

BEFORE THE NATIONAL GREEN TRIBUNAL

SOUTHERN ZONE, CHENNAI

Original Application No. 124 of 2022 (SZ)

In

Appeal No. 12 of 2024 (SZ)

In

Appeal No. 24 of 2023 (SZ)

In

Appeal No. 30 of 2023 (SZ)

In the matter of:

B. Ramkumar Adityan,
S/o, Mr. R.Balakrishnan Adityan & Mrs. Selvarathi,
No. 563, Thoothukudi Road, Virapandianpattinam,
Tiruchendur, Thoothukudi District – 628 216

...Applicant

Versus

The Secretary,
Minister of Environment, Forest and
Climate Change and Others

...Respondents

REPORT FILED BY 3RD RESPONDENT- PUBLIC WORKS DEPARTMENT

INDEX

S. No.	Date	Description	Page No.
1.	19.06.2023	Final Approval by the Ministry of Environment and Forest for the Pen Monument	1 - 7
2.	-	Reply for the specific conditions for the pen monument	8 - 9
3.	-	Reply for the General conditions for the pen monument	10 - 13
4.	March 2023	Environmental Impact Assessment Report	14 - 349
5.	-	Shoreline Changes and Dredge Disposal Studies Final Report	350 - 382
6.	March 2023	Report on Construction, Detailing and Mitigation Measures	383 - 435
7.	April 2023	Road Connectivity & Traffic Management Plan	436 - 460
8.	April 2023	Crowd Management Plan Report	461 - 479
9.	April 2023	Emergency Evacuation Plan Report	480 - 515

(Note: The page numbers are at the top centre of every page)



Through

Dr. D. Shanmuganathan

Standing Counsel for Tamil Nadu

National Green Tribunal

Southern Zone, Chennai

DATE : 22.10.2024

F.No.11/20/2023-IA.III
Government of India
Ministry of Environment, Forest and Climate Change
IA-III Section (CRZ)

Indira Paryavaran Bhawan
Jor Bagh Road
New Delhi – 110003
Dated: 19th June, 2023

To

**The Public Works Department,
Government of Tamil Nadu,
Building Construction Division 1,
Chepauk, Chennai-600005
Tamil Nadu
Email: eebcddivision1@gmail.com**

Subject: Proposal for Construction of Muthamizh Arignar Dr. Kalaignar Pen Monument in Bay of Bengal, Off the Coastal of Marina Beach near Triplicane Village, Chennai District by the Public Works Department, Government of Tamil Nadu-CRZ Clearance regarding.

Sir,

This has reference to your proposal No. No.IA/TN/CRZ/425137/2022 dated 08th April, 2023 on the above mentioned project proposal for CRZ Clearance, in accordance with the provisions of the Coastal Regulation Zone (CRZ) Notification, 2011 issued under the Environment (Protection) Act, 1986.

2. The Ministry of Environment, Forest and Climate Change has examined the proposal for CRZ Clearance to the project for Construction of Muthamizh Arignar Dr. Kalaignar Pen Monument in Bay of Bengal, Off the Coastal of Marina Beach near Triplicane Village, Chennai District by the Public Works Department, Government of Tamil Nadu.

3. The proposal was considered by the Expert Appraisal Committee (EAC) for Infrastructure Development, Coastal Regulation Zone, Building / Construction and Miscellaneous projects, in its meeting held on 17th April, 2023. The project proponent and their consultant made detailed presentation and informed as under:

- (i) The proposal is for Construction of Muthamizh Arignar Dr. Kalaignar Pen Monument in Bay of Bengal, Off the Coastal of Marina Beach near Triplicane Village, Chennai District by the Public Works Department, Government of Tamil Nadu for promoting tourism.
- (ii) As per CRZ Notification 2011 the activity shall require clearance from MoEF&CC after being recommended by the concerned CZMA as per Para 4 (ii) (j) construction of memorials/ monuments and allied facilities by the concerned State Government in CRZ-IV (A) areas, in exceptional cases, with adequate environmental safeguards etc.
- (iii) The Terms of Reference (ToR) was considered in 307th EAC meeting held on 24th August 2022, in the Ministry of Environment, Forest and Climate Change, New Delhi. TOR was granted on 15th September, 2022 with specified conditions.
- (iv) The Public Hearing was conducted on 31/01/2023 by District Collector Chennai at Kalaivanar Arangam, 1 Wallahjah Road Anna Salai Triplicane, Chennai, Tamil Nadu.



