soil, if any during excavation will be utilised for landscaping or filling up low lying areas.
1.2	*Impact on Climate*	
	No significant impact on Climate.	-
1.3	*Impact on Ambient Air Quality*	
	Expected during construction phase – Dust, Emissions from DG sets and Vehicles	Periodic watering during construction, providing dust hood for equipments etc.
1.4	*Impact on Ambient Noise Quality*	
	Construction activities, Movement of vehicles, Operation of construction equipment and DG sets etc.	Providing PPE for workers, using vehicle silencers, portable street barriers near the sensitive receptors.

Sl. No.	Prediction of Impacts	Mitigation Measures
2	**Impact on Water Environment**	
2.1	*Impact on Hydrology*	
	No significant impact on surface water flow.	Diversion of flow through alternative routes shall be made.
2.2	*Impact on Water Quality*	
	Dumping of construction debris, possibility of diverting sewage into storm water drain affects the water quality of receiving body	Dumping construction debris into low lying areas, making UGD connection mandatory for all households within the Municipal Corporation limits.
3	**Impact on Land Environment**	
3.1	*Impact on Land use*	
	No significant impact on land use	-
3.2	*Impact on Soil Characteristics*	
	No significant impact on soil characteristics	Periodical desilting should be carried out prior to monsoon season. De-silted soil should be dumped into municipality approved landfill site
4	**Impact on Biological Environment**	
4.1	*Impact on Terrestrial Ecology*	
	Cutting of trees on the alignment	Compensatory afforestation at the rate of 10 trees for one tree felled will be carried out in the project region in consultation with the forest department
4.2	*Impact on Aquatic Ecology*	
	No impact since no aquatic biota found in the project area	-
5	*Impact on Socio-Economic Environment*	
	Positive impact since this project will avoid human hardship due to floods and inundation.	-

5.3. Environmental Monitoring Plan for the Project

The environmental monitoring plan for the project is presented in Table 15. For each of the environmental components, the monitoring plan specifies the technical aspects of monitoring like locations of monitoring; frequency of monitoring and duration, sampling method, parameters to be monitored and standards to be compared. The monitoring plan also specifies the applicable standards, and implementation and supervising responsibilities.

Table 15 : Environmental Monitoring Plan

Technical Aspect of Monitoring	Details of each Technical Aspect
Air Quality Monitoring	
Project stage	Construction stage
Parameter	PM10, PM 2.5, SO_2, NO_x, and CO
Sampling Method	High volume air sampler to be located 50 m from the source of pollution in the downwind direction. Method specified by CPCB for analysis shall be followed.
Standards	Revised National Ambient Air Quality (NAAQ) Standards set by CPCB

Technical Aspect of Monitoring	Details of each Technical Aspect
Frequency	Once in every season for three seasons (except monsoon) per year for two years
Duration	Continuous 24 hours / or for 1 full working day
Locations near the drain *	Two locations near sensitive receptors at construction site
Other Locations**	Two monitoring station near each construction related facility namely, concrete mix plant and labour camp area.
Measures	Wherever air pollution parameters increase above specified standards, additional measures as decided by the engineer shall be adopted.
Implementation	Contractor through NABL/MoEF&CC approved monitoring agencies
Supervision	Environmental officer appointed by Cuddalore Municipality
Water quality Monitoring	
Project stage	Construction & Operation stage
Parameter	pH, BOD, COD, TDS, Pb, Oil & Grease, Detergents and Fecal Coliforms for Surface water. pH, TDS, Total hardness, Sulphate, Chloride, Fe, and Pb for groundwater.
Sampling Method	Grab sample collected from source and analysis as per Standard Methods for Examination of water and Waste water
Standards	Indian standards for Inland Surface Water (IS; 2296, 1982) and for Drinking water (IS; 10500,1991)
Frequency	Twice a year (pre monsoon and post monsoon seasons) during the entire construction period)
Duration	One-time grab sampling
Locations near the Project drain*	Surface water – Six locations i.e., nearby water bodies or confluence point of project drain Ground water – Two locations
Other Location**	Two locations at construction and labour camps
Measures	At locations of increased water pollution towards downstream, all inflow channels shall be checked for pollution loads and channel delivering higher pollution loads shall be terminated from disposal into the water source.
Implementation	Contractor through NABL/MoEF&CC approved monitoring agencies
Supervision	Environmental officer appointed by Cuddalore Municipality
Noise Level Monitoring	
Project stage	Construction stage
Parameter	Noise level on dB (A) scale
Sampling Method	Measure equivalent noise levels using an integrated noise level meter kept at a distance of 15m from edge of the pavement
Standards	Noise Pollution (Regulation and Control) Rules, 2000
Frequency	Once in every seasons (except monsoon) for each year of construction.
Duration	Reading to be taken at 15 seconds interval for 15 minutes every hour for 24 hours and then average will be taken.
Locations near the project drain. *	Two locations near sensitive receptors at construction site
Other Locations**	Two monitoring station near each construction related facility namely, concrete mix plant and labour camp area.
Measures	In case of noise levels causing disturbance to the sensitive receptors, management measures as suggested in the EMP shall be carried out.
Implementation	Contractor through NABL/MoEF&CC approved monitoring agencies
Supervision	Environmental officer appointed by Cuddalore Municipality
Soil / Silt Monitoring	
Project stage	Construction stage
Parameter	Lead as Pb, Sodium Absorption Ratio, Oil and Grease
Sampling Method	EPA 3050B, IS 11624: 1986 and EPA 9071 B

Technical Aspect of Monitoring	Details of each Technical Aspect
Frequency	Twice a year (pre monsoon and post monsoon seasons) during the entire construction period)
Duration	One-time grab sampling
Locations near the project drain. *	Six locations near sensitive receptors at construction site
Measures	At locations of increased pollution towards downstream, all inflow channels shall be checked for pollution loads and channel delivering higher pollution loads shall be terminated from disposal into the water source.
Implementation	Contractor through NABL/MoEF&CC approved monitoring agencies
Supervision	Environmental officer appointed by Cuddalore Municipality

**Locations along the project stretch and cost are part of BOQ for Contractor.*
*** Locations mentioned here includes concrete mix plant and labour camp. This activity is part of Contractor's responsibility and related cost. Hence it is not covered under BOQ*.

5.4. Environmental Management Action Plan

The environmental impacts due to the project-related activities during the pre-construction phase, construction phase and operation phase & maintenance phase and the recommended mitigation and management measures as also the responsible agency for action are presented in the below Table

Table 16 : Environmental Management Action Plan

Sl. No.	Project Activity	Potential Impacts	Mitigation Measures / Enhancement Measures	Responsible Agency	
				Implementing	Monitoring
DESIGN PHASE					
1.	Discharge of sewage & sullage into drain water	Contamination of drain water and ground water resulting in health & safety issue	• All the sewage outlets from households and sewage carrying drains shall be connected to nearest UGD system.	Cuddalore Municipality (Cuddalore Municipality)	Cuddalore Municipality
2.	Dumping of wastes in to the drain	Siltation of drain and hindrance to flow of drain water, Flooding of nearby areas	• Provision for installation of sign boards and waste collection bins are made along the drains.	DPR Consultant	Cuddalore Municipality
3.	Structural Stability	Failure of drains and flooding of nearby areas damages the drain crossing structure.	• Proper design of the structure by considering the terrain and soil characteristics, hydrology and geology of the area	DPR Consultant	Cuddalore Municipality
4.	Health & Safety of the public	Chances of causing water borne diseases	• Barbed wire fencing is proposed at all the crossing locations for a length of 100 m upstream and downstream. • Provision for installation of sign boards and waste collection bins are made along the drains.	DPR Consultant	Cuddalore Municipality
5.	Flooding of drain	Loss of Property and life	• Past 30 years rainfall data was collected to design the drains • Wherever necessary, width and height of the drain is increased to accommodate the excess water flow during rainy season.	DPR Consultant	Cuddalore Municipality
6.	Permissions/ clearances	Delay in project implementation	• All the clearances relevant to project activities shall be obtained from the concerned statutory bodies and relevant agencies prior to the start of construction work. • Tree cutting permission shall be obtained from the concerned district collector prior to the commencement of the work.	DPR Consultant/ Cuddalore Municipality	Cuddalore Municipality
PRE-CONSTRUCTION PHASE					
1.	Cutting of trees	Loss of tree cover	• Adequate tree protection shall be given for the adjacent trees, by providing tree guard. • Take adequate care to determine root protection zone and minimize root loss. • Avoid tree cutting wherever possible. • Plant ten trees for each tree cut to compensate the loss of tree cover • As far as possible plant trees in the project area	Cuddalore Municipality	Cuddalore Municipality
2.	Utility Relocation	Potential damage to utilities	• Obtain permission from the concerned agencies such as water supply board, electricity board and telephone service providers • Provide the alternative connections before shifting the utility	Cuddalore Municipality	Cuddalore Municipality

Sl. No.	Project Activity	Potential Impacts	Mitigation Measures / Enhancement Measures	Responsible Agency	
				Implementing	Monitoring
			and Restore the affected utilities in least time frame.		
3.	Construction material sourcing	Materials from unauthorized source will lead to legal issues	• Secure minor minerals such as Sand, Earth and aggregates from MoEF&CC approved sources. • Contactor should procure the other raw materials such as Cement, Steel etc. from the local market.	Contractor	Cuddalore Municipality
4.	Setting up of Construction camp and labor camp	Cumulative impacts on various environmental components.	• To the possible extent, camp should be located in barren or non-fertile land. • A minimum distance from 500m away from major settlement or village in downward direction. • Minimum 250m away from the surface water bodies. • 500m away from the protected areas like forests, National Parks, Wildlife sanctuary etc., • Sufficiently wide access roads (at least 5.5m wide) for heavy vehicle movement.	Contractor	Cuddalore Municipality
CONSTRUCTION PHASE					
1.	Excavation, cutting and filling operations for the construction of Storm water drainage	Changes in drainage pattern and water contamination due to improper disposal of excavated material	• Use excavated soil for filling of low laying area in the project area • Immediately transport the excess soil to a site identified by the Cuddalore Municipality Engineer.	Contractor	Cuddalore Municipality
		Induced soil erosion and flooding of nearby areas	• Creation of soil barriers or mounds and stone pitching • Provide adequate temporary drainage arrangements.	Contractor	Cuddalore Municipality
		Loss of top soil due to excavation and Soil erosion.	• Silt trap shall be used to avoid erosion of soil • Top soil to be protected and compacted after completion of the work • Use the soil for landscaping.	Contractor	Cuddalore Municipality
		Noise, vibration and dust from construction activities	• Use less noise generating equipment for all activities • Jack hammers mufflers shall be used to arrest the noise • Provide personal protective equipment, ear muffs, ear plugs etc. during construction • Construction activities shall be stopped during night time • Sprinkle water to arrest dust and remove excess matter/construction debris from the site as soon as possible. Air quality and noise level monitoring shall be conducted as per environmental monitoring plan.	Contractor	Cuddalore Municipality
		Safety hazards to laborers and nearby resident population	• Adequate safety precautions such as helmets, safety shoes, gloves etc. should be provided to the labor group. • Provide appropriate signage near the construction activities to sensitize the community and minimize accidents.	Contractor	Cuddalore Municipality
		Contamination of top soil due to	• Necessary care is to be taken to avoid spillage of	Contractor	Cuddalore

Sl. No.	Project Activity	Potential Impacts	Mitigation Measures / Enhancement Measures	Responsible Agency	
				Implementing	Monitoring
		spillage of fuels and grease	construction materials, fuels and grease.		Municipality
2.	Construction of storm water drainage structures.	Noise and vibration disturbances to Sensitive receptors, residents and businesses	• Limit work to daylight hours as possible • Use less noise generating equipment • Ensure proper maintenance of equipment and machineries • Use temporary noise barriers if required near sensitive receptors such as schools and hospitals	Contractor	Cuddalore Municipality
		Dust generation	• Damp down the worksite by water spraying water to avoid the dust generation • Remove of excess materials after completion of the work • Clean sites upon completion of activities	Contractor	Cuddalore Municipality
		Reduced pedestrian and vehicle access to residences and businesses	• Establish work sequence and methods to minimize access disruption • Shop keepers will be informed prior to construction along the commercial areas. • Contractor should deploy more work force for the speedy completion of activities in these areas. • Provide alternative safe access such as temporary bridges and crossings, planks/makeshift pathways, detours and walkways.	Contractor	Cuddalore Municipality
		Increased traffic inconvenience (emissions, congestions, longer travel times)	• Material supply and disposal of silt and debris shall be scheduled during non-peak hours to avoid the traffic congestions. • Construction along major transportation corridor will be completed in time bound manner to reduce impact on travel to public. • Material carrying vehicles should possess Pollution Under Control certificates • Traffic diversion sign boards/caution boards shall be installed at worksite.	Cuddalore Municipality, Contractor	Cuddalore Municipality
		Generation of construction debris	• Construction debris shall be disposed in the municipality approved landfill area without any nuisance to public.	Contractor	Cuddalore Municipality
3.	Construction Camps	Health impacts due to absence of housing and sanitation facilities in labor camps.	• The Contractor should ensure provision of appropriate housing, water supply, and sanitation facilities to construction labor. • Contractor should employ local labors for both skilled and unskilled works. • Air quality and noise level monitoring shall be conducted as per environmental monitoring plan.	Contractor	Cuddalore Municipality
		Health impacts to nearby resident	• Labor camp should be established 500m from the nearby	Contractor	Cuddalore

Sl. No.	Project Activity	Potential Impacts	Mitigation Measures / Enhancement Measures	Responsible Agency	
				Implementing	Monitoring
		population due to labour camps	existing settlements. • The Contractor should ensure provision of appropriate housing, water supply, and sanitation facilities and access to medical facilities to construction labour. • Air, water quality and noise level monitoring shall be conducted as per environmental monitoring plan.		Municipality
4.	Diversion of water flow for the construction activity such as drain construction, stone pitching, revetment.	Minor changes in storm water flow characteristics, possible impact on canal banks	• Proper construction of the diversion bunds so as to minimize the changes in the drain flow characteristics. • Construction activity should be held during non-monsoon season which will avoid the deterioration of water body. • Water quality monitoring shall be conducted as per environmental monitoring plan.	Cuddalore Municipality, Contractor	Cuddalore Municipality
5.	Construction activities revetment, surfacing, side wall construction, stone pitching	Increased air pollution in terms of dust and emissions from vehicles and DG sets	• Dust Suppression: In order to curb the increased fugitive dust emissions in the area due to vehicular movement and raw material transport, provisions would be made for sprinkling of water on the access roads near the residential areas leading to the construction site. Sprinkling of water would be carried out on a regular basis and coordinated with the period of construction\haulage at a particular location. Daily inspection at access roads and at construction site should be carried out to ensure removal of construction debris to the landfill sites. • Trucks carrying construction material to be adequately covered to avoid the dust pollution and to avoid the material spillage. • Avoiding Non-productive use of Construction Machinery: Idling of delivery trucks or other equipment should not be permitted during periods when it is being unloaded or not in active use by sensitizing the drivers and operators. • Use modern construction machinery to reduce the impacts on the nearby residents. • Construction material shall be covered or stored in such a manner so as to avoid being affected by wind direction. Air quality and noise level monitoring shall be conducted as per environmental monitoring plan.	Cuddalore Municipality, Contractor	Cuddalore Municipality
		Increase in ambient noise levels due to operation of construction machinery and movement of transportation vehicles	• Construction contracts should specify that the construction equipment should meet the noise and air emission levels as per EPA Rules, 1986. • For protection of construction workers, earplugs should be provided to those working very close to the noise generating machinery. • Noisy construction operations in residential and sensitive	Cuddalore Municipality, Contractor	Cuddalore Municipality

Sl. No.	Project Activity	Potential Impacts	Mitigation Measures / Enhancement Measures	Responsible Agency	
				Implementing	Monitoring
			areas should be done only between 7.30am and 6.00pm. • Regular maintenance of construction equipment and vehicles to keep them with low noise during their operation. • Air quality and noise level monitoring shall be conducted as per environmental monitoring plan.		
		Pollution of surface water bodies due to run off from construction sites during rainy season	• Provide cut-off drains where ever required • Slit trap shall be provided at places where, water flow is more or at locations which are more susceptible for soil erosion. • Management of loose soil as per the EMP	Cuddalore Municipality, Contractor	Cuddalore Municipality
6.	Extraction of ground water for construction activities	Reduction in ground water availability	• Optimum utilization of groundwater for construction. • Obtaining necessary clearance from Ground Water Dept., if required • Ensure the utilization of ground water should not affect the water supply for local settlements • Water quality monitoring shall be conducted as per environmental monitoring plan.	Contractor	Cuddalore Municipality
7.	Inward migration of construction labour force in to project area	Pressure for firewood due to increase in fuel demand	• Alternate fuel source such as LPG, Kerosene, should be provide to the construction workers at labor camps. • Contractor should encourage to use LPG or Kerosene to the workers and adequate awareness program shall be conducted on it benefits.	Contractor	Cuddalore Municipality
8.	Barricading the site	Trespassing of animals and people into construction site.	• The construction site should be barricaded at all time in a day with adequate marking, flags, reflectors etc. for the safety of general traffic movement and pedestrians. • At busy commercial areas flag man should be engaged to caution/divert the commuters. • Shoring and shuttering shall be provided for deep excavations/trenches.	Contractor	Cuddalore Municipality
9.	Availability of first aid kit at construction site	Injuries to construction worker or peoples in the construction site.	• A readily available first aid unit including an adequate supply of sterilized dressing material and appliances shall be provided as per the requirement under the Factory Act.	Contractor	Cuddalore Municipality
10.	Occupational Health and Safety	Health impacts during construction.	• The Contractor should be required to comply with all the precautions as required for the safety of workmen as per the International Labor Organization (ILO) convention No. 62 as far as those are applicable to the Contract. • The Contractor will make sure that during the construction work all the relevant provision of the Factory Act, 1948 and the building and other Construction Workers (regulation of	Contractor	Cuddalore Municipality

Sl. No.	Project Activity	Potential Impacts	Mitigation Measures / Enhancement Measures	Responsible Agency	
				Implementing	Monitoring
			Employment and Condition of Services) Act, 1996 are adhered to. • The Contractor shall not employ any person below the age of 14 years for any work and he should not engage women for painting work with the product containing lead in any form. • Pre-employment as well as periodic health checkup program should be carried out. • Contactor should engage registered medical practitioner present near the construction camp.		
11.	Safety of Pedestrians	Inconvenient to pedestrians crossing drain and Injuries due to accidents.	• Special consideration shall be given in the local traffic management to the safety of pedestrians. • Appropriate sign boards/ cautions boards shall be placed to caution pedestrians. If necessary a flagman can be engaged at both the ends to ensure the safety of the pedestrians. • Provide alternative safe access such as temporary bridges and crossings, planks/makeshift pathways, detours and walkways. • The temporary traffic arrangement should be kept free of encroachments / commercial activities.	Contractor	Cuddalore Municipality
12.	Traffic Control and Safety	Traffic congestion & road accidents	• Detailed traffic control plans shall be prepared and submitted to the engineers for approval prior to the commencement of work. • The traffic control plan shall contain details of temporary diversion, details of arrangements for construction under traffic, details of traffic arrangement f=after cessation of work each day. Signages Safety measures for transport of hazardous materials and arrangements of flagmen. • The Contractor shall take all necessary measures for the safety of traffic during demolition and site clearing activities. • Contractor shall provide, erect and maintain such barricades, including signs, markings, flags, lights and flagmen as may be required by the Cuddalore Municipality for the information and protection of traffic. • At busy commercial areas flag man should be engaged to caution/divert the commuters.	Contractor	Cuddalore Municipality
13.	Access to adjacent public properties	Inconvenient to public to access their properties	• Contractor shall at all times during construction, make available, at least pedestrian access to adjacent properties so as not to obstruct the ingress and egress from the	Contractor	Cuddalore Municipality

Sl. No.	Project Activity	Potential Impacts	Mitigation Measures / Enhancement Measures	Responsible Agency	
				Implementing	Monitoring
			neighboring houses and commercial and other buildings. • Provide alternative safe access such as temporary bridges and crossings, planks/makeshift pathways, detours and walkways.		
14.	Compensatory Plantation	Selection of foreign tree species for plantation. Protection to trees	• Indigenous tree species shall be planted along the project drain • Plantation shall be carried out one meter away from the edge of the drain. • Space between plant to plant shall be kept 3m and space between first row to second row is 3m. • Size of the pit shall be 60cmX60cmX60cm. • Convexity and concavity of the land shall be rectified to maintain uniformity with the surrounding landscape. • Turfing shall be made on the margin of land kept for plantation to avoid soil erosion. • Plantation shall be made prior to monsoon season • Fencing should be provided around the tree for protection • Plantation shall made in surplus land available for drain • Additional plantation shall be made in landscaping areas	Contractor	Cuddalore Municipality
OPERATION & MAINTAINANCE PHASE					
1.	Plantation & Landscaping	Improvement in micro climate and aesthetic beauty of the project sites	• Conduct plantation as per the landscape plan. • Growth and survival rate of the trees shall be ensured.	Cuddalore Municipality	Cuddalore Municipality
2.	Uninterrupted water flow.	Increase in ground water table due to non-concreting drains surface.	• Rainwater harvesting pits shall be provided to recharge the ground water table and to reduce ground water use. • Excess storm water shall be collected in nearest ponds which will enhance the ground water table.	Cuddalore Municipality	Ground Water Dept.
		Generation of additional sewage due to contamination of surface water bodies by disposing untreated sewage.	• Diverting of sewage entering to the drains to nearest UDG system, which leads to STP and treated water will be used for irrigation or discharging in to the river. • In case of industrial effluent identified, necessary action to be taken in coordination with the TNPCB.	Cuddalore Municipality	Cuddalore Municipality
		Improvement of public health status due to reduction in waterborne diseases	• Silted material should be removed time to time. • Water quality monitoring shall be conducted as per environmental monitoring plan.	Cuddalore Municipality	Cuddalore Municipality
3.	Site inspection & Periodical maintenance	Poor management of drains will result in health issues, obstruction to flow rate, structure damage and nuisance to public.	• Periodical site visit by senior official to ensure the flow, structural stability and hygienic level of the drains • Solid waste management system should be implemented effectively along the drains. • De-siltation of the drains will be carried out prior to monsoon	Cuddalore Municipality	Cuddalore Municipality

Sl. No.	Project Activity	Potential Impacts	Mitigation Measures / Enhancement Measures	Responsible Agency	
				Implementing	Monitoring
			season and desilted materials shall be disposed in municipal approved landfill area. • Water quality monitoring shall be conducted at least for two season to ensure the water quality. • Proper awareness program shall be conducted through public and students involvement		

5.5. Institutional Strengthening and Arrangement

Though rich in legal and regulatory instruments, the implementing agencies are unable to regulate and monitor a sound environmental management plan due to lack of enforcement capacity. Therefore, violations or missed mitigation commitments often go unreported. The gaps and deficiencies pointed out can be removed by proper arrangements. Institutional strengthening component has accordingly been identified. As such, the overall arrangement is as follows.

5.5.1. *Organizational Arrangements*

The Environmental officer should be appointed for the project by the Cuddalore Municipality, who will be responsible for supervising the implementation of the mitigation measures proposed in the EMP by the Contractor and will be reporting to TNUIFSL regarding the implementation of the EMP and other environmental matters related to the project. TNUIFSL will monitor the implementation of Environmental Management Plan (EMP) and related measures.

Grievance Redressal Mechanism

In order to redress the grievance raised by any affected person from project implementation, project level Grievance Redressal Committee (GRC) shall be established as a grievance redressal mechanism.

GRIEVANCE REDRESSAL COMMITTEE (GRC)

The Project level GRC shall be constituted with three persons with (preferably one of them as woman).

1. One from the ULB/Implementing Agency (Convener)
2. Any One Elected Representative
3. A person who is publicly known in the local area.

The GRC shall Convene meetings of the committee as necessary at such place or places in the PIA as he considers appropriate; and_ Conduct the proceedings in an informal manner as he considers appropriate with the object to bring an amicable settlement between the parties.

Step by step approach will be followed for redressing grievances. First, the aggrieved PAP to approach the GRC in the first stage and the grievance committee will look into the grievances and resolve the issues. The proceedings of GRC will be documented.

If not satisfied with the resolution provided by GRC, then the complainants can appeal to the grievance redressal mechanisms available at the office of CMA/DTP/CoC at Chennai. The GRC will be in lace, prior to invitation of bids. Details are enclosed in Document-12 in Volume –II.

GRIEVANCE REDRESSAL:

Initially any aggrieved PAP will be directed to approach GRC, controlled by the appropriate Commissioner of ULB / or the authorized signatory which is constituted by the PIA. It will consist of a panel of three Members, one of whom shall be the PIA representative from the sub-project. The others will include representative of the residents of the area / local body who are publicly known to be persons of integrity, good judgment and command respect; and a representative of local NGO/CBO. If the grievance of the PAP is not addressed by PIA, subsequently it will refer to District Collector, during the Collectors weekly grievance redress day. If the PAP is still unsatisfied with the decisions taken by the project and the Collector, he would as a last recourse can appeal in the court of law.

The PIA representative of the GRC shall:

Convene meetings of the committee as necessary at such place or places in the PIA as he considers appropriate; and Conduct the proceedings in an informal manner as he considers appropriate with the object to bring an amicable settlement between the parties; The report of the members shall be recorded in writing and attested copies thereof shall be provided to the parties. All expenses incurred in arranging grievance negotiations and meetings of GRC as well as logistics required, shall be arranged by the borrower.

5.5.2. *Environmental Training*

A short-term training shall be provided for the Official concerned of the project and the contractor staff to raise their level of environmental awareness and for the effective implementation of the EMP. Help of State Pollution Control Board shall be sought in this regard. An environmental awareness program shall be conducted at community and local level to educate the public about the importance of the drain for the city. To make it more effective, NGO's and school children should be involved.

5.5.3. *Environmental Monitoring*

In order to ensure that the prescribed environmental norms are maintained during the constructional and the operational phases, regular monitoring is one of the most important components of the institutional arrangement. The field reports of various environmental components shall be submitted monthly to TNUIFSL through Cuddalore Municipality, and lapses, if any, have to be taken care of.

5.5.4. *Reporting Mechanism*

A reporting mechanism is proposed to provide necessary feedback along with monthly progress report for project management about the implementation of the EMP. The reporting system will operate linearly with the contractor, reporting to Cuddalore Municipality, who in turn shall report to TNUIFSL. All reporting by the contractor and Cuddalore Municipality shall be on a monthly basis. TNUIFSL shall be responsible for preparing targets for each of the identified EMP activities. All subsequent reporting by the contractor shall be monitored as per these targets set by them before the Contractor proceeds with the work.

5.5.5. *Block Cost Estimates for Environmental Management Plan*

The phase wise cost of implementing above mitigation measures during construction phase is estimated and presented in Table 17. During Phase I EMP cost is works out to Rs. 5.51 lakhs and for Phase II and Phase III is Rs. 3.58 and Rs. 6.06 respectively. The recurring operational cost for all the three Phase is Rs. 43.73 Lakhs. Safety cost including cost provision for workers personal protective measures and insurance for contractors' laborers during construction and operation phase shall be incurred by contractor which shall be part of contractor cost.

Table 17 : Environmental Management Action Plan

Sl. No.	Item	Assumptions	Cost in Rs.		
			Phase I	Phase II	Phase III
	A. During Construction Phase				
1	Provision of Labor Camp Facilities (sanitation and water supply)	Lump Sum	1,00,000	1,00,000	1,00,000
2	Compensatory plantation of ten times the number of trees to be cut and their fencing and maintenance for 18 Months including Temporary Tree Protection	Rs.1750 / Tree x 150 trees	1,31,250		1,31,250
3	Environmental Monitoring				
3.1	Air Quality Monitoring at 4 sensitive locations for three seasons for one year	Rs. 4000 / location x 2 locations x 3 seasons x 1 year	24,000	24,000	24,000
3.2	Surface Water Quality Monitoring at 6 sensitive locations for two seasons for one year	Rs. 1500 / location x 6 locations x 2 seasons x 1 year	18,000	18,000	18,000
3.3	Sub-Surface Water Quality Monitoring at 6 sensitive locations for two seasons for one year	Rs. 1700 / location x 6 locations x 2 seasons x 1	20,400	20,400	20,400

Sl. No.	Item	Assumptions	Cost in Rs.		
			Phase I	Phase II	Phase III
		year			
3.4	Soil / Silt quality Monitoring at 5 sensitive locations for two seasons for one year	Rs. 1000 / location x 6 locations x 2 seasons x 1 year	12,000	12,000	12,000
3.5	Noise Monitoring at 4 sensitive locations for three seasons for one year	Rs. 1000 / location x 4 locations x 3 seasons x 1 year	12,000	12,000	12,000
4	Dust Suppression at Site	Rs. 800 / trip x 1 trip / day x 100,70,125 days x 1½ year	1,08,000	62,000	1,38,000
5	Temporary Traffic Arrangements at construction site	Lump Sum	1,25,000	1,00,000	1,50,000
6	Access to public properties using wooden plank of sufficient width and length	Provision made in the BoQ (Item No. 7 of General Abstract)			
7	Provision for Barricading the work place	Provision made in the BoQ (Item No. 6 of General Abstract)			
8	Provision for construction of Rain Water Harvesting structures in Storm Water Drains	Provision made in the BoQ (Item No. 1 of General Abstract)			
9	Fencing the Drain wherever necessary to prevent depositions of Solid Wastes in the drainage	Provision made in the BoQ (Item No. 11 of General Abstract)			
10	Demolition & conveyance of debris of dilapidated Storm Water Drains/ Inadequate drains for providing new drains , including conveyance of debris	Provision made in the BoQ (Item No. 3 of General Abstract)			
	Total During Construction Phase = Rs. 15,14,700		**5,50,650**	**3,58,400**	**6,05,650**
	B. Annual Cost During Operational Phase from 2nd Year Onwards for First Three Years				
1	Maintenance of Avenue Plantation	Rs.100/plant x 150 plants	52,500		52,500

Sl. No.	Item	Assumptions	Cost in Rs.		
			Phase I	Phase II	Phase III
2	Water quality monitoring at 4 sensitive locations by SPCB approved lab as per EMAP	Rs.1500/location x 4 locations	6,000	6,000	6,000
3	Silt quality monitoring at 4 sensitive locations by SPCB approved lab as per EMAP	Rs.1000/location x 4 locations	4,000	4,000	4,000
4	Training for Focus Groups (6 FG for I Year and 7 FG for II and III Year)	Rs. 25000 / FG x 14 Nos.	1,75,000		1,75,000
5	IEC Activities	Lump Sum	19,46,000		19,46,000
6	Disposal of silt	Cost included in the Annual O&M Cost			
	Total During Operational Phase = Rs. 43,73,000		**21,83,500**	**10,000**	**21,83,500**

Table 18 : GENERAL ABSTRACT FOR PHASE-I (Micro Drains in Flood Prone Areas)

Sl. No.	Description	Amount in Lakh
1	Construction of Storm Water Drains of various sizes, Kerb and Gutters	3696.27
2	Construction of Culverts of various sizes	167.04
3	Demolition & conveyance of debris of dilapidated Storm Water Drains	20.82
4	Providing Iron Barricading at the site for a period of 28 days.	24.97
5	Providing access to Public Properties for crossing trenches during execution	2.59
6	Hire charges for Dewatering - Diesel Pumpset	1.31
7	Rehabilitation and Strengthening of Visweswara pond	19.47
8	Rehabilitation and Strengthening of Perumal pond	13.21
9	Cost of Constructing 2 x 2 m Culverts across National Highway Road	26.73
10	Cost of Constructing 2 x 2 m Culverts across State Highway Road	40.10
	Base Cost	**4012.51**
11	Road Restoration Charges	22.34
12	Shifting of service utilities @ 0.5 %	20.06
13	Physical Contingencies and Un foreseen	89.48
14	Labour Welfare fund @ 1%	40.13
15	Environmental Management Plan cost during construction Phase	5.51
16	Provision for obtaining CRZ clearance from TNCZMA	10.00
	Total Cost in Lakh	**4200.03**
	In crore	**42.00**