- (v) The proposed project falls under CRZ IA, CRZ II, and CRZ IV-A. The CRZ Classification as:

S. No.	Description	Area in Sq.m	CRZ classification
1	Pen Pedestal	2263.08	CRZ IV-A
2	Pedestrian Pathway Above Sea	2073.01	CRZ IV-A
3	Lattice Bridge Above Beach & Land	1856.00	CRZ IA, Partially-CRZ-II, and CRZ IV-A
4	Pedestrian Pathway in Beach	1610.60	CRZ II
5	Pedestrian Pathway from Muthamizh Arignar Dr. Kalaignar Memorial to Bridge through beach	748.44	CRZ II
Total area		8551.13	

- (vi) The centre coordinates of the proposed site as per IRS Map are:

S. No.	Latitude	Longitude
A	13° 3'53.794"N	80°17'9.182"E
B	13° 3'55.109"N	80°17'11.732"E
C	13° 3'54.365"N	80°17'16.132"E
D	13° 3'53.725"N	80°17'19.908"E
E	13° 3'52.008"N	80°17'30.015"E
F	13° 3'51.537"N	80°17'32.802"E

- (vii) The Pen Monument is 30 m height (6 m pedestal above the HTL).
- (viii) The total length of the Bridge: Over the Land and intertidal area-290 m (220 m in CRZ II and 70 m in CRZ IA Intertidal area (No construction), Over the Sea-360 m – CRZ IVA and width of the Bridge is 7.0 m.
- (ix) The water requirement: Construction Phase: The total water requirement will be ~ 15 KLD (Domestic:~5 KLD, Construction purpose: ~ 10 KLD) and source of water is through Metro water tankers and Operation Phase: Domestic: ~ 5 KLD and supplied through water dispensers for drinking purpose.
- (x) The power requirement: Construction Phase: 500 kVA and sourced from TANGEDCO and 125 kVA for power backup, Operation Phase: Power supply and DG backup for lighting load, 100 kV Sourced from TANGEDCO. The DG set will be equipped from existing Memorial (which got its clearance from TNSCZMA dated 06/01/2021 and it is under construction. Approximately 185 Kw will be generated through solar panels, which will be installed on the roof of the lattice bridge.
- (xi) The Solid Waste: Construction Phase: Approximately 45.0 kg/day of municipal waste will be generated in premises will be disposed in municipal corporation bins on daily basis, Operation Phase: Approximately 98.0 kg/day of municipal waste will be generated in the premises shall be disposed through municipal/corporation bins on daily basis. All the domestic sewage facilities will be provided in the Muthamizh Arignar Kalaignar Memorial.
- (xii) The INS Adyar (defence installation) 0.81 Km from the project site.
- (xiii) A greenbelt programme will improve the ecological condition of the region. The greenbelt area is 921 Sq.m (10.77%) out of the total area 8551.00 Sq.m.

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- (xiv) Environment Management Plan: Social Environment: Fishermen can engage in their fishing activities even during the construction period. It will become an internationally acclaimed landmark tourism site. Overall aesthetics of the project site and around the Marina Beach will be improved and its positive impacts - direct and indirect employment will be generated.
- (xv) Marine Ecology: The proposed project doesn't involve any dredging and construction methodology utilise modernized equipment for piling operations for the foundation of the project, using encased drilling equipment. Debris trap, silt curtain will be used to prevent spillage of debris and waste into the sea.
- (xvi) The pedestrian bridge has been designed so as not to disturb the movement of fishing boats. Pillars spacing -16 m) (Height from sea level to pedestrian bridge 6.0m). The lattice bridge has been designed so that no pillars will be erected in the CRZ IA area of about 70 mts. There is clear passage for all the marine fauna to have access to the sandy areas including turtles, fishing boats and human movement.
- (xvii) For sand accumulation and Erosion, no dredging is required for proposed project; as it is open construction in situ piling. Due to the use of modern construction equipment, there will be no concrete spillage.
- (xviii) Sporadic nesting of sea turtle has been reported from Ennore to Tiruvanmiyur coastal area. However, care will be taken to monitor the nesting during the construction and mitigation measures will be implemented. During the nesting period of Olive Ridley Turtles i.e. from January to March no construction activity will be carried out in CRZ IA area and adjacent beaches. No illumination will be done during night time.
- (xix) The road connectivity to the project site and impact on the existing traffic network and Emergency Evacuation Plan during natural calamity/manmade is prepared by Joint Venture of CUBE and IIT Madras by analysing present and anticipated traffic.
- (xx) Major concerns during the Public Hearing and its compliance:

Major concerns during the PH and Post Public Hearing representations	Compliance by PP
Impact on Marine Ecology and fishing potentiality	The impact on various aspects of ecology among the marine life, life of turtles, prawns etc., have been studied in detail by accredited experts and researchers and based on their recommendation; all necessary steps would be taken to minimize the impact on ecology due to this project.
Shoreline Analysis with erosion and accretion	From the studies and report of NCCR, the project coastal region is Low Accretion Zone.
Construction of structures in CRZ IA	The construction in CRZ 1A is through stilts and lattice bridge without any obstruction to natural flow of water or sediments or marine organisms.
Affecting the livelihood of the fishermen	The proposed project doesn't affect livelihood of fishermen, as fishing vessels can operate beyond bridge region and bridge is constructed on pillars with large spans of around 16 m for free flow of water, sediment and marine organisms.



Financial and Social Impacts	All the opinions are noted, it will become an internationally acclaimed landmark tourism site, positive impacts – Direct and Indirect employment will be generated and overall aesthetics of the project site in and around the Marina Beach will be improved.
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- (xxi) Total Manpower requirement during the Construction Phase: 100 and Operation Phase:30.
- (xxii) The total cost of the project ₹81 Crore.
- (xxiii) The Tamil Nadu State Coastal Zone Management Authority (TNSCZMA) has recommended the proposal for CRZ clearance *vide* letter No. 2914/EC.3/2023-1, dated 06/04/2023.