Table 19 : GENERAL ABSTRACT FOR PHASE-II (Improvement of Channels-PWD)

Sl. No.	Description	Amount in Lakh
1	Construction of retaining wall to Chinna Vaaikkaal	727.48
2	Construction of retaining wall to Vandipalayam channel	851.58

Sl. No.	Description	Amount in Lakh
3	Providing precast concrete slabs for Kondangi surplus channel 1 (2520 m)	350.00
4	Providing precast concrete slabs for Kondangi surplus channel 2 (745 m)	50.00
5	Rehabilitation of all channels by Widening & Desilting	241.92
6	Construction of new culverts and replacing inadequate culverts along channels	314.61
	Base Cost	**2535.60**
7	Physical Contingencies and Unforeseen @ about 2.5% of Base Cost	63.39
8	Price variation for changes of SOR 2016-2017 @ about 8% of Base Cost	215.14
9	Labour Welfare Fund @ 1%	25.36
10	Environmental management plan during construction phase	3.58
	Total Cost in Lakh	**2843.06**
	In Crore	**28.43**

Table 20 : GENERAL ABSTRACT FOR PHASE-III (Micro Drains in Other Areas)

Sl. No.	Description	Amount in Lakh
1	Construction of Storm Water Drains of various sizes, Kerb and Gutters	6600.96
2	Construction of Culverts of various sizes	193.94
4	Demolition & conveyance of debris of dilapidated Storm Water Drains	19.85
5	Providing Iron Barricading at the site for a period of 28 days.	44.83
6	Providing access to Public Properties for crossing trenches during execution	4.91
7	Hire charges for Dewatering - Diesel Pumpset	1.66
8	Cost of Constructing 2 x 2 m Culverts across National Highway Road	33.41
9	Cost of Constructing 2 x 2 m Culverts across State Highway Road	187.11
	Base Cost	**7086.67**
10	Road Restoration Charges	33.41
11	Shifting of service utilities @0.5%	35.43
12	Fencing the Drain wherever necessary to prevent depositions of Solid wastes	17.72
13	Physical Contingencies and Unforeseen @ about 2.5% of Base Cost	171.20
14	Price variation for changes of SOR 2016-2017 @ about 6% of Base Cost	425.20
15	Labour Welfare Fund @ 1%	70.87
16	Environmental management plan during construction phase	6.06
17	Provision for obtaining CRZ clearance from TNCZMA	10.00
	Total Cost in Lakh	**7856.56**
	In crore	**78.57**

6. STAKE HOLDER'S MEETING

Stakeholder Consultation meeting for preparation Storm Water Drain at Cuddalore Municipality was carried out on 25.06.2016 at Council Hall, Cuddalore Municipality Office. Communications were sent by Cuddalore Municipality, to the all the Stake Holders for large participation of stake holders. The dissemination meeting commenced at 11.00 am and concluded in afternoon by 1.00 pm. The purpose of meeting was to explain to the Stakeholders about Storm Water Drain in Cuddalore Municipality.

Stakeholders occupying highest rung of decision-making attended the workshop to discuss project related issues on a common platform. A wide array of stakeholders were invited for meeting ranging from Heads of the Departments from various fields like BSNL, TNRSP, EB, Highways, Ward Members, Councilors, Municipal Engineers etc., A total of 94 participants attended the meeting. Details of the participants in the meeting have been listed at the end.

Programme Schedule

25.06.2016 (Saturday)

10.30 am	Registration
11.00 am	Ice breaking
11.15 am	Welcome Address by Shri. Murugesh, Municipal Commissioner of Cuddalore.
11.20 am	**Key note by Shri. M.C. Sampath, Minister of Industries, Tamil Nadu.**
11.30 am	Power point presentation of Storm Water Drain by Shri. Pari Dhanunjayan - Shah Technical Consultants Pvt. Ltd.,
12.45 pm	**Voices of the Stakeholders**
01.45 pm	**Vote of thanks by Shri. Chairman, Cuddalore Municipality**

(Tea & Snacks was served simultaneously without break)

STAKEHOLDERS MEETING PROCEEDINGS:
Shri. M.C. Sampath, Minister of Industries, Tamil Nadu, Chaired the meeting:

The Minister of Industries, Tamil Nadu welcomed the gathering and delivered the keynote address. He briefed the importance of Storm Water Drain Construction and it's purpose for the welfare of Cuddalore Municipality People.

The need for Storm Water Drain was emphasised by the Minister and he described about the heavy floods which massacred Cuddalore district during the month of December 2015. The houses, roads and rivers were over flooded and stagnated due to lack

of Storm Water Drain and this resulted in many bumpy roads with ups and downs and the entire area resulted in scouring and Cuddalore was left behind huge disaster. Hence forth he requested one and all the departments to be co-operative in building Storm Water Drain throughout Cuddalore Municipality at the earliest.

Then, Shri. M.C. Sampath Minister of Industries requested the Shah Technical Consultants Pvt. Ltd., Chennai to make the presentation.

Shri. Pari Dhananjayan – Senior Manager of Shah Technical Consultants Pvt. Ltd., Chennai structured the presentation for Storm Water Drain.

1) Due to geographical location Cuddalore is, often affected by storms which causes floods. One of the main reason for the floods is inadequacy in the Strom Water Drainage System.
2) A detailed study in the field was carried out carried out, which consist of identifying the most affected areas in the floods during November, 2015. Conditions of the existing storm water drainage system; locating areas of encroachments on the drains; collection of list of water bodies, rivers, odais and photographs on the conditions of drains or culverts, along with encroachments has been enclosed.
3) The Consultants indicated that, during November, 2015 floods 9 areas viz., 1) Nellikuppam Road, 2) Bharathi Road, 3) Beach Road, 4) Kammiyam Pettai, 5) Kesavan Thottam, 6) Mariasusai Nagar, 7) Pudupalayam Road, 8) Capper hills Road (Compost Yard to Kondangi, 9) Samipillai Colony &Tulasi Nagar were affected severely.
4) Topographical survey was carried out for the entire town covering a total road length of 326 km. Based on the survey contour plans were prepared and based on the terrain, the project area has been divided into 6 zones.,, viz Thenpennaiyar south zone, Gedilam North, Gedilam south, Capper Hills nallah zone, Gedilam North east and Gedilam south east, for design purpose
5) Out of the 6 zones, only 4 zones have been taken into consideration for this project. The reason for not taking the last 2 zones are as the streets in that particular area are found to be narrow viz., Gedilam North East and Gedilam South East Zones, are located in between Sea and Uppanaar Odai.
6) The Zones have been divided into smaller zones based on the water sheds and the SWD system has been designed.
7) Under the existing Storm Water Drainage system (consisting of drains and culverts), if the sizes are adequate and the condition is good, these drains/culverts are proposed to be utilized. If the sizes are either insufficient or not in good condition then drains/ culverts are proposed to be replaced with adequate sizes. In addition where there are no

drains/culverts, new drains and culverts are proposed. The drains have been designed with rain intensity considering 2 year return period.

8) The Odais (Nallah), coming from Capper hills (Kondangi lake) and Thiruvanthipuram anicut, are designed to carry the Storm Water flow of 5 year return period. The existing sections of Odais are improved by desilting, increasing the bottom and top widths and depths, to enhance their carrying capacities.
9) The environmental and social aspects have been studied and their impact assessed and incorporated in the report.
10) Out of the total road length of 326 km, omitting the narrow streets drainage system has been proposed for 227 km.
11) Out of the 227 km, for 174 km rectangular type drains are proposed and for balance 53 km Kerbs & Gutters are proposed.
12) Out of the 174 km drains, the existing drains for a length of 76 km utilized and 36 km drains are replaced and for balance 32 km new drains are proposed.
13) The outfalls, 164 numbers, are located at water ways and water bodies.
14) The total cost of the project is Rs. 112 crores and for annual maintenance cost works out to Rs.139 lakhs

Points raised by the Stakeholder in the Meeting

After the detailed presentation, the participants entered into a detailed discussion and raised questions on the subjects presented, as well as offered suggestions for incorporating into the Project Report.

Sl. No.	Participant	View / Suggestions
1	Thiru Maruthavaanan, President, Residents Welfare Association	1) For the implementation of this project, we are ready to cooperate 2) The project has been prepared scientifically 3) Along with the improvements of Gedilam and Thenpennaiyar rivers, this project has to be included. 4) For the flow from higher elevation to lower elevations system has to be designed accordingly 5) To improve the carrying capacity of Kondangi lake 6) The centre of the roads has to be raised and should tapper towards the drain 7) Encroachments have to be removed 8) For the next 50 years the project has to designed accordingly
2	Thiru. T.S.Thirumarban Advocate, VCK	1) Drains to be raised to road levels 2) Culverts to be constructed in such a way that it should not damage the UGSS

Sl. No.	Participant	View / Suggestions
		3) Existing drains to be widened and improved 4) Blockages from the drains to be removed 5) Encroachments to be removed 6) Fresh ponds to be constructed in Government porampokku land 7) Since Vandipaalayam area is in the low level, normal rains brings in stagnation. 8) Encroachments to be removed along with alternative
3	Thiru Balu, Vallivilas Jewellers	1) Rain water conservation method should be considered in this project 2) Flooding in low level areas should be eradicated while designing this project 3) Resettlement and Rehabilitation has to be carried out when people are evacuated at the time of natural disasters.
4	Raj Mohan, NGO	1) To desilt the Kondangi lake and include the estimate cost in this project 2) Buckingham canal and Kondangi lake has to be removed so that the floods will never occur. 3) Encroachments has to be removed in Pudhupaalayam area
5	P. Ramalingam, Secretary, Consumer awareness & environment protection	1) To mitigate floods encroachments has to be removed
6	EE / TWAD / Cuddalore	1) HSC to be completed in the exiting UGSS 2) During rainy seasons Man holes are punctured to let the flood water in to the MHs 3) Raise the road levels with proper grades on either side so that rain water will not get stagnated
7	ADE / Highways	1) The culvert at Vandipalayam Junction is narrow and therefore it has to be modified. 2) A water pipe line passes through the culvert reduces the flow.
8	EE / PWD	1) Proposal for RS.20 crores for improvements to Gedilam River has been submitted to Government 2) 2. The modification of sections of the canals from Thiruvanthipuram

The Shah Technical Consultants Pvt. Ltd. taking into account the views and suggestions, as mentioned above gave a consolidated reply as furnished below:

1. The encroached areas have been identified and the management plan to evacuate the encroachment has been incorporated in the report.
2. At all Out Fall locations Rain water harvesting structures, consisting of 2 wells with recharges bores, have been proposed.
3. Provision has been given for desilting and increasing the sections of Odais (Nallah), coming from Kondangi lake and Thiruvanthipuram anicut. In respect of Gedilam/Thenpennaiyar rivers, Buckingham Canal and Kondangi lake, since they are under the purview of PWD, suitable action shall be taken by PWD. The Executive engineer/ PWD, informed that a proposal for desilting and widening of river Gedilam has been submitted to Government and approval sought for. Will be discussed with NH officials and action will be taken.
4. All small water bodies, based on their capacity, location, and if it is owned by the Municipality, then they are considered for disposal of storm water. However the excess water, that over flows from the water body, will be let into the nearby Nallahs/rivers, by proposing separate drains from the water bodies.

After detailed discussions the Chairman Cuddalore Municipality delivered Votes of Thanks.

Following are the copy of the news paper cutting published on June 26th 2016, about the stake holders meeting convened.

கடலூர் நகராட்சி கூட்டத்தில் அமைச்சர் எம்.சி.சம்பத் பேசியபோது எடுத்த படம்.

கடலூரை

தன்னிறைவு பெற்ற நகராட்சியாக மாற்ற நடவடிக்கை எடுக்கப்படும்

அமைச்சர் எம்.சி.சம்பத் பேச்சு

கடலூர், ஜூன்.26–

கடலூர் மாவட்டம் இயற்கை சீற்றங்களாலும், பலத்த மழையின் காரணமாகவும் அடிக்கடி பாதிக்கப்படுகிறது. இதில் கடலூர் நகராட்சியில் குடியிருப்பு பகுதிகளிலும், சாலைகளிலும் தண்ணீர் தேங்கி பெரும் சேதம் ஏற்படுகிறது.

இதற்கு காரணம் போதிய நீர் வடிகால், கால்வாய்கள் இல்லாதே காரணம் ஆகும். இதனையொட்டி பொது மக்கள் கால்வாய்கள், மழைநீர் வடிகால்கள் அமைத்து தர வேண்டும் என அரசுக்கு கோரிக்கை வைத்தனர்.

இதனால் வரும் காலங்களில், மழையின் போது தேங்கும் நீரை வடிய வைக்க, கால்வாய் கட்டுவதற்காக விரிவான திட்டம் தயாரிக்க முதல்வர் ஜெயலலிதா உத்தரவிட்டுள்ளார்.

இதற்கான திட்டத்தைத் தயாரிக்க சென்னையை சேர்ந்த தனியார் நிறுவனத்திடம் ஒப்படைக்கப்பட்டுள்ளது. அந்நிறுவனம் நகர பகுதியில் தண்ணீர் தேங்கும் இடங்கள், வடிவதற்கான வாய்ப்புகள், கடல் மட்டத்தில் இருந்து எவ்வளவு உயரம் என முழுவதுமாக கணக்கீடு செய்துள்ளனர்.

இதைத்தொடர்ந்து கடலூர் நகராட்சி ஒருங்கிணைந்த மழைநீர் வடிகால் மற்றும் கால்வாய்கள் அமைத்தல், விரிவான திட்ட அறிக்கை தயாரித்தல் தொடர்பான ஆலோசனைக் கூட்டம் நகராட்சி அலுவலகத்தில் நடந்தது.

முதன்மையான நகராட்சி கூட்டத்திற்கு, தமிழக தொழில்துறை அமைச்சர் எம்.சி.சம்பத் தலைமை தாங்கி பேசும்போது, 'கடலூர் நகராட்சி மக்களுக்கு அனைத்து வசதிகளும் செய்து தருவேன். தன்னிறைவு பெற்ற நகராட்சியாக மாற்றியமைக்க துணையாக இருப்பேன்.

தூய்மையான நகராட்சி என்ற பெயர் எடுக்க நான் ஒத்துழைப்பு தருவேன். என்னை மீண்டும் எம்.எல்.ஏ.வாக தேர்ந்தெடுத்த உங்களுக்கு நன்றியை தெரிவித்துக் கொள்கிறேன் என்றார்.

நகரமன்ற தலைவர் குமரன், துணை தலைவர் சேவல்குமார், நகராட்சி மண்டல இயக்குனர் (பொறுப்பு) ராமமூர்த்தி ஆகியோர் முன்னிலை வகித்தனர். நகராட்சி கமிஷனர் முருகேசன் வரவேற்றார்.

அதைத்தொடர்ந்து கடலூரில் ஒருங்கிணைந்த மழைநீர் வடிகால் மற்றும் கால்வாய்கள் அமைப்பது தொடர்பாக நுகர்வோர் அமைப்பு நிர்வாகிகள், அனைத்து குடியிருப்போர் நலச்சங்க நிர்வாகிகள், உட்பட பலர் பேசினர். இதில் கவுன்சிலர்கள் வக்கீல் பாலகிருஷ்ணன், தமிழ்செல்வன், அன்பு, சங்கர், கூட்டுறவு சங்க தலைவர் ரவிச்சந்திரன் உள்பட அனைத்துதுறை அதிகாரிகள் கலந்து கொண்டனர்.

தினத்தந்தி

கடலூர் மாவட்ட செய்திகள்

கடலூர் நகராட்சி அலுவலகத்தில் நடைபெற்ற கலந்தாய்வு கூட்டத்தில் அமைச்சர் எம்.சி.சம்பத் பேசிய போது எடுத்த படம்.