4. The EAC deliberated on the proposal. The Committee noted that the activity is a permissible as per CRZ Notification 2011 and require prior CRZ clearance; Erosion and accretion should continue to be monitored by NCCR and NOC should be obtained from INS Adyar which is 0.81 Km away from the project site. The Committee also noted the representations received pre and post Public Hearing by the Ministry and forwarded to the PP, deliberated / discussed in detail during the meeting along with letters provided by State Forest and Ministry of Fisheries, Animal Husbandry and Dairying (Departments of Fisheries) and different Association on the points raised in representations. As the PP intimated that some court cases notice / intimation has been received on the project but no stay / direction has been given by any of the Courts, however, the Committee suggested that, if any court directions related to the project is received, the PP shall act according to the court directions. The Committee also advised to PP should submit immediately revised road connectivity and Traffic Management Plan and Crowd Management Plan & Emergency Evacuation Plan (EEP), plan of dedicated pathway for the rescue team and during emergency, entry shall be controlled by the automated system. The same has been submitted by PP *vide* e-mail dated 18/04/2022 and circulated to all EAC members including MoEF&CC. The Committee found that the additional information submitted by the project proponent through e-mail is satisfactory and considered.

The Committee after detailed deliberations, considering the submissions made by the project proponent and recommendations of the Tamil Nadu CZMA, recommended the proposal for CRZ Clearance.

5. Based on the recommendation of the Tamil Nadu Coastal Zone Management Authority and considering the submissions made by the project proponent, the Ministry of Environment, Forest and Climate Change, in acceptance of the recommendations of the Expert Appraisal Committee (CRZ), hereby accords CRZ Clearance to the proposal for **Construction of Muthamizh Arignar Dr. Kalaignar Pen Monument in Bay of Bengal, Off the Coastal of Marina Beach near Triplicane Village, Chennai District by the Public Works Department, Government of Tamil Nadu** under the provisions of the CRZ Notification, 2011 and amendments thereto, subject to the compliance of terms and conditions as under:-

PART A – SPECIFIC CONDITIONS:

- (i) All construction shall be strictly in accordance with the provisions of the CRZ Notification, 2011, as amended from time to time.
- (ii) NOC should be obtained from INS Adyar prior to commencement of construction.
- (iii) Monitoring of Erosion and accretion studies should be conducted and same should be submitted to Regional Office.
- (iv) Any temporary physical infrastructure setup and excavated material during construction of the project shall not be dumped in water bodies or adjacent areas

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and the site shall be restored to its original condition after completion of construction of work.

EB - (v)

The road connectivity and Traffic Management Plan as submitted to implemented in totality and compliance report should be submitted to Regional Office.

EB - (vi)

The Crowd Management Plan & Emergency Evacuation Plan (EEP) as submitted to be implemented in totality and compliance report should be submitted to Regional Office on six monthly basis.

(vii)

Management of the visitors will be strictly through access controlled and regulated to maintain the number of visitors at any given point of time as stated in the crowd management plan

RO (viii)

There will be no construction activity in the areas of turtle nesting, if any, during the turtle nesting season from 1st January to 30th April of every year.

(ix)

No groundwater shall be extracted within the CRZ area to meet the water requirements during the construction and/or operation phase of the project.

(x)

Permanent labour camp, machinery and material storage shall not be set up in the CRZ area.

(xi)

The project proponents will certify that there is no legal restriction on the proposed project activities at the proposed site.

(xii)

The Project Proponent should comply order / direction, if any, issued by Hon'ble Court / tribunal on the project.

(xiii)

This CRZ Clearance letter is subject to final order of the Hon'ble National Green Tribunal (Southern Zone) I.A. No. 181/2022 and other cases, if any.

(xiv)

All the conditions stipulated by the Tamil Nadu Coastal Zone Management Authority for CRZ clearance 2011 vide letter No. 2914/EC.3/2023-1, dated 06/04/2023 and commitments made by the PP before the TN CZMA and EAC shall be followed in letter and spirit. An expert monitoring committee should be set up during implementation of the project.

(xv)

All necessary clearance from the concerned authority, as may be applicable should be obtained prior to commencement of project or activity

PART B - GENERAL CONDITIONS:

(i).

Management of solid waste in accordance with the Solid Waste Management Rules, 2016 shall be strictly implemented.

(ii).

'Consent to Establish' and /or 'Consent to Operate' shall be obtained from State Pollution Control Board under the provisions of Air (Prevention and Control of Pollution) Act, 1981 and / or the Water (Prevention and Control of Pollution) Act, 1974, as may be applicable.

(iii).

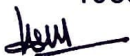
Disposal of muck during construction phase should not create any adverse effect on the neighbouring communities and be disposed taking the necessary precautions for general safety and health aspects of people, only in approved sites with the approval of Competent Authority.

(iv).