கடலூரை

தன்னிறைவு பெற்ற நகராட்சியாக மாற்ற நடவடிக்கை

கலந்தாய்வு கூட்டத்தில் அமைச்சர் எம்.சி.சம்பத் உறுதி

கடலூர், ஜூன் 26– கடலூரை தன்னிறைவு பெற்ற நகராட்சியாக மாற்ற நடவடிக்கை எடுக்கப்படும் என்று கடலூரில் நடந்த கலந்தாய்வு கூட்டத்தில் அமைச்சர் எம்.சி.சம்பத் உறுதி அளித்தார்.

குடியிருப்புகளில் மழைநீர்

கடந்த 2015-ம் ஆண்டு நவம்பர் மாதங்களில் பெய்த கன மழையால் கடலூர் நகராட்சி பகுதியில் பல இடங்களில் குடியிருப்புகளை தண்ணீர் தேங்கியது. வேறுசில சாலைகளிலும் மழை நீர் தேங்கி நின்றதால் பல இடங்களில் அரிப்பு ஏற்பட்டு சாலைகள் குண்டும், குழியுமாக மாறியது. போதிய மழைநீர் வடிகால், கால்வாய்கள் இல்லாததால் பெருத்த சேதம் ஏற்பட்டது.

இதனால் நகராட்சி பகுதியில் போதிய மழைநீர் வடிகால், கால்வாய்கள் அமைத்து தர வேண்டும் என்று பொதுமக்கள் கோரிக்கை வைத்தனர். இந்த கோரிக்கை ஏற்கப்பட்டு தற்போது தமிழக அரசு கடலூர் நகராட்சி பகுதியில் பிரதான மழைநீர் வடிகால்கள் மற்றும் கால்வாய்கள் அமைக்கவும், விரிவான திட்ட அறிக்கை தயாரிக்கவும் தொடர்பான கலந்தாய்வு கூட்டம் நடந்தது. கூட்டத்துக்கு அமைச்சர் எம்.சி.சம்பத் தலைமை தாங்கி பேசினார்.

அப்போது அவர் கூறியதாவது:–

தன்னிறைவு நகராட்சியாக மாற்ற நடவடிக்கை

கடலூர் நகராட்சி பல வார்டு நெருக்கமான கொண்ட பெரிய நகராட்சியாக இருக்கிறது. அதாவது இந்த நகராட்சியில் இரண்டு லட்சத்துக்கு மேற்பட்ட மக்கள் வசிக்கிறார்கள்.

மழை சேதம் ஏற்படாமல் தடுக்க

கடந்த 2015-ம் ஆண்டு பெய்த கன மழையால் பல இடங்களில் தண்ணீர் தேங்கியது. இதற்கு முதல் அமைச்சர் ஜெயலலிதாவின் சீரிய முயற்சியால் தொடர்ந்து தேங்காமல் வரும் காலங்களில் நடவடிக்கை எடுக்கப்பட்டது. கடலூர் நகராட்சியை தன்னிறைவு பெற்ற நகராட்சியாக மாற்றுவதற்கு வருங்காலங்களிலும் தேவையான நகராட்சி பகுதியான தேவையான புதிதாகவும் வடிகால் அமைக்கவும் மேலும் தேவையான வசதிகளை ஏற்படுத்தவும் தமிழக அரசு தயாராக உள்ளது. அதற்கு தேவையான இடங்களில் குடிநீர் வினியோகம் செய்ய வேண்டும்.

இவ்வாறு அமைச்சர் எம்.சி.சம்பத் பேசினார்.

கூட்டத்தில் ஆணையாளர் முருகேசன் வரவேற்றார். நகராட்சி நிர்வாக மண்டல இயக்குனர் (பொறுப்பு) ராமமூர்த்தி, நகராட்சி தலைவர் குமரன், துணை தலைவர் சேவல்குமார், வேளாண் துறை ஆணையர் ராமமோகன் உள்பட பலர் முன்னிலை வகித்தனர்.

மழைநீர் சேகரிப்பு திட்டம்

அதைத்தொடர்ந்து கடலூரில் ஒருங்கிணைந்த மழைநீர் வடிகால்கள் மற்றும் கால்வாய்கள் அமைப்பது தொடர்பாக நுகர்வோர் அமைப்பு நிர்வாகிகள், அனைத்து குடியிருப்போர் நலச்சங்க நிர்வாகிகள், பொதுப்பணித்துறை, நெடுஞ்சாலைத்துறை குடிநீர் வடிகால் வாரியம், மின்சார வாரியம், வருவாய் துறை, ஊரக வளர்ச்சி துறை, நகராட்சி நிர்வாகம் உள்பட பல துறை அதிகாரிகள் கலந்து கொண்ட கலந்தாய்வு கூட்டம் நடந்தது. கூட்டத்தில் கவுன்சிலர்கள் பாலகிருஷ்ணன், தமிழ்செல்வன், கவுதமி, ராஜா, ராஜேஷ்வரி, சேகர், அன்பு, சங்கர், சாந்தா, கூட்டுறவு சங்க தலைவர் ரவிச்சந்திரன் உள்பட அனைத்து துறை அதிகாரிகள் கலந்து கொண்டனர்.

4,110 கோடிக்கு மழைநீர் வடிகால் திட்டம்

இந்த கூட்டம் தொடர்பாக நகராட்சி அதிகாரி ஒருவரிடம் கேட்ட போது, மழைக்காலங்களில் கடலூர் நகராட்சி பகுதியில் தண்ணீர் தேங்கி நிற்காமலும் நிரந்தரமாக மழைநீர் வடிகால்கள், கால்வாய்கள் அமைப்பதற்காக ரூ.110 கோடியில் திட்டம் தயாரிக்கப்பட்டுள்ளது. அந்த திட்டம் பற்றி பல்வேறு அமைப்புகள், அரசுத்துறை அதிகாரிகளிடம் கருத்துகேட்கப்பட்டது. அனைவரும் சொல்லும் இந்த திட்டத்தை அரசு செயல்படுத்தும் என்றார்.

பத்திரிகையாளர்கள் வெளியேற்றம்

கடலூர் நகராட்சிக்கான ஒருங்கிணைந்த மழைநீர் வடிகால்கள் மற்றும் கால்வாய்கள் அமைப்பதுதொடர்பான கலந்தாய்வு கூட்டத்தில் அமைச்சர் எம்.சி.சம்பத் கலந்து கொண்டு பேசி முடித்தவுடன், செய்தி சேகரித்துக் கொண்டிருந்த பத்திரிகை நிருபர்கள், புகைப்படக்காரர்கள் நிருபரை வெளியேற்றப்பட்டனர். இதனால் கூட்ட அரங்கில் அதிகாரிகள், பொது நல அமைப்பினர் என்ன கருத்து தெரிவித்தார்கள் என்ற விவரங்களை முழுமையாக சேகரிக்க முடியாமல் நிருபர்கள் வெளியே காத்திருந்தனர். இதனால் அங்கு சிறிது நேரம் பரபரப்பு ஏற்பட்டது.

7. Social Impact Assessment

The objective of Social Impact Assessment is to assess the Social Impacts arising out of implementation of Storm Water Drainage Project to the selected areas of Cuddalore Municipality and based on the outcome of Impact Assessment, appropriate mitigation measures through management plan is proposed.

Field visits and surveys to finalise the design of drains were undertaken by Shah Technical Consultants (P) Ltd., Chennai Officials and found that there is no social impacts.

Minimizing Impacts

The basic objective of provision of Storm Water Drains to Cuddalore Municipality in order to avoid the flooding and inundation and for proper disposal of Storm Water. Hence it is proposed to provide Storm Water Drains in the width coverage. In the design of Storm Water Drains, the width of drains also considered in order to minimize the Social Impacts in addition to the technical aspects considered for designing the drains. The narrow streets and lanes are provided with one side drains in order to avoid Social Impacts.

Social Category

Since there is no private land acquisition and no social impacts to PAPs, as per ESMF this **Phase is categorized as S3**.

Social Impacts

In this project the Storm Water Drains are proposed to be constructed for a length of 59.24 km. These drains are proposed to be constructed in the Panchayat Roads and Canals maintained by the Cuddalore Municipality based on the social impact assessment it is observed that there is no private land acquisition and hence no R&R social impact was found.

Unforeseen Impacts

If any unforeseen impacts encountered during implementation will be addressed in accordance with the principles of the ESMF (Refer Entitlement Matrix Annexure-2) adopted by TNUIFSL.

8. PROJECT BENEFITS

The following benefits are expected to accrue due to the implementation of the storm water drainage project at Cuddalore.

- Short-term socio-economic benefits from the construction work if local people are to gain employment in the construction work force.
- Once the new drains are functioning they should contribute to an improvement in the environmental hygiene and aesthetics of the town by helping to remove the large and unsightly pools of wastewater that are an almost permanent feature of the city.
- Betterment of health and improved community hygiene would be facilitated.
- Given the relatively poor reserves of groundwater in the area, there would be addition benefit if water from the drains is directed into the aquifer, through purpose drilled recharging boreholes.
- Generally the social impacts are beneficial in nature and these include improved sanitation and public health.

Reduction in flooding

Three different agencies were involved in installation of Storm Water Drains in Cuddalore Town viz. Local body, State & National Highway and Public Works Department. Storm Water collected in the street drains are discharges into channels flows within the town limit.

The carrying capacity of these drains / channels are not adequate to drain the storm water during rainy days mostly due to accumulation of silt and garbage blocking the free flow of storm. Besides, the disposal points are not properly connected either to water way or water bodies.

This causes the inundation, back flooding over the roads. Due to this roads are damaged, besides causing inconvenience to the public till entire storm is drained off. In the year 2015, inundation and storm water stagnation in several pockets in the town were there from 9th November to 27th December, during field visit and reconnaissance survey, the team has noticed the water mark in compound wall of houses.

This has been studied and the existing drains are replaced with adequate size drains and culverts. In National Highways and State Highways minimum size of 2.0 m X 2.0 m box culverts are proposed and rest of the roads adequate size box culverts are proposed instead of existing pipe culverts. The disposals of drains are proposed till end of the waterways. Therefore the flooding hotspots identified earlier will be free from flooding in future.

The Micro Drains (street drains) are designed for 2 years return period and Macro Drains (Channels) are designed for 5 years return periods. The existing channel sections are modified by deepening and widening the channel to accommodate flow for 5 years return period. Since all the street drains are either connected to channels or rivers, the flow will be discharged finally to the river without causing flooding in the catchment area.

9. CONCLUSION

Due to the frequent and regular flooding Cuddalore is affected with loss of productivity, loss of livelihood, loss of properties, disruption of normal life, increased risk of water borne diseases due to unhygienic environment, damage to the roads etc.

To alleviate the problems caused due to flooding a proper storm water drainage system to collect, convey and dispose the rain water is required and accordingly the following proposal were made.

- New storm drains are proposed in uncovered areas.
- In undeveloped areas / sparsely populated areas, where the minimum road network exists, the drains are sized by duly considering the future flow from these undeveloped areas on the upstream side.
- Minimum of 0.45 m x 0.45 m section is proposed for new drains. In initial reaches where the flow is less and thus if size required is less than 0.45 m x 0.45 m then kerbs and gutters are proposed.
- RCC covered drains are proposed in all bus route roads and drains having more than 1.2 m width.
- All the proposed drains are to be constructed using RCC M25 concrete.
- Kutcha drains are replaced with new RCC drains.
- If road width is less than 3 m and in newly added villages and undeveloped areas, Gutter and gully is proposed. If road width is less than 10m, single side drains are proposed. Two side drains are proposed for roads having more than 10m width.
- About 105 km length of drains were provided in the town and out of which about 68 km length of drains were observed as inadequate and need replacement.
- In addition to the replaced drains, additional length of 65 km drains are proposed.
- The total length of drains thus proposed is about 170 km. In addition to the drains kerbs and gutters are proposed for a length of 54 km.
- The total cost for both the works is estimated at a total base Cost of Rs. 136.25 Crores
- Improvements & Rehabilitation to nallah and odai by widening within the RoW and deepening by desilting, for a length of about 17.5 km is proposed at a base cost of Rs.25.36 Crores.
- The total project cost including price variation, contingencies and road variation works out to Rs. 149.00 Crores. Annual Maintenance cost for the Project works out to Rs.1.61 Crores.
- The works proposed above are planned to be carried out in three phases as below:
  Phase I – Providing drainage facilities in flood prone area at a cost of Rs.42.00 Crores

Phase II – Improvements to channels including widening and lining at a cost of Rs.28.43 Crores

Phase III – Providing street drains to all the four zones at a cost of Rs.78.57 Crores

Annexure

Annexure 1 - Environmental Screening Form

Annexure 2 - Photographs of Sampling Locations

Annexure 3 - Results of Environmental Baseline Data Analysis

Annexure 4 – Strip Plan

Annexure 5 – Coastal Zone Management Plan of Tamil Nadu

Annexure 5.1 - Storm Network marked in CZM Plan

Annexure 1 - Environmental Screening Form

ENVIRONMENTAL SCREENING FORM

Name of the Borrower	:	Cuddalore Municipality
Project location	:	Cuddalore Town
Project	:	Consulting Services for Preparation of Detailed Project Report for Providing Storm Water Drains in Cuddalore Municipality Area

Project Components

Sl. No.	Components	Details
1	Brief description of the project proposal	To provide storm water drainage system to Cuddalore Municipality to collect, convey and safe disposal of storm water
2	Number of project sites and Project components	Storm water drains are proposed in the streets were there are no drains available and where the sizes of the existing drains are not sufficient to carry the design flow.
3	Details of Alignment and Component	About .62 Kms of new drains and about 36 kms of existing drains are proposed with higher size drains. For details pls refer the DPR
4	Location of the Project Sites & Current Use (Provide information for all sites involved in the project)	The project sites are the drains that proposed along the side of the road for a total length of 326 kms

Biological Environment

Sl. No.	Components	Yes	No	Details
5	Is the project adjacent to any of the following (Provide information for all sites and alignment of the project)			
(i).	Cultural Heritage site		✓	
(ii).	Protected Area		✓	
(iii).	Wet Land/ Mangrove/ Estuarine Region	✓		The project on implementation will improve the surface water quality and Wetland / estuarine region.
(iv).	Natural Forests		✓	
(v).	Other Sensitive Environmental Components as listed in ESMF		✓	
(vi).	Residences, schools, hospitals etc	✓		The project on implementation will improve the flooding situation and reduce the inundation in these sensitive areas.
(vii).	Drinking water source, upstream and downstream uses of rivers etc			
(viii).	Lowlying areas prone to flooding / areas of Tidal Influence (CRZ)	✓		The project aims to alleviate the present flooding situation by providing drains have the hydraulic capacity co discharge the storm water

6.	Does the proposed project could cause the following			
(i).	Impact on Surrounding Environmental Conditions	✓		No impact on endangered species. Minimum impact on air, noise and water for which mitigation measures are suggested.
(ii).	Degradation of land / eco-systems		✓	
(iii).	Loss or impacts on Cultural / heritage properties		✓	
(iv).	Water Resource Problems		✓	
(v).	Pollution of Water bodies / ground water		✓	This project will help improve / minimize the pollution
(vi).	Cutting of Trees / Loss of Vegetation	✓		The drains are routed to avoid cutting of trees
(vii).	Health & Safety Risks in the neighbourhood		✓	This project will help improve the sanitation
(viii).	Potential risk of habitat fragmentation due to the clearing activities? (eg. Hindrance to the local bio diversity like disturbing the migratory path of animals/ birds etc.)		✓	No ecologically sensitive areas are present in the project area. The impact during construction will be minimum
	Physical Environment			
Sl. No.	**Components**	**Yes**	**No**	**Details**
7	Will the project affects the River flow pattern, stream pattern or any other irrigation canal?		✓	It will improve the river / stream / canal flow pattern and the quality of water
8	Water quantity? Estimated usage of water quantity for the project	✓		About 0.15 ML
9	Estimated energy consumption for the project activities	✓		The equipments used by the contractors will be normally powered by fuel rather than electricity. Electricity might be used for lighting and other minor equipments. Approximate energy consumed thus might be about 20,000 kWh
10	Any other resources proposed to be utilized for project activity? (eg., ground water)	✓		-

Environmental Enhancement Measure				
Sl. No.	**Components**	**Yes**	**No**	**Details**
21	Has the Project design considered the following?			
(i).	Is the project design considering energy conservation measures/energy recovery options?	✓		Energy consumption is not envisaged in the Project
(ii).	Is the project considering waste minimization or waste reuse/recycle options?	✓		The project aims to prevent the pollution of water bodies, water ways and recharge of ground water.
(iii).	Has the project design considered RWH or any other environmental enhancement measure?	✓		The project considers rain water conservation and harvesting
(iv).	Has the project design considered extreme events, drought, flood, natural disasters?	✓		The project is designed for mitigating flood caused by known extreme rainfall in the recent years.
	General			
22	Please indicate whether any other features of the project that could influence ambient environment		✓	
23	Has any consultation with the public or stakeholders been conducted?	✓		Yes

Date:

Signature and name of the Borrower

Enclosures: (Provide maps with the geographical location of the project; and an appropriately scaled map clearly showing the project area and project sites with land use, existing buildings, infrastructure, vegetation, adjacent land use, utility lines, access roads and any planned construction, as required).