All liquid waste arising from the proposed development will be disposed of as per the norms prescribed by Central / State Pollution Control Board. There shall not be any disposal of untreated effluent into the sea / coastal water bodies. It shall be ensured that the wastewater generated is treated in the STP as committed by the project proponent. The treated waste water shall be reused for landscaping, flushing and / or HVAC cooling purposes etc. within the development. The project proponent should also make alternate arrangement for situation arising due to malfunctioning of STP. There shall be regular monitoring of standard parameters of the effluent discharge from STP under intimation to the SPCB.

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- (v). Any hazardous waste generated during construction phase, shall be disposed off as per applicable rules and norms with necessary approvals of the State Pollution Control Board.
- (vi). A copy of the clearance letter shall be uploaded on the website of the concerned State Coastal Zone Management Authority/State Pollution Control Board. The Clearance letter shall also be displayed at the Regional Office, District Industries Centre and Collector's Office/ Tehsildar's office for 30 days.
- (vii). A six-monthly monitoring report shall need to be submitted by the project proponent to the concerned Regional Office of this Ministry regarding the implementation of the stipulated conditions.
- (viii). The Ministry of Environment, Forest & Climate Change or any other Competent Authority may stipulate any additional conditions or modify the existing ones, if necessary in the interest of environment and the same shall be complied with.
- (ix). Full co-operation shall be extended to the officials from the Regional Office of MoEF&CC, during monitoring of implementation of environmental safeguards stipulated. It shall be ensured that documents/data sought pertinent is made available to the monitoring team. A complete set of all the documents submitted to MoEF&CC shall be forwarded to the concerned Regional Office of MoEF&CC.
- (x). In the case of any change(s) in the scope of the project, the project would require a fresh appraisal by this Ministry.
- (xi). The Ministry reserves the right to add additional safeguard measures subsequently, if considered necessary, and to take action to ensure effective implementation of the suggested safeguard measures in a time bound and satisfactory manner, including revoking of the environment clearance under the provisions of the Environmental (Protection) Act, 1986, for non-compliance.
- (xii). All other statutory clearances such as the approvals for storage of diesel from Chief Controller of Explosives, Fire Department, Civil Aviation Department, Forest Conservation Act, 1980 and Wildlife (Protection) Act, 1972 etc. shall be obtained, as applicable by project proponent from the respective Competent Authorities.
- (xiii). The project proponent should advertise in at least two local Newspapers widely circulated in the region, one of which shall be in the vernacular language informing that the project has been accorded CRZ Clearance and copies of clearance letters are available with the State Pollution Control Board (SPCB) and may also be seen on the website of the Ministry of Environment, Forest and Climate Change at <https://parivesh.nic.in/>. The advertisement should be made within Seven days from the date of receipt of the Clearance letter and a copy of the same should be forwarded to the concerned Regional Office of this Ministry.
- (xiv). A copy of the clearance letter shall be sent by the proponent to concerned Panchayat, Zilla Parisad/Municipal Corporation, Urban Local Body and the Local NGO, if any, from whom suggestions/ representations, if any, were received while processing the proposal.
- (xv). The proponent shall upload the status of compliance of the stipulated conditions, including results of monitored data on their website and shall update the same periodically. It shall simultaneously be sent to the Regional Office of MoEF&CC, the respective Zonal Office of CPCB and the SPCB.
- (xvi). The environmental statement for each financial year ending 31st March in Form-V as is mandated to be submitted by the project proponent to the concerned State Pollution Control Board as prescribed under the Environment (Protection) Rules, 1986, as amended subsequently, shall also be put on the website of the project



proponent along with the status of compliance of clearance conditions and shall also be sent to the respective Regional Office of the Ministry by e-mail.

6. This Clearance is subject to final order of the Hon'ble Supreme Court of India in the matter of Goa Foundation Vs Union of India in Writ Petition (Civil) No.460 of 2004 as may be applicable to this project.

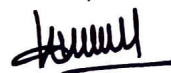
7. The Ministry reserves the right to stipulate additional conditions, if found necessary at subsequent stages and the project proponent shall implement all the said conditions in a time bound manner. The Ministry may revoke or suspend the CRZ clearance, if implementation of any of the above conditions is not found satisfactory.

8. Concealing factual data or submission of false/fabricated data and failure to comply with any of the conditions mentioned above may result in withdrawal of this clearance and attract action under the provisions of the Environment (Protection) Act, 1986.

9. Any appeal against this CRZ clearance shall lie with the National Green Tribunal, if preferred, within a period of 30 days as prescribed under Section 16 of the National Green Tribunal Act, 2010.

10. The above conditions shall be enforced, *inter-alia* under the provisions of the Water (Prevention & Control of Pollution) Act, 1974, the Air (Prevention & Control of Pollution) Act, 1981, the Environment (Protection) Act, 1986, Hazardous and Other Wastes (Management and Transboundary Movement) Rules, 2016 and the Public Liability Insurance Act, 1991 along with their amendments and Rules and any other orders passed by the Hon'ble Supreme Court of India / High Courts and any other Court of Law relating to the subject matter.

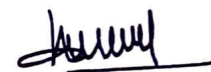
11. This issues with approval of the Competent Authority.



(Dr. H. Kharkwal)
Scientist 'E' (CRZ)

Copy to:

1. The Principal Secretary, Department of Environment and Climate Change, Government of Tamil Nadu, No.1, Jeenis Road, Panagal Building, Ground Floor, Saidapet, Chennai-600015, Tamil Nadu.
2. The Deputy DGF (C), Ministry of Environment, Forest and Climate Change, Integrated Regional Office, 1st and 11nd Floor, Handloom Export Promotion Council, 34, Cathedral Garden Road, Nungambakkam Chennai – 600034, Tamil Nadu.
3. The Member Secretary, Tamil Nadu Coastal Zone Management Authority, Department of Environment, Government of Tamil Nadu, Ground Floor, Panagal Building, Saidapet, Chennai-600015, Tamil Nadu.
4. The Member Secretary, Central Pollution Control Board, Parivesh Bhawan, CBD-cum-Office Complex, East Arjun Nagar, Delhi – 110032
5. The Member Secretary, Tamil Nadu Pollution Control Board, 76, Mount Salai, Guindy, Chennai – 600032, Tamil Nadu.
6. Guard File / Monitoring File / Website / Record File



(Dr. H. Kharkwal)
Scientist 'E' (CRZ)

**PROPOSED CONSTRUCTION OF MUTHAMIZH ARIGNAR DR. KALAINAR PEN MONUMENT IN
BAY OF BENGAL OFF THE COAST OF MARINA BEACH NEAR TRIPLICANE VILLAGE,
CHENNAI DISTRICT.**

GRANT OF CRZ CELARANCE BY MoEF & CC

COMPLIANCE OF TERMS AND CONDITIONS:

S.NO	SPECIFIC CONDITIONS	REPLY
I.	All construction shall be strictly in accordance with the provisions of the CRZ Notification, 2011, as amended from time to time.	Will be complied with.
II.	NOC should be obtained from INS Adyar prior to commencement of construction.	Already a letter of request submitted INS Adyar.
III.	Monitoring of erosion and accretion studies should be conducted and same should be submitted to Regional Office.	Erosion and Accretion studies would be conducted by NCCR during and after the implementation phase.
IV.	Any temporary physical infrastructure setup and excavated material during construction of the project shall not be dumped in water bodies or adjacent areas and the site shall be restored to its original condition after completion of construction of work.	Will be complied with.
V.	The road connectivity and Traffic Management plan as submitted to implemented in totality and compliance report should be submitted to Regional Office.	Road connectivity studies and Traffic Management Plans is being evolved by Centre for Urbanization, Building & Environment (CUBE), a JV unit of IIT Madras and Government of Tamil Nadu.
VI.	The Crowd Management Plan & Emergency Evacuation Plan (EEP) as submitted to be implemented in totality and compliance report should be submitted to Regional Office on six months basis.	Crowd Management Plan and Emergency Evacuation Plan is being evolved by Centre for Urbanization, Building & Environment (CUBE), a JV unit of IIT Madras and Government of Tamil Nadu.
VII.	Management of the visitors will be strictly through access controlled and regulated to maintain the number of visitors at any given point of time as stated in the Crowd Management Plan	Will be complied with.
VIII.	There will be no construction activity in the areas of turtle nesting, if any, during the turtle nesting season from 1 st January to 30 th April of every year.	Will be scrupulously followed and complied.
IX.	No groundwater shall be extracted within the CRZ area to meet the water requirements	Will be scrupulously followed and complied.

	during the construction and /or operation phase of the project.	
X.	Permanent labour camp, machinery and material storage shall not be set up in the CRZ area.	Labour camps will be setup outside of the CRZ area.
XI.	The project components will certify that there is no legal restrictions on the proposed project activities at the proposed site.	Will be complied with.
XII.	The Project Proponent should comply order/ direction, if any, issued by Hon'ble Court/ tribunal on the project.	Will be complied in letter and spirit.
XIII.	This CRZ clearance letter is subject to final order of the Hon'ble National Green Tribunal (Southern Zone) I.A.No.181/2022 and other cases, if any.	Accepted.
XIV.	All the conditions stipulated by the Tamil Nadu Coastal Zone Management Authority for CRZ clearance 2011 vide letter no. 2914/EC.3/2023-1, DATED 06/04/2023 and commitments made by the PP before the TNCZMA and EAC shall be followed in letter and spirit. An expert monitoring committee should be set up during implementation of the project	Will be complied. The Expert Monitoring Committee (EAC) including IIT, NCCR, CUBE & other agencies will set up prior to the implementation of the project.
XV.	necessary clearance from the concerned authority, as may be applicable should be obtained prior to commencement of project or activity	All necessary clearances from all concerned statutory bodies will be obtained prior to be commencement of the project.