Annexure 2 - Photographs of Sampling Locations

STROM WATER DRAINAGE PROJECT PHOTOS CUDDALORE

AAQ, NOISE MONITORING AND GROUNDWATER SAMPLING AT THIRUPAPULIYUR

STROM WATER DRAINAGE PROJECT PHOTOS CUDDALORE

AAQ, NOISE MONITORING AND GROUNDWATER SAMPLING AT CUDDALORE OT

STROM WATER DRAINAGE PROJECT PHOTOS CUDDALORE

AAQ, NOISE MONITORING AND GROUNDWATER SAMPLING AT MANJAKUPPAM

STROM WATER DRAINAGE PROJECT PHOTOS CUDDALORE

SURFACE WATER AND SOIL SAMPLING AT GADILAM RIVER

SOIL SAMPLING AT CAPPER

SURFACE WATER SAMPLING AT EANIKARAN THOTTAM

STROM WATER DRAINAGE PROJECT PHOTOS CUDDALORE

SURFACE WATER AND SOIL SAMPLING AT KAMMIYAM PETTAI RIVER

Annexure 3 – Results of Environmental Baseline Data Analysis

Issued to :

M/s. SHAH TECHNICAL CONSULTANTS
PRIVATE LIMITED,
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GROUND FLOOR, VIJAYARAGHAVA ROAD,
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(AN ISO : 9001, ISO : 14001 & OHSAS : 18001 CERTIFIED COMPANY)

RECOGNISED BY MINISTRY OF ENVIRONMENT & FOREST, GOVERNMENT OF INDIA

TEST REPORT

REPORT NUMBER	:	ABC/STCPL/01/AS/200516/A 280
SAMPLE DRAWN BY	:	ABC Techno Labs India Private Limited
SAMPLE DESCRIPTION	:	AMBIENT AIR QUALITY MONITORING (24 Hourly)
PROJECT NAME	:	CUDDALORE STORM WATER DRAINAGE PROJECT
LOCATION OF SAMPLING	:	AAQ1-THIRUPAPULIYUR Geographical Location - N-11°44'58.28", E-79°45'07.65"
CLASSIFICATION OF AREA	:	RESIDENTIAL AREA
DATE OF SAMPLING	:	20-05-2016 to 21-05-2016
REPORT DATE	:	27-05-2016

Meteorological Conditions

Temp: 26-38 °C , **Relative Humidity** : 40-89 % , **Rain Fall:** Nil, **Average Wind Speed:** 3 Km/Hr
Predominant Wind Direction: Southwest , **Cloud Cover** : Scattered Clouds

S. No.	Parameters	AAQ 1	Test Method	Standards*
1	SPM -Suspended Particulate Matter, µg/m³	102	IS 5182: Part 4 (Reaff. 2005)	Not Specified
2	RPM-Particulate Matter size less than 10- µm (PM_{10}), µg/m³	49.6	Gravimetric	100
3	Sulphur Dioxide (SO_2), µg/m³	7.8	Improved West & Gaeke	80
4	Nitrogen Dioxide (NO_2), µg/m³	16.8	Modified Jacob & Hochheister	80
5	Lead (Pb), µg/m³	BDL (<0.1)	IS 5182 P 22: 2004	1
6	Carbon Monoxide (CO), mg/m³	(BDL<0.1)	By Electrochemical Sensor	2

*National Ambient Air Quality Standards prescribed by Ministry of Environment and Forests, Government of India vide Gazette Notification G.S.R. 826(E) dated 18.11.2009
BDL- Below Detection Limit

.....END OF REPORT.....

ABC Techno Labs

27/05/16

A. Robson Chinnadurai
Quality Manager

Authorized Signatory

V. Verified

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TEST REPORT

REPORT NUMBER	:	ABC/STCPL/01/AS/200516/A 281
SAMPLE DRAWN BY	:	ABC Techno Labs India Private Limited
SAMPLE DESCRIPTION	:	AMBIENT AIR QUALITY MONITORING (24 Hourly)
PROJECT NAME	:	CUDDALORE STORM WATER DRAINAGE PROJECT
LOCATION OF SAMPLING	:	AAQ2-CUDDALORE OT Geographical Location - N-11°42'29.01", E-79°45'26.17"
CLASSIFICATION OF AREA	:	RESIDENTIAL AREA
DATE OF SAMPLING	:	20-05-2016 to 21-05-2016
REPORT DATE	:	27-05-2016

Meteorological Conditions

Temp: 26-38 °C , **Relative Humidity** : 40-89 % , **Rain Fall:** Nil, **Average Wind Speed:** 3 Km/Hr
Predominant Wind Direction: Southwest , **Cloud Cover** : Scattered Clouds

S. No.	Parameters	AAQ 2	Test Method	Standards*
1	SPM -Suspended Particulate Matter, µg/m³	82.4	IS 5182: Part 4 (Reaff. 2005)	Not Specified
2	RPM-Particulate Matter size less than 10- µm (PM_{10}), µg/m³	41.7	Gravimetric	100
3	Sulphur Dioxide (SO_2), µg/m³	6.6	Improved West & Gaeke	80
4	Nitrogen Dioxide (NO_2), µg/m³	12.2	Modified Jacob & Hochheister	80
5	Lead (Pb), µg/m³	BDL (<0.1)	IS 5182 P 22: 2004	1
6	Carbon Monoxide (CO), mg/m³	(BDL<0.1)	By Electrochemical Sensor	2

*National Ambient Air Quality Standards prescribed by Ministry of Environment and Forests, Government of India vide Gazette Notification G.S.R. 826(E) dated 18.11.2009
BDL- Below Detection Limit

.....END OF REPORT.....

ABC Techno Labs

27/05/16

A. Robson Chinnadurai
Quality Manager

Authorized Signatory

Verified

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TEST REPORT

REPORT NUMBER	:	ABC/STCPL/01/AS/200516/A 282
SAMPLE DRAWN BY	:	ABC Techno Labs India Private Limited
SAMPLE DESCRIPTION	:	AMBIENT AIR QUALITY MONITORING (24 Hourly)
PROJECT NAME	:	CUDDALORE STORM WATER DRAINAGE PROJECT
LOCATION OF SAMPLING	:	AAQ3-MANJAKUPPAM Geographical Location - N-11°45'47.33", E-79°45'47.47"
CLASSIFICATION OF AREA	:	RESIDENTIAL AREA
DATE OF SAMPLING	:	20-05-2016 to 21-05-2016
REPORT DATE	:	27-05-2016

Meteorological Conditions

Temp: 26-38 °C , **Relative Humidity** : 40-89 % , **Rain Fall:** Nil, **Average Wind Speed:** 3 Km/Hr
Predominant Wind Direction: Southwest , **Cloud Cover** : Scattered Clouds

S. No.	Parameters	AAQ 3	Test Method	Standards*
1	SPM -Suspended Particulate Matter, µg/m³	88.5	IS 5182: Part 4 (Reaff. 2005)	Not Specified
2	RPM-Particulate Matter size less than 10- µm (PM_{10}), µg/m³	47.6	Gravimetric	100
3	Sulphur Dioxide (SO_2), µg/m³	6.9	Improved West & Gaeke	80
4	Nitrogen Dioxide (NO_2), µg/m³	13.8	Modified Jacob & Hochheister	80
5	Lead (Pb), µg/m³	BDL (<0.1)	IS 5182 P 22: 2004	1
6	Carbon Monoxide (CO), mg/m³	(BDL<0.1)	By Electrochemical Sensor	2

*National Ambient Air Quality Standards prescribed by Ministry of Environment and Forests, Government of India vide Gazette Notification G.S.R. 826(E) dated 18.11.2009
BDL- Below Detection Limit

.....END OF REPORT.....

A. Robson Chinnadurai
Quality Manager

Authorized Signatory

Verified

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T. NAGAR, CHENNAI - 600017.

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India Private Limited

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RECOGNISED BY MINISTRY OF ENVIRONMENT & FOREST, GOVERNMENT OF INDIA

TEST REPORT

REPORT NUMBER	:	ABC/STCPL/01/NS/200516/N1-N3
SAMPLED BY	:	ABC TECHNO LABS INDIA PRIVATE LIMITED
SAMPLE DESCRIPTION	:	NOISE LEVEL MONITORING
PROJECT NAME	:	CUDDALORE STORM WATER DRAINAGE PROJECT
CLASSIFICATION OF AREA	:	COMMERCIAL AREA/ HIGHWAYS
DATE OF SAMPLING	:	20-05-2016 to 21-05-2016
REPORT DATE	:	27-05-2016

Location Code	Sample location	Geographical Location	Lday [dB(A)]	Lnight [dB(A)]	Leq [dB(A)]
N1	Thirupapuliyur	N-11°44′51.09″ E-79°45′27.85″	63.8	49.2	62.1
N2	Cuddalore OT	N-11°42′57.43″ E-79°46′05.21″	58.6	46.8	56.9
N3	Manjakuppam	N-11°45′24.32″ E-79°45′48.30″	56.4	45.3	54.8

Method: IS: 9989-1981(Reaff: 2001)-Ambient

AMBIENT NOISE STANDARDS

AMBIENT NOISE STANDARDS	Lday dB(A)	Lnight dB(A)
Industrial Area	75	70
Commercial Area	65	55
Residential Area	55	45
Silence Zone	50	40

.....END OF REPORT.....

ABC Techno Labs

A. Robson Chinnadurai
Quality Manager
27/05/16

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TEST REPORT

REPORT NUMBER : ABC/STCPL/01/SS/200516/S1-S3
SAMPLE COLLECTED BY : ABC TECHNO LABS INDIA PRIVATE LIMITED
SAMPLE DESCRIPTION : SOIL ANALYSIS
PROJECT NAME : CUDDALORE STORM WATER DRAINAGE PROJECT
DATE OF SAMPLING : 20-05-2016 to 21-05-2016
REPORT DATE : 27-05-2016

Sampling Location			S1- Gadilam River	S2-Capper Hills Canal	S3-Kammiyam Pettai River
Geographical Location			N-11°44'23.49" E-79°45'44.42"	N-11°43'42.50" E-79°44'50.29"	N-11°45'34.68" E-79°44'48.57"
S.No.	Parameters	Test Methods			
1	Lead as Pb, mg/Kg	EPA 3050 B	9.62	BDL(<5)	7.13
2	Sodium Absorption Ratio(SAR)	IS 11624:1986 By Calculation	13.6	1.62	5.87
3	Oil & Grease, mg/Kg	EPA 9071 B	BDL(<10)	BDL(<10)	BDL(<10)

BDL- Below Detection Limit

.....END OF REPORT.....

A. Robson Chinnadurai
Quality Manager
27/05/16

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TEST REPORT

REPORT NUMBER : ABC/STCPL/01/WS/210516/GW1
SAMPLE DRAWN BY : ABC TECHNO LABS INDIA PRIVATE LIMITED,
SAMPLING METHOD : IS: 3025 PART 1 – 1987
SAMPLE DESCRIPTION : GW1-GROUND WATER , THIRUPAPULIYUR
Geographical Location - N-11°44′58.28″, E-79°45′07.65″
PROJECT NAME : CUDDALORE STORM WATER DRAINAGE PROJECT
DATE OF SAMPLING : 21-05-2016
REPORT DATE : 27-05-2016

S. No	PARAMETER	UNIT	RESULTS	TEST PROCEDURE	ACCEPTABLE LIMIT AS PER IS 10500 :2012
			GW1		
1	pH at 25 °C	-	7.67	IS : 3025 Part 11- 1983 (Reaff:2002)	6.5-8.5
2	Total dissolved solids	mg/l	805	IS : 3025 Part 15-1984 (Reaff: 2003)	500
3	Total Hardness as $CaCO_3$	mg/l	340	IS : 3025 Part 21-1983 (Reaff: 1998)	200
4	Chloride as Cl^-	mg/l	154	IS : 3025 Part 32-1988 (Reaff: 2003)	250
5	Sulphate as SO_4	mg/l	88	APHA 22nd EDN -4500- SO_4^{2-} E	200
6	Fluoride as F	mg/l	0.39	APHA 22nd EDN -4500-F B&D	1
7	Iron as Fe	mg/l	BDL(<0.05)	IS : 3025 Part 53-2003	0.30
8	Lead as Pb	mg/l	BDL(<0.01)	APHA 22ndEDN -3111 B	0.01

BDL – Below Detection Limit

Contd .....

A. Robson Chinnadurai
Quality Manager
27/05/16

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TEST REPORT

REPORT NUMBER : ABC/STCPL/01/WS/210516/GW2
SAMPLE DRAWN BY : ABC TECHNO LABS INDIA PRIVATE LIMITED,
SAMPLING METHOD : IS: 3025 PART 1 – 1987
SAMPLE DESCRIPTION : GW2-GROUND WATER - CUDDALORE OT
Geographical Location - N-11°42′29.01″, E-79°45′26.17″
PROJECT NAME : CUDDALORE STORM WATER DRAINAGE PROJECT
DATE OF SAMPLING : 21-05-2016
REPORT DATE : 27-05-2016

S. No	PARAMETER	UNIT	RESULTS	TEST PROCEDURE	ACCEPTABLE LIMIT AS PER IS 10500 :2012
			GW2		
1	pH at 25 °C	-	7.55	IS : 3025 Part 11- 1983 (Reaff:2002)	6.5-8.5
2	Total dissolved solids	mg/l	384	IS : 3025 Part 15-1984 (Reaff: 2003)	500
3	Total Hardness as $CaCO_3$	mg/l	140	IS : 3025 Part 21-1983 (Reaff: 1998)	200
4	Chloride as Cl^-	mg/l	89	IS : 3025 Part 32-1988 (Reaff: 2003)	250
5	Sulphate as SO_4	mg/l	55	APHA 22nd EDN -4500- SO_4^{2-} E	200
6	Fluoride as F	mg/l	0.31	APHA 22nd EDN -4500-F B&D	1
7	Iron as Fe	mg/l	BDL(<0.05)	IS : 3025 Part 53-2003	0.30
8	Lead as Pb	mg/l	BDL(<0.01)	APHA 22ndEDN -3111 B	0.01

BDL – Below Detection Limit

Contd .....

ABC Techno Labs

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27/05/16

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TEST REPORT

REPORT NUMBER : ABC/STCPL/01/WS/210516/GW3
SAMPLE DRAWN BY : ABC TECHNO LABS INDIA PRIVATE LIMITED,
SAMPLING METHOD : IS: 3025 PART 1 – 1987
SAMPLE DESCRIPTION : GW3-GROUND WATER - MANJAKUPPAM
Geographical Location - N-11°45′47.33″, E-79°45′47.47″
PROJECT NAME : CUDDALORE STORM WATER DRAINAGE PROJECT
DATE OF SAMPLING : 21-05-2016
REPORT DATE : 27-05-2016

S. No	PARAMETER	UNIT	RESULTS	TEST PROCEDURE	ACCEPTABLE LIMIT AS PER IS 10500 :2012
			GW3		
1	pH at 25 °C	-	7.12	IS : 3025 Part 11- 1983 (Reaff:2002)	6.5-8.5
2	Total dissolved solids	mg/l	991	IS : 3025 Part 15-1984 (Reaff: 2003)	500
3	Total Hardness as $CaCO_3$	mg/l	310	IS : 3025 Part 21-1983 (Reaff: 1998)	200
4	Chloride as Cl^-	mg/l	243	IS : 3025 Part 32-1988 (Reaff: 2003)	250
5	Sulphate as SO_4	mg/l	134	APHA 22nd EDN -4500- SO_4^{2-} E	200
6	Fluoride as F	mg/l	0.47	APHA 22nd EDN -4500-F B&D	1
7	Iron as Fe	mg/l	BDL(<0.05)	IS : 3025 Part 53-2003	0.30
8	Lead as Pb	mg/l	BDL(<0.01)	APHA 22ndEDN -3111 B	0.01

BDL – Below Detection Limit

.....END OF REPORT.....