**PROPOSED CONSTRUCTION OF MUTHAMIZH ARIGNAR DR. KALAINAR PEN
MONUMENT IN BAY OF BENGAL OFF THE COAST OF MARINA BEACH NEAR TRIPPLICANE
VILLAGE, CHENNAI DISTRICT.**

GRANT OF CRZ CELARANCE BY MoEF & CC

COMPLIANCE OF TERMS AND GENERAL CONDITIONS:

S.NO	GENERAL CONDITONS	REPLY
I.	Managements of solid waste in accordance with the Solid Waste Management Rules 2016 shall be strictly implemented.	Will be strictly implemented during the construction phase.
II.	'Consent to Establish' and/ or 'Consent to Operate' shall be obtained from State Pollution Control Board under the provisions of Air (Prevention and Control of Pollution) Act, 1981 and/ or the Water (Prevention and Control of Pollution) Act, 1974, as may be applicable.	Will be obtained from the Tamil Nadu Pollution Control Board (TNPCB)
III.	Disposal of muck during construction phase should not create any adverse effect on the neighbouring communities and be disposed taking the necessary precautions for general safety and health aspects of people, only in approved sites with the approval of Competent Authority.	Mud obtained from the construction phase will be removed and conveyed to far off places and disposed of as per the guidelines of various environmental regulations and standard procedures with approval of competent authority.
IV.	All liquids waste arising from the proposed development will be disposed of as per the norms prescribed by central/ state pollution control Board. There shall not be any disposal of untreated effluent into the sea/coastal water bodies. It shall be ensured that the wastewater generated is treated in the STP as committed by the project proponent. The treated waste water shall be reused for landscaping, flushing and/or HVAC Cooling purposes etc., within the development. The project proponent should also make alternate arrangement for situation arising due to malfunctioning of	No liquid waste anticipated during the construction phase however regular monitoring carried out and all necessary action will be taken as per standard procedures.

	STP. There shall be regular monitoring as standard parameters of the effluent discharge from STP under intimation to the SPCB.	
V.	Any hazardous waste generated during construction phase, shall be disposed off as per applicable rules and norms with necessary approvals of the State Pollution Control Board.	No hazardous waste materials proposed to be used for the construction however necessary vigilant monitoring would be enforced and hazardous materials any generated will be disposed of using standard procedures as approved by the Tamil Nadu Pollution Control Board (TNPCB).
VI.	A copy of the clearance letter shall be uploaded on the websites of the concerned State Coastal Zone Management Authority/ State Pollution Control Board. The Clearance letter shall also be displayed at the Regional Office, District Industries Centre and Collector's Office/ Tehsildar's office for 30 days	Complied with.
VII.	A six- monthly monitoring report shall need to be submitted by the project proponent to the concerned Regional Office to this Ministry regarding the implementation of the stipulated conditions.	Will be complied with.
VIII.	The Ministry of Environment, Forest & Climate change or any other competent Authority may stipulate any additional conditions or modify the existing ones, if necessary in the interest of environment and the same shall be complied with.	Will be complied with.
IX.	Full co-operation shall be extended to the officials from the Regional Office of MoEF&CC, during monitoring of implementation of environmental safeguards stipulated. It shall be ensured that documents/data sought pertinent is made available to the monitoring team. A complete set of all the documents submitted to MoEF&CC shall be forwarded to the concerned Regional Office of MoEF&CC.	Will be complied with.

X.	In the case of any change(s) in the scope of the project, the project would require a fresh appraisal by this Ministry.	Will be complied with.
XI.	The Ministry reserves the right to add additional safeguard measures subsequently, if considered necessary, and to take action to ensure effective implementation of the suggested safeguard measures in a time bound and satisfactory manner, including revoking of the environment clearance under the provisions of the Environment (Protection) Act, 1986, for non-compliance.	Will be complied with in total.
XII.	All other statutory clearances such as the approvals for storage of diesel from Chief Controller of Explosives, fire Department, Civil Aviation Department, Forest Conservation Act, 1980 and Wildlife (Protection) Act, 1972 etc., shall be obtained, as applicable by project proponent from the respective Competent Authorities.	Will be complied with in total.
XIII.	The project proponent should advertise in at least two local newspapers widely circulated in the region, one of which shall be in the vernacular language informing that the project has been accorded CRZ Clearance and copies of clearance letters are available with the State Pollution Control Board (SPCB) and may also be seen on the website of the Ministry of Environment, Forest and Climate Change at https://parivesh.nic.in/ . The advertisement should be made within seven days from the date of receipt of the Clearance letter and a copy of the same should be forwarded to the concerned Regional Office of this Ministry.	Will be complied with.

XIV.	A copy of the clearance letter shall be sent by the proponent to concerned Panchayat, Zilla Parisad/Municipal Corporation, urban Local Body and the Local NGO, if any, from whom suggestions/ representations, if any, were received while processing the proposal.	Will be complied with.
XV.	The proponent shall upload the status of compliance of the stipulated conditions, including results of monitored data on their websites and shall update the same periodically. It shall simultaneously be sent to the Regional Office of MoEF&CC, the respective Zonal Office of CPCB and the SPCB.	Will be complied with.
XVI.	The environmental statement for each financial year ending 31 st March in Form-V as is mandated to be submitted by the project proponent to the concerned State Pollution Control Board as prescribed under the Environment (Protection) Rules, 1986, as amended subsequently, shall also on the websites of the project proponent along with the status if compliance of clearance conditions and shall also be sent to the respective Regional Office of the Ministry by e-mail.	Will be complied with.

Environmental Impact Assessment Report

For

**Proposed Construction of Muthamizh Arignar Dr.Kalaignar Pen
Monument in Bay of Bengal off the Coast of Marina Beach near
Triplicane Village, Chennai District**

By

**Public Works Department
Building Construction Division 1
Chepauk, Chennai-600 005**

Report Prepared by



HUBERT ENVIRO CARE SYSTEMS (P) LTD, CHENNAI

MARCH 2023

Declaration by the Project Proponent

M/s. Public Works Department declaration/ undertaking that the contents (information and data) of EIA report preparation for the “Proposed construction of Muthamizh Arignar Dr.Kalaignar Pen Monument in Bay of Bengal off the Coast of Marina Beach near Triplicane Village, Chennai District” and the information and content provided in the report are factually correct.

For, M/s.Public Works Department

TABLE OF CONTENTS

1.	INTRODUCTION.....	13
1.1	Purpose of the Report	13
1.2	Identification of Project & Project Proponent	13
1.3	Need of the Project	14
1.4	Brief Description of Project	14
1.4.1	Nature and Size of the Project	14
1.4.2	Location of the Project	15
1.5	Project Cost	17
1.6	Scope of the study	17
1.7	ToR Compliance	19
1.7.1	Specific ToR Compliance	19
2.	PROJECT DESCRIPTION	94
2.1	Need of the Project	94
2.2	Project Location	94
2.3	Size and Magnitude of the Project	95
2.4	Project Details & Requirement	96
2.5	Building Materials	102
2.6	Water Requirement	102
2.7	Wastewater Generation and Treatment	102
2.8	Fire- fighting System	103
2.9	Solid Waste Management	103
3.	DESCRIPTION OF BASELINE ENVIRONMENT	105
3.1	Introduction	105
3.2	Study Area	105
3.3	Description of the Study Area	106
3.4	Environmentally/Ecologically Sensitive areas	109
3.5	Physical Conditions	113
3.6	Air Environment	133

3.6.1	Meteorological Conditions	134
3.6.2	Meteorological Data Collection	134
3.6.3	General Meteorological Scenario based on IMD Data	134
3.6.4	Ambient Air Quality	138
3.7	Noise Environment	145
3.8	Water Environment	148
3.9	Ground water resources	159
3.10	Soil as a resource and its Quality	166
3.10.1	Results and Discussions	168
3.10.2	Analysis of Physico-Chemical parameters of Sediment samples from the study area	169
3.10.3	Results and Discussions	172
3.11	Biological Environment	173
3.11.1	Methodology	173
3.11.2	Flora Study	174
3.11.3	Fauna	174
3.11.4	Floristic Composition within the study area	174
3.11.5	Rare and endangered Floral species	175
3.11.6	Faunal Communities	176
3.11.7	Mammals	177
3.11.8	Avifauna	177
3.11.9	Reptiles and Amphibians	177
3.11.10	Butterfly	178
3.11.11	Aquatic Ecology	178
3.11.12	Impact on Biological Environment and Wildlife	180
3.11.13	Impact on Flora	180
3.11.14	Impact on Fauna	180
3.11.15	Green Belt Development	181
3.12	Socio Economic profile	181
3.12.1	Socio Economic Aspects	181

3.12.2 Population	183
3.12.3 Population Density and Sex Ratio	184
3.12.4 Scheduled Castes and Scheduled Tribes	184
3.12.5 Education & Literacy	185
3.12.6 Employment and Livelihood	187
3.12.7 Social Economic Profile of the study area	187
3.12.8 Employment and livelihood	205
3.12.9 Educational infrastructure within study area	228
3.12.10 Dwelling within study area	251
3.12.11 Urbanization within the study area	251
4 ANTICIPATED ENVIRONMENTAL IMPACTS & MITIGATION MEASURES.....	254
4.1 Identification of Impacts	254
4.2 Impacts during Construction Phase	254
4.2.1 Impact on Air Environment	254
4.2.2 Impact on Water Environment	255
4.2.3 Impact on Noise Environment	255
4.2.4 Impact on Topography and Land Use	255
4.2.5 Impact on Soil	255
4.2.6 Impact due to Solid Waste Generation and Hazardous Waste Generation	256
4.2.7 Impact on Terrestrial Ecology	256
4.2.8 Impact on Aquatic Ecology	256
4.3 Impacts during Operational Phase	256
4.3.1 Impact on Air Quality	256
4.3.2 Impact on Water Quality	257
4.3.3 Impact on Soil Quality	257
4.3.5 Impact due to Solid Waste Generation & Hazardous Waste Generation	257
4.3.6 Impact on Topography and Land Use	257
4.3.7 Impact due to Earth Quake	258
4.3.8 Impact due to Fire Accidents	258