ABC Techno Labs

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TEST REPORT

REPORT NUMBER : ABC/STCPL/01/SW/210516/SW1
SAMPLE DRAWN BY : ABC TECHNO LABS INDIA PRIVATE LIMITED,
SAMPLING METHOD : IS: 3025 PART 1 – 1987
SAMPLE DESCRIPTION : SW1-SURFACE WATER – GADILAM RIVER
Geographical Location - N-11°44′23.49″, E-79°45′44.42″
PROJECT NAME : CUDDALORE STORM WATER DRAINAGE PROJECT
DATE OF SAMPLING : 21-05-2016
REPORT DATE : 27-05-2016

S. No	PARAMETER	UNIT	RESULTS	TEST PROCEDURE	IS :2296-1982 Class A (Surface water as drinking Water Source)
			SW1		
1	pH at 25 °C	-	8.25	IS : 3025 Part 11- 1983 (Reaff:2002)	6.5-8.5
2	Total Dissolved Solids	mg/l	17633	IS : 3025 Part 15-1984 (Reaff: 2003)	500
3	Oil & Grease	mg/l	BDL(<4)	IS:3025:Part39:1991 (Reaff:2003)	Not Specified
4	Dissolved Oxygen	mg/l	5.7	IS:3025:Part-38:1989 (Reaff:2003)	>6
5	Chemical Oxygen Demand	mg/l	48	IS:3025:Part-58:2006	Not Specified
6	Biochemical Oxygen Demand at 27°C for 3 days	mg/l	7.6	IS:3025:Part-44:1993 (Reaff:2003)	2
7	Lead as Pb	mg/l	BDL(<0.05)	APHA 22ndEDN -3111 B	0.1
8	Anionic Surfactants as MBAS	mg/l	BDL (<0.025)	APHA 22nd EDITION - 5540 C	0.20

BDL – Below Detection Limit

.....END OF REPORT.....

ABC Techno Labs

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Quality Manager

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TEST REPORT

REPORT NUMBER : ABC/STCPL/01/SW/210516/SW2
SAMPLE DRAWN BY : ABC TECHNO LABS INDIA PRIVATE LIMITED,
SAMPLING METHOD : IS: 3025 PART 1 – 1987
SAMPLE DESCRIPTION : SW2-SURFACE WATER – EANIKARAN THOTTAM
Geographical Location - N-11°43'21.04", E-79°46'09.02"
PROJECT NAME : CUDDALORE STORM WATER DRAINAGE PROJECT
DATE OF SAMPLING : 21-05-2016
REPORT DATE : 27-05-2016

S.No	PARAMETER	UNIT	RESULTS	TEST PROCEDURE	IS :2296-1982 Class A (Surface water as drinking Water Source)
			SW2		
1	pH at 25 °C	-	6.47	IS : 3025 Part 11- 1983 (Reaff:2002)	6.5-8.5
2	Total Dissolved Solids	mg/l	136	IS : 3025 Part 15-1984 (Reaff: 2003)	500
3	Oil & Grease	mg/l	BDL(<4)	IS:3025:Part39:1991 (Reaff:2003)	Not Specified
4	Dissolved Oxygen	mg/l	6.5	IS:3025:Part-38:1989 (Reaff:2003)	>6
5	Chemical Oxygen Demand	mg/l	15.8	IS:3025:Part-58:2006	Not Specified
6	Biochemical Oxygen Demand at 27°C for 3 days	mg/l	BDL(<2)	IS:3025:Part-44:1993 (Reaff:2003)	2
7	Lead as Pb	mg/l	BDL(<0.05)	APHA 22ndEDN -3111 B	0.1
8	Anionic Surfactants as MBAS	mg/l	BDL (<0.025)	APHA 22nd EDITION - 5540 C	0.20

BDL – Below Detection Limit

.....END OF REPORT.....

ABC Techno Labs

27/05/16

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Quality Manager

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TEST REPORT

REPORT NUMBER : ABC/STCPL/01/SW/210516/SW3
SAMPLE DRAWN BY : ABC TECHNO LABS INDIA PRIVATE LIMITED,
SAMPLING METHOD : IS: 3025 PART 1 – 1987
SAMPLE DESCRIPTION : SW3-SURFACE WATER – KAMMIYAM PETTAI RIVER
Geographical Location - N-11°43'42.50", E-79°44'50.29"
PROJECT NAME : CUDDALORE STORM WATER DRAINAGE PROJECT
DATE OF SAMPLING : 21-05-2016
REPORT DATE : 27-05-2016

S.No	PARAMETER	UNIT	RESULTS	TEST PROCEDURE	IS :2296-1982 Class A (Surface water as drinking Water Source)
			SW3		
1	pH at 25 °C	-	8.30	IS : 3025 Part 11- 1983 (Reaff:2002)	6.5-8.5
2	Total Dissolved Solids	mg/l	12416	IS : 3025 Part 15-1984 (Reaff: 2003)	500
3	Oil & Grease	mg/l	BDL(<4)	IS:3025:Part39:1991 (Reaff:2003)	Not Specified
4	Dissolved Oxygen	mg/l	5.3	IS:3025:Part-38:1989 (Reaff:2003)	>6
5	Chemical Oxygen Demand	mg/l	62	IS:3025:Part-58:2006	Not Specified
6	Biochemical Oxygen Demand at 27°C for 3 days	mg/l	8.6	IS:3025:Part-44:1993 (Reaff:2003)	2
7	Lead as Pb	mg/l	BDL(<0.05)	APHA 22ndEDN -3111 B	0.1
8	Anionic Surfactants as MBAS	mg/l	BDL (<0.025)	APHA 22nd EDITION - 5540 C	0.20

BDL – Below Detection Limit

.....END OF REPORT.....

ABC Techno Labs

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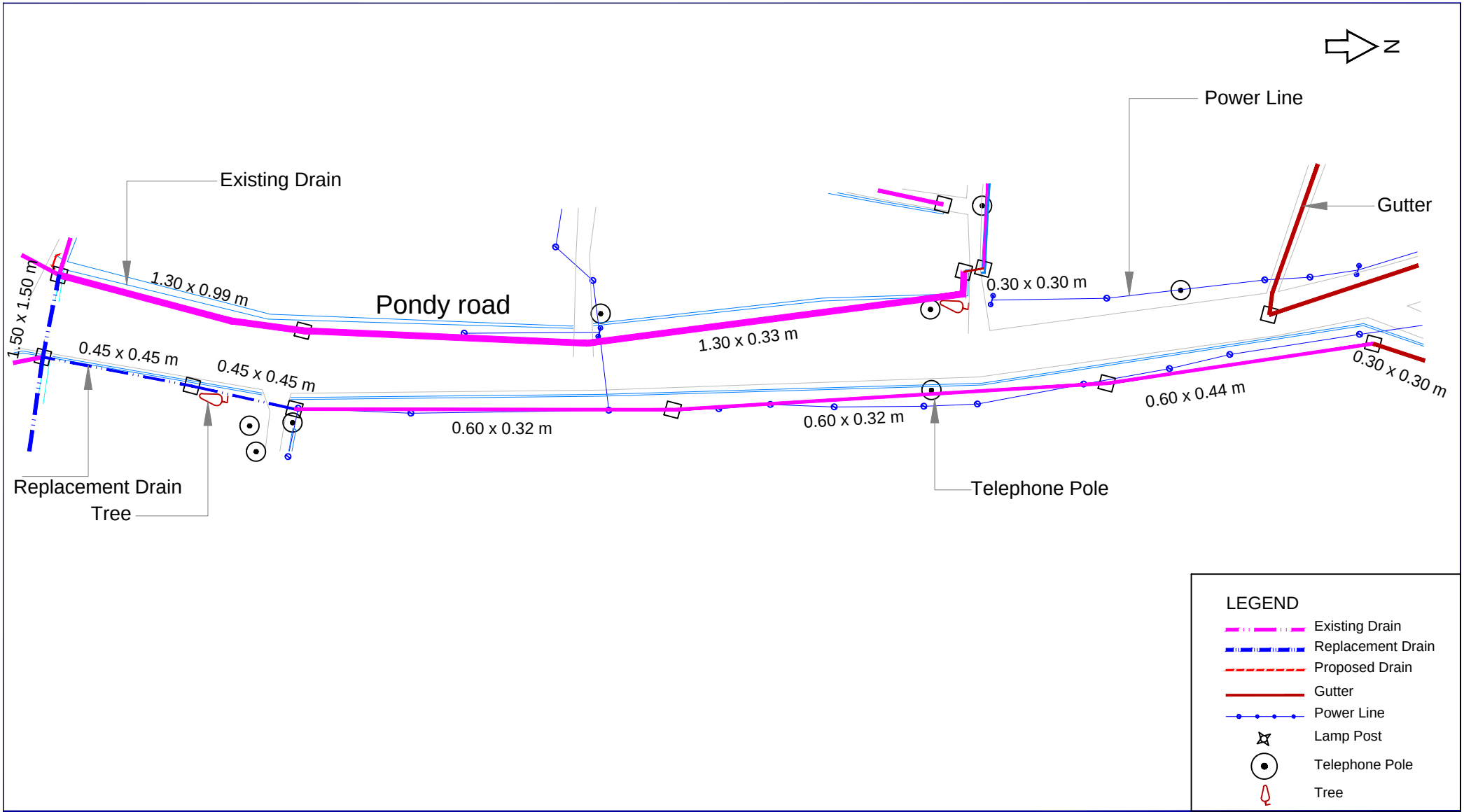
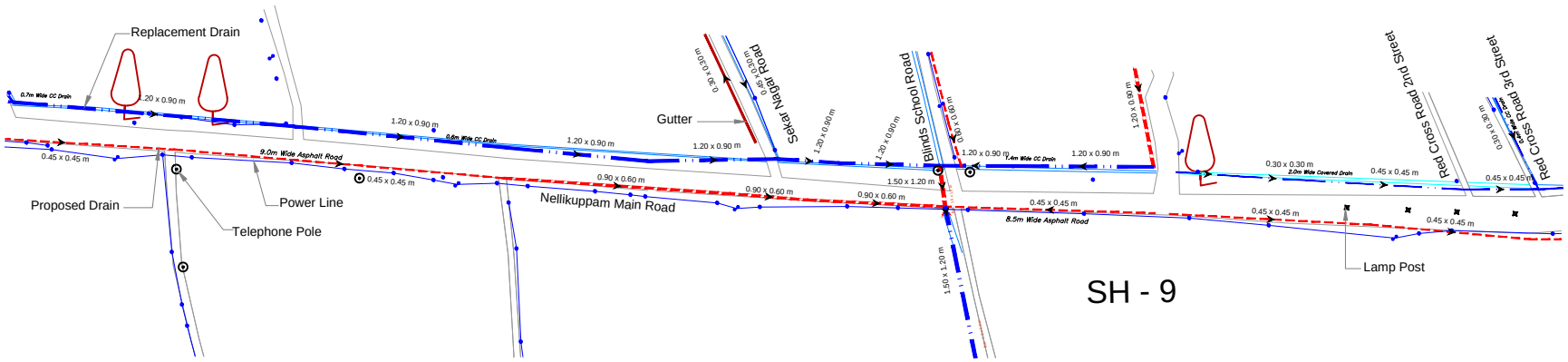
Annexure 4 – Strip Plan



Client: Cuddalore - Municipality	**Notes:**	**Dwg. No.:** STC/CUD/	**Project:** Preparation of Detailed Project Report (DPR) Providing Integrated Storm Water Drains (SWDs) for Cuddalore Municipality
Consultants: STC Shah Technical Consultants (P) Ltd., Chennai		**Scale:** 1:1 (A1)	
		Date: Dec-2016	
		Drawn By: Punitha	**Title:** STRIP PLAN PONDY ROAD
		Checked By: L.Thiyagarajan	
		Approved By: D.Pari	

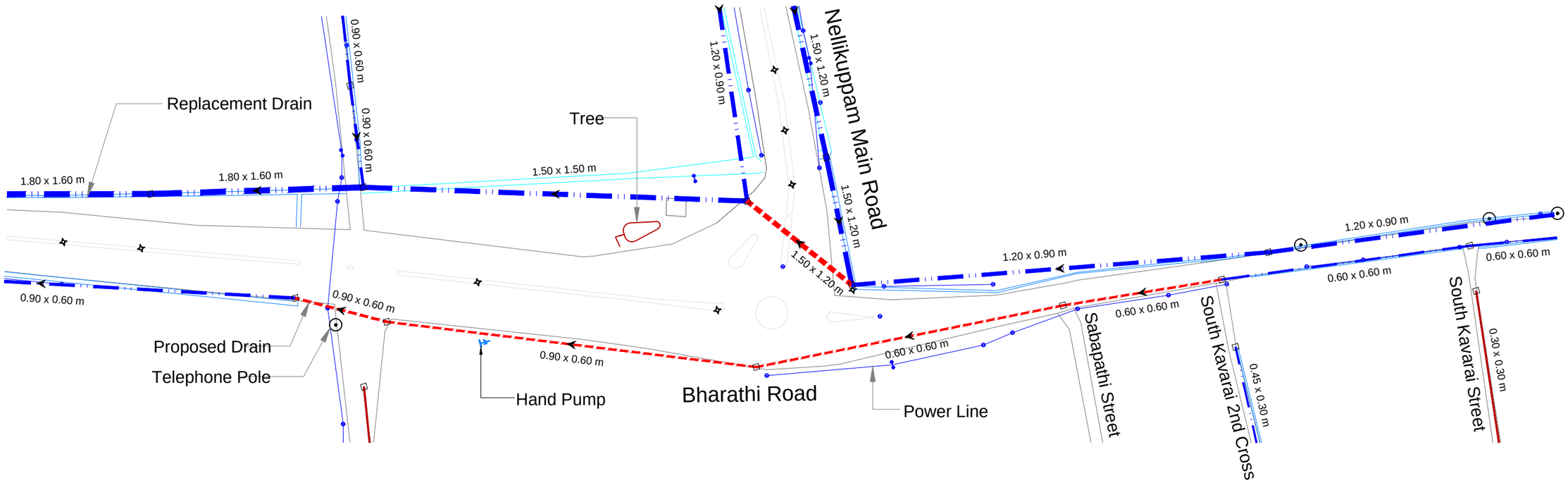


N

LEGEND

- Existing Drain
- Replacement Drain
- Proposed Drain
- Gutter
- Power Line
- Lamp Post
- Telephone Pole
- Tree

Client: Cuddalore - Municipality	**Notes:**	**Dwg. No.:** STC/CUD/	**Project:** Preparation of Detailed Project Report (DPR) Providing Integrated Storm Water Drains (SWDs) for Cuddalore Municipality
Consultants: STC Shah Technical Consultants (P) Ltd., Chennai		**Scale:** 1:1 (A1)	
		Date: Dec-2016	
		Drawn By: Punitha	**Title:** STRIP PLAN NELLIKUPPAM MAIN ROAD
		Checked By: L.Thiyagarajan	
		Approved By: D.Pari	



LEGEND

- Existing Drain
- Replacement Drain
- Proposed Drain
- Gutter
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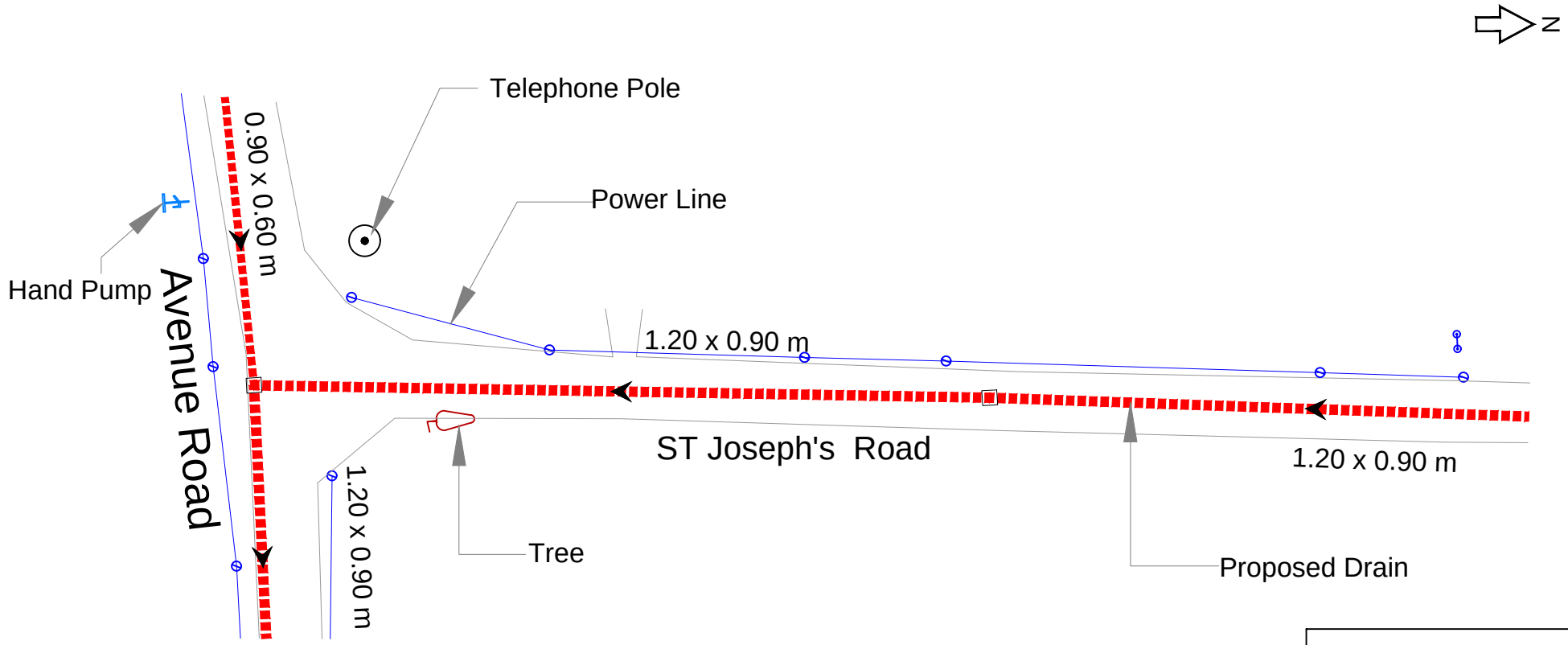
- Lamp Post
- Telephone Pole
- Tree

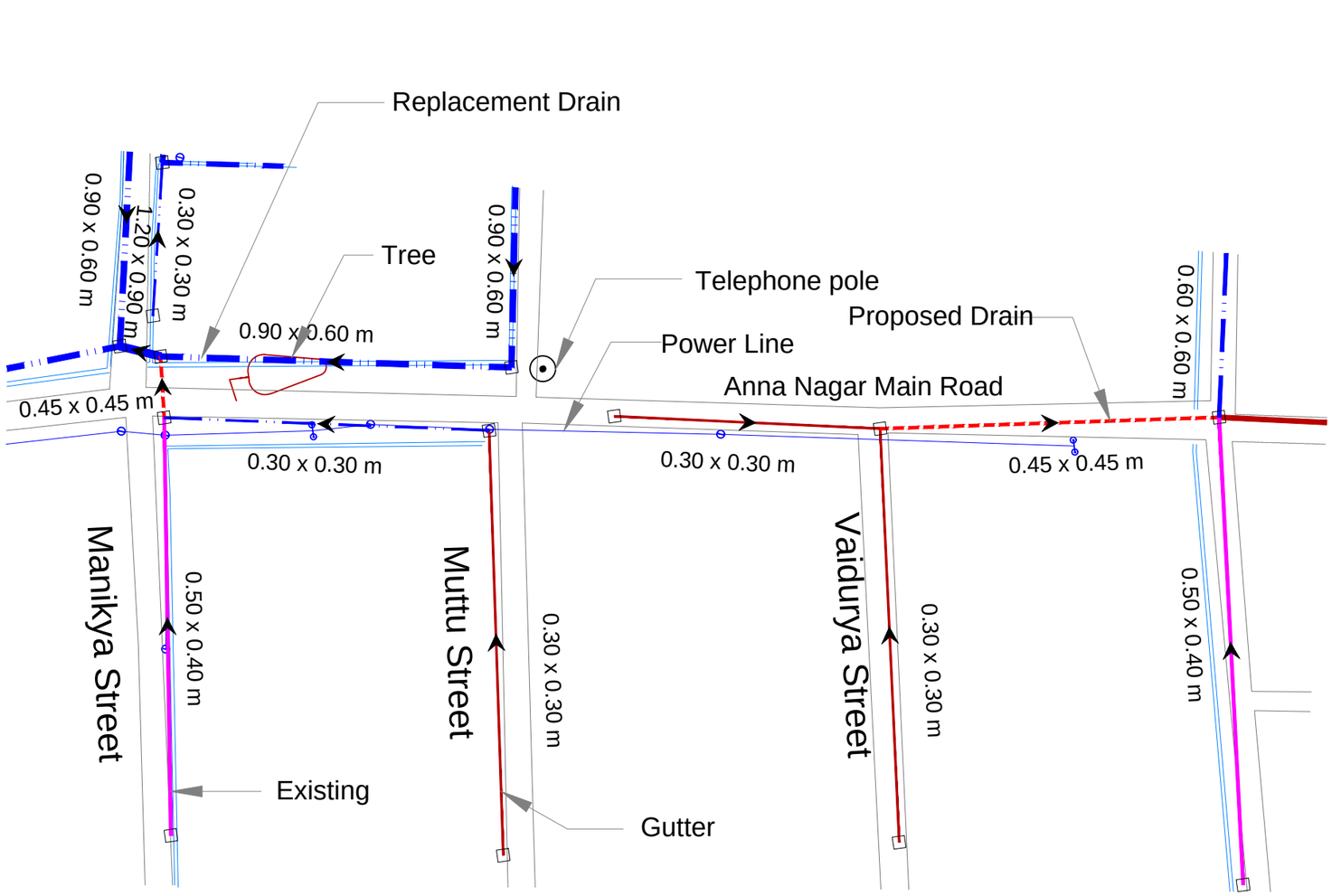
Client: **Cuddalore - Municipality**	Notes:	Dwg. No.: STC/CUD/	Project: Preparation of Detailed Project Report (DPR) Providing Integrated Storm Water Drains (SWDs) for Cuddalore Municipality
Consultants: STC **Shah Technical Consultants (P) Ltd., Chennai**		Scale: 1:1 (A1)	
		Date: Dec-2016	
		Drawn By: Punitha	Title: STRIP PLAN BHARATHI ROAD
		Checked By: L.Thiyagarajan	
		Approved By: D.Pari	



LEGEND

- Existing Drain
- Replacement Drain
- Proposed Drain
- Gutter
- Power Line
- Lamp Post
- Telephone Pole
- Tree

Client: Cuddalore - Municipality	Notes:	Dwg. No.: STC/CUD/	Project: Preparation of Detailed Project Report (DPR) Providing Integrated Storm Water Drains (SWDs) for Cuddalore Municipality
Consultants: STC Shah Technical Consultants (P) Ltd., Chennai		Scale: 1:1 (A1)	
		Date: Dec-2016	
		Drawn By: Punitha	Title: STRIP PLAN ST JOSEPH'S ROAD
		Checked By: L.Thiyagarajan	
		Approved By: D.Pari	

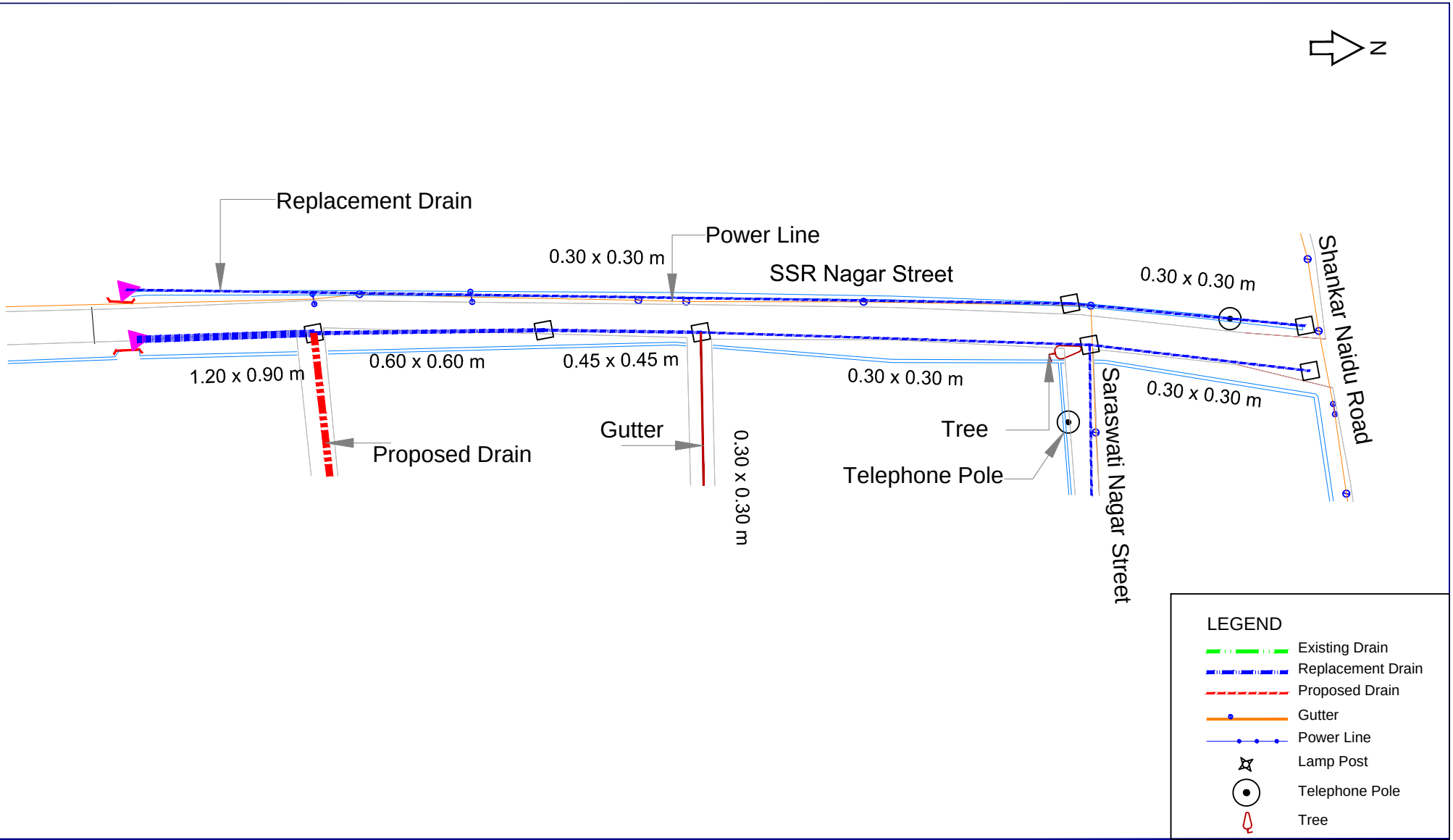


LEGEND

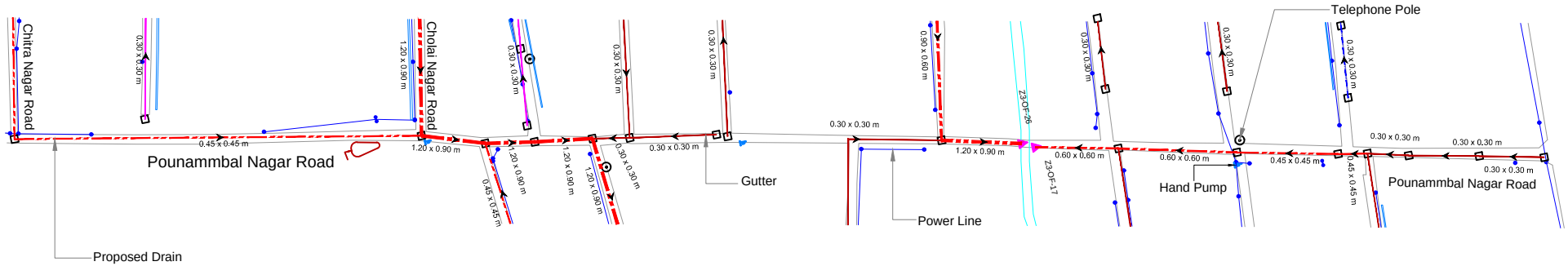
- Existing Drain
- Replacement Drain
- Proposed Drain
- Gutter
- Power Line
- Lamp Post
- Telephone Pole
- Tree

Client: Cuddalore - Municipality	Notes:	Dwg. No.: STC/CUD/	Project: Preparation of Detailed Project Report (DPR) Providing Integrated Storm Water Drains (SWDs) for Cuddalore Municipality
Consultants: STC Shah Technical Consultants (P) Ltd., Chennai		Scale: 1:1 (A1)	
		Date: Dec-2016	
		Drawn By: Punitha	Title: STRIP PLAN ANNA NAGAR MAIN ROAD
		Checked By: L.Thiyagarajan	
		Approved By: D.Pari	

Client: Cuddalore - Municipality	**Notes:**	**Dwg. No.:** STC/CUD/	**Project:** Preparation of Detailed Project Report (DPR) Providing Integrated Storm Water Drains (SWDs) for Cuddalore Municipality
Consultants: STC Shah Technical Consultants (P) Ltd., Chennai		**Scale:** 1:1 (A1)	
		Date: Dec-2016	
		Drawn By: Punitha	**Title:** STRIP PLAN KK NAGAR ROAD
		Checked By: L.Thiyagarajan	
		Approved By: D.Pari	



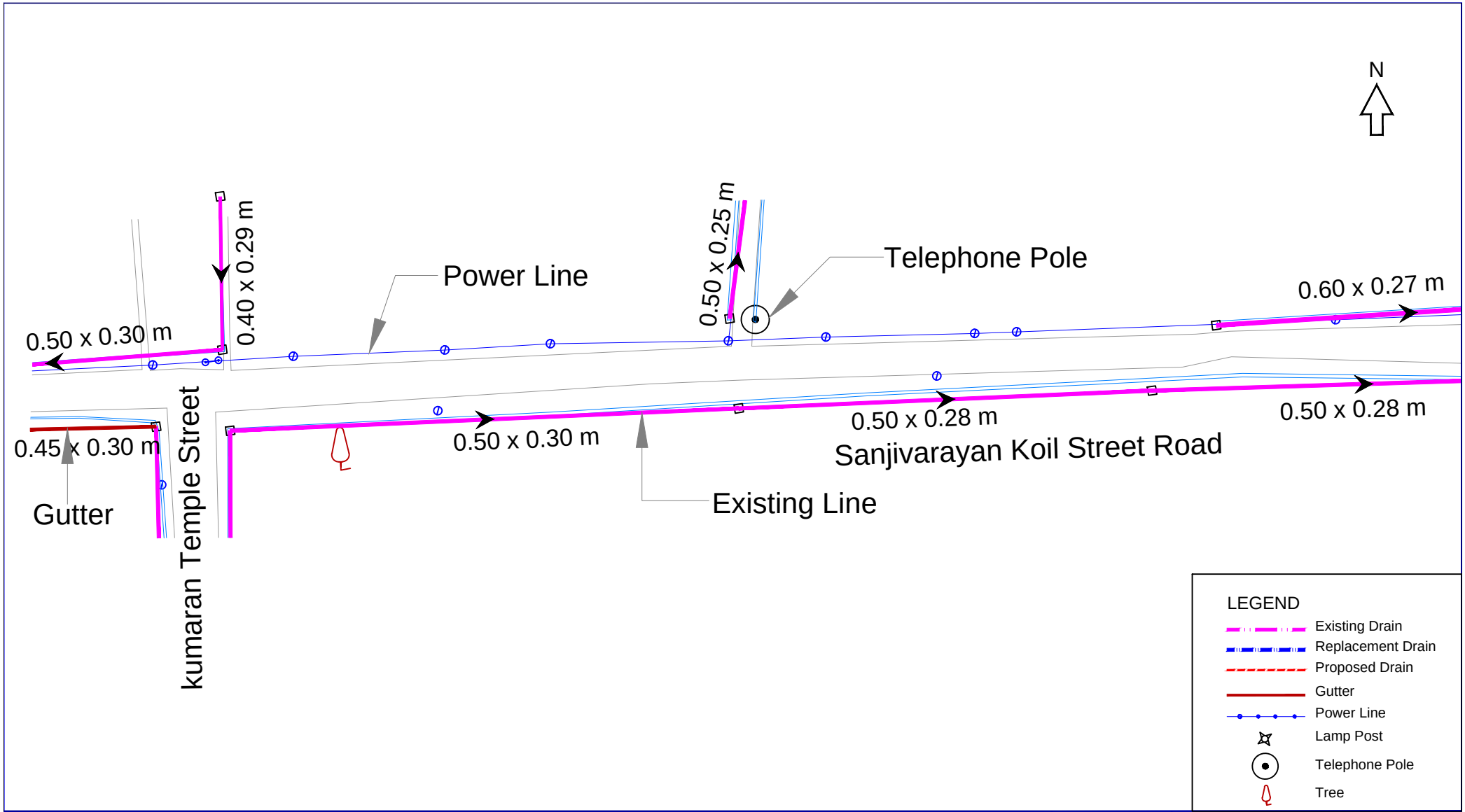
Client: Cuddalore - Municipality	**Notes:**	**Dwg. No.:** STC/CUD/	**Project:** Preparation of Detailed Project Report (DPR) Providing Integrated Storm Water Drains (SWDs) for Cuddalore Municipality
Consultants: STC Shah Technical Consultants (P) Ltd., Chennai		**Scale:** 1:1 (A1)	
		Date: Dec-2016	
		Drawn By: Punitha	**Title:** STRIP PLAN SSR NAGAR ROAD
		Checked By: L.Thiyagarajan	
		Approved By: D.Pari	



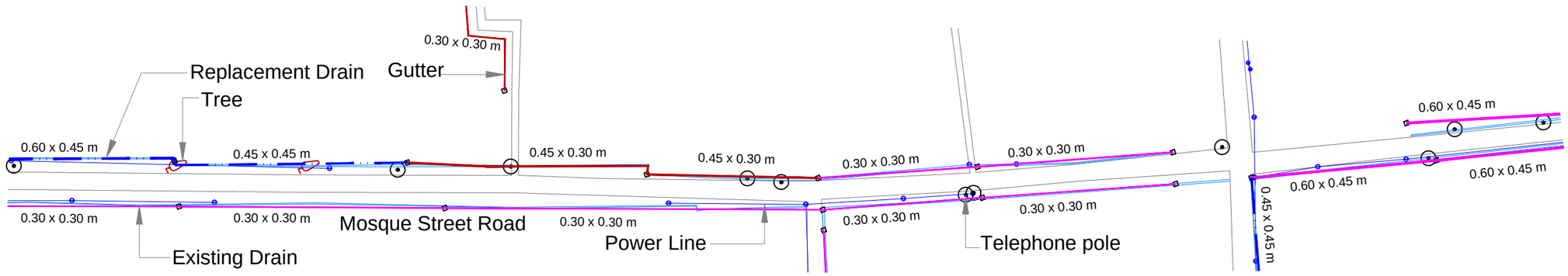
LEGEND

- Existing Drain
- Replacement Drain
- Proposed Drain
- Gutter
- Power Line
- Lamp Post
- Telephone Pole
- Tree

Client: Cuddalore - Municipality	**Notes:**	**Dwg. No.:** STC/CUD/	**Project:** Preparation of Detailed Project Report (DPR) Providing Integrated Storm Water Drains (SWDs) for Cuddalore Municipality
Consultants: STC Shah Technical Consultants (P) Ltd., Chennai		**Scale:** 1:1 (A1)	
		Date: Dec-2016	
		Drawn By: Ranjith	**Title:** STRIP PLAN POUNAMBAL NAGAR ROAD
		Checked By: L.Thiyagarajan	
		Approved By: D.Pari	



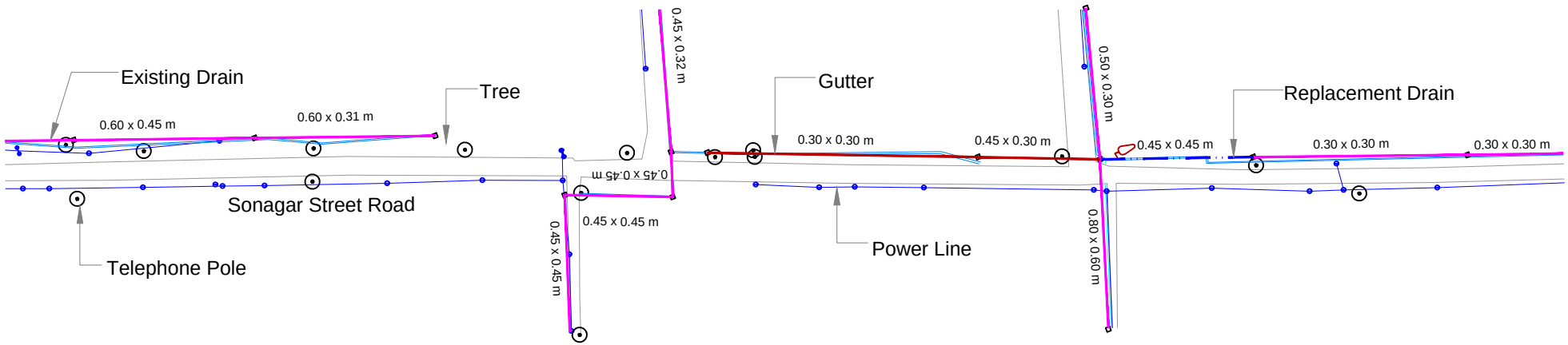
Client: Cuddalore - Municipality	**Notes:**	**Dwg. No.:** STC/CUD/	**Project:** Preparation of Detailed Project Report (DPR) Providing Integrated Storm Water Drains (SWDs) for Cuddalore Municipality
Consultants: STC Shah Technical Consultants (P) Ltd., Chennai		**Scale:** 1:1 (A1)	
		Date: Dec-2016	
		Drawn By: Punitha	**Title:** STRIP PLAN SANJIVARAYAN KOIL STREET
		Checked By: L.Thiyagarajan	
		Approved By: D.Pari	



LEGEND

- Existing Drain
- Replacement Drain
- Proposed Drain
- Gutter
- Power Line
- Lamp Post
- Telephone Pole
- Tree

Client: **Cuddalore - Municipality**	Notes:	Dwg. No.: STC/CUD/	Project: Preparation of Detailed Project Report (DPR) Providing Integrated Storm Water Drains (SWDs) for Cuddalore Municipality
		Scale: 1:1 (A1)	
		Date: Dec-2016	
Consultants: STC **Shah Technical Consultants (P) Ltd., Chennai**		Drawn By: Punitha	Title: STRIP PLAN MOSQUE STREET
		Checked By: L.Thiyagarajan	
		Approved By: D.Pari	



LEGEND

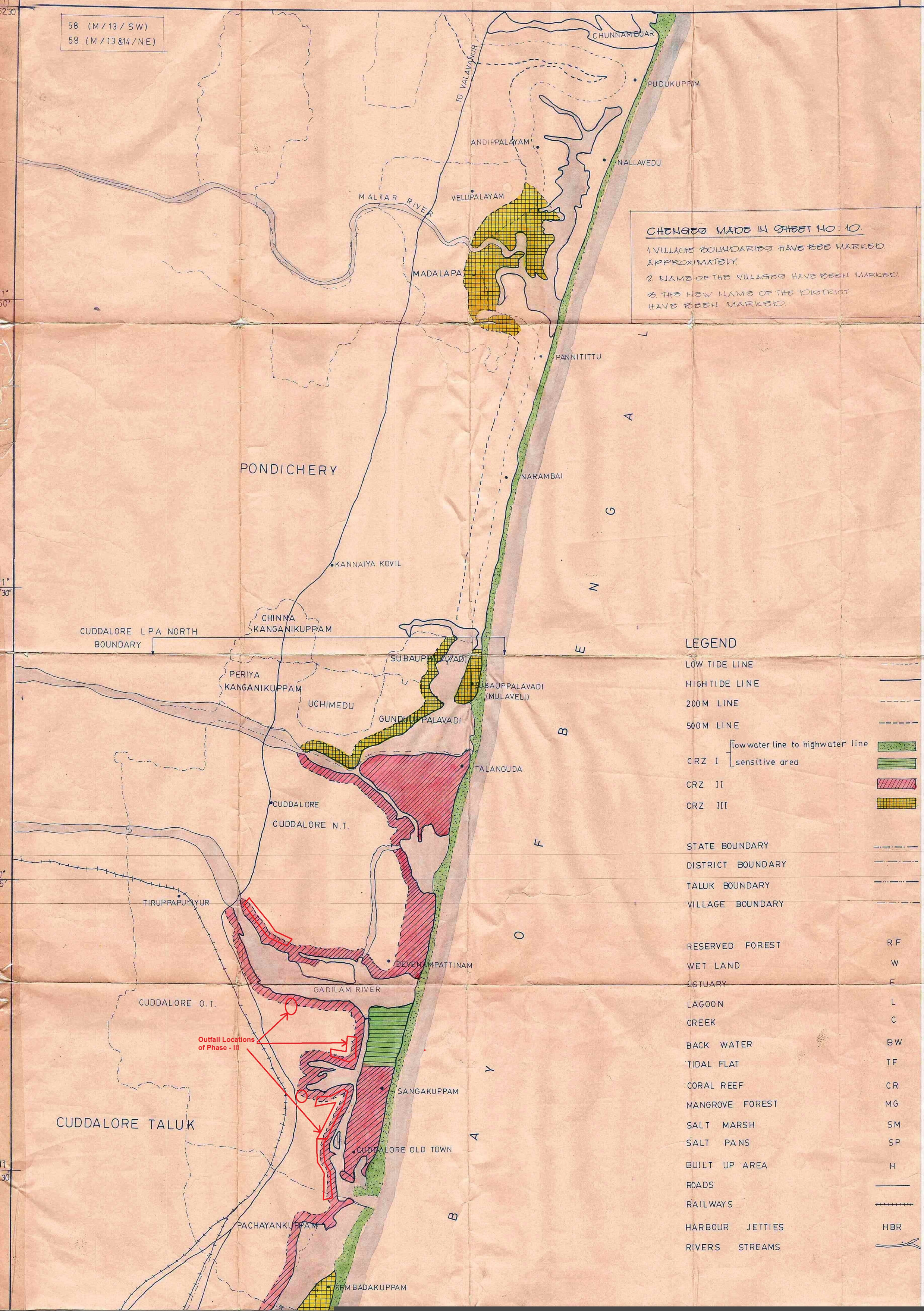
- Existing Drain
- Replacement Drain
- Proposed Drain
- Gutter
- Power Line
- Lamp Post
- Telephone Pole
- Tree

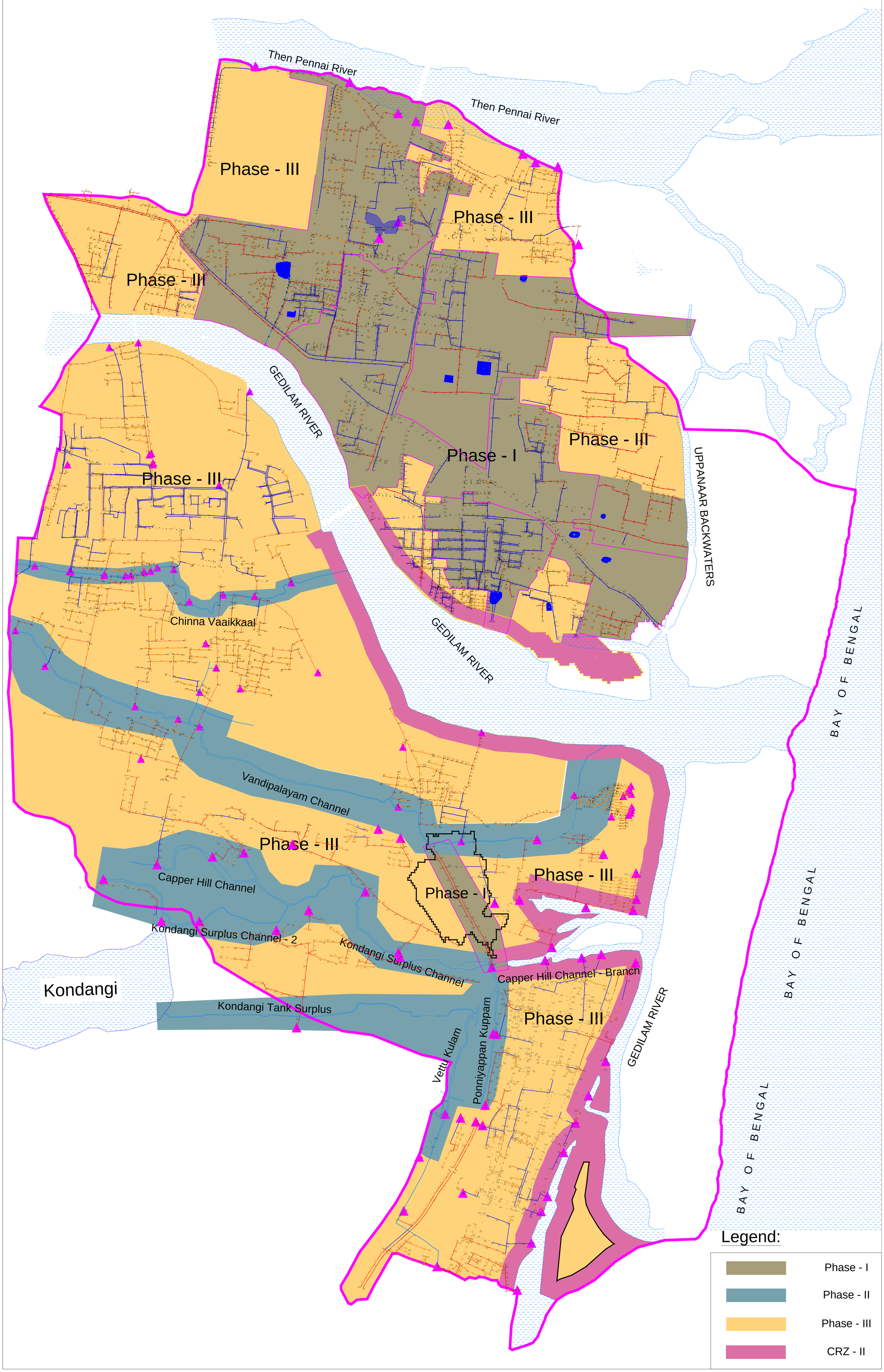
Client: Cuddalore - Municipality	**Notes:**	**Dwg. No.:** STC/CUD/	**Project:** Preparation of Detailed Project Report (DPR) Providing Integrated Storm Water Drains (SWDs) for Cuddalore Municipality
Consultants: STC Shah Technical Consultants (P) Ltd., Chennai		**Scale:** 1:1 (A1)	
		Date: Dec-2016	
		Drawn By: Punitha	**Title:** STRIP PLAN SONAGAR STREET
		Checked By: L.Thiyagarajan	
		Approved By: D.Pari	

Annexure 5 – Coastal Zone Management Plan

ANNEXURE V - COASTAL ZONE MANAGEMENT PLAN OF TAMILNADU

10



Annexure 5.1 - Storm Network marked in CZM Plan

CRZ Marked in Annexure 5.1 Storm Network