4.3.10.1	Air Pollution Management	261
4.3.10.2	Water and Wastewater Management	262
4.3.10.3	Noise Level Management	262
4.3.11	Environmental Impact Matrix	262
5.	ANALYSIS OF ALTERNATIVES	267
5.1	Introduction	267
5.2	Choice of Alternate locations	267
6.	ENVIRONMENTAL MONITORING PROGRAMME	273
6.1	implementation schedule of mitigation measures	273
6.2	Environmental Monitoring	273
6.3	Cost Provision for Environmental Measures	274
7.	ADDITIONAL STUDIES.....	276
7.1	Public Hearing	276
7.2	Risk Assessment	294
7.3	Hazard Assessment and Evaluation	304
7.4	Disaster Management Plan	306
7.5	Social Impact Assessment	308
7.6	Rehabilitation & Resettlement Action Plans	309
7.7	Bathymetry Survey	309
7.7.1	Introduction	309
7.7.2	Nature of Survey	310
7.7.3	Bathymetry Survey	310
7.7.4	Findings of Bathymetric Study	314
7.7.5	Field survey photos	315
8.	PROJECT BENEFITS	318
8.1	Improvement in the Physical Infrastructure	318
8.2	Financial Benefits of the Project	318
8.3	Social Benefits of the Project	318

9.	ENVIRONMENTAL COST BENEFIT ANALYSIS.....	320
10.	ENVIRONMENTAL MANAGEMENT PLAN	322
10.1	Landscaping and Greenbelt Development	322
10.2	Wastewater Management	323
11.	SUMMARY & CONCLUSION.....	332
11.1	Conclusion	332

LIST OF FIGURES

Figure 1-1 Index Map Of The Project Site	16
Figure 1-2 Google Imagery Study Area Of 10-Km Radius	17
Figure 2-1 Project Site Location	95
Figure 2-2 Project Site Coordinates	95
Figure 2-3 Master Plan	100
Figure 2-4 Htl And Ltl Demarcation Map By Irs Anna University (1:4000 Scale)	101
Figure 3-1 Map Showing The Satellite Image Of The Study Area	107
Figure 3-2 Topo Map Of The Study Area	108
Figure 3-3 Environmentally Sensitive Areas Within 15 Km From Project Boundary	112
Figure 3-4 Geology & Minerals Map Of Tamil Nadu	115
Figure 3-5 Land Use Map Of Chennai District	117
Figure 3-6 Land Use/Land Cover Pattern Of Chennai District	117
Figure 3-7 Land Use/Land Cover Pattern Of The Study Area	118
Figure 3-8 Land Use/Land Cover Map Of The Study Area	119
Figure 3-9 Physical Map Of Tamil Nadu State	120
Figure 3-10 Contour Map Of Study Area	121
Figure 3-11 Geomorphology Map Of Chennai District	123
Figure 3-12 Geomorphology Pattern Of The Study Area	124
Figure 3-13 Geomorphology Map Of Study Area	125
Figure 3-14 Hydrogeology Map Of Pia District	127
Figure 3-15 Drainage Map Of The Study Area	129
Figure 3-16 Soil Map Of India	130
Figure 3-17 Wind Hazard Map Of Tamil Nadu	131
Figure 3-18 Seismicity Map Of Tamil Nadu	132
Figure 3-19 Wind Rose During Study Period (May 2021)	136
Figure 3-20 Wind Rose During Study Period (October 2022)	137
Figure 3-21 Map Showing The Ambient Air Quality Monitoring Locations	139
Figure 3-22 Trends Of Measured Ambient Concentrations In The Study Area	144
Figure 3-23 Map Showing The Noise Monitoring Locations	147
Figure 3-24 Map Showing The Surface Water Monitoring Locations	151
Figure 3-25 Depth To Water Level During Pre-Monsoon & Post Monsoon Of Chennai District	160
Figure 3-26 Map Showing The Groundwater Monitoring Locations	162
Figure 3-27 Map Showing The Soil Monitoring Locations	167
Figure 5-1 Site I, Ii And Iii Falls Under Crz Sites	268
Figure 7-1 Bathymetry Survey Transects	311
Figure 7-2 Interpolated Depth Measurements	312
Figure 7-3 Bathymetry Survey Transects (Proposed Site)	313
Figure 7-4 Interpolated Depth Measurements At Marina Beach	313
Figure 7-5 Distance From Sea Shore And Corresponding Depth	314
Figure 7-6 Distance From Sea Shore And Corresponding Depth	316

LIST OF TABLES

Table 1-1 Project Details	14
Table 2-1 Details Of Proposed Land Use	96
Table 2-2 Wastewater Characteristics	103
Table 3-1 Environmentally Sensitive Areas Within 15km From Project Boundary	109
Table 3-2 District Land Use/Land Cover Statistics For Chennai District	116
Table 3-3 Land Use/Land Cover Statistics Of 10 Km Radius Of The Study Area	118
Table 3-4 Geomorphology Of The Study Area	123
Table 3-5 Climatological Summary – Chennai (Minambakkam) Region (1971-2000)	134
Table 3-6 Meteorology Data For The Study Period (May 2021)	136
Table 3-7 Meteorology Data For The Study Period (October 2022)	137
Table 3-8 Details Of Ambient Air Quality Monitoring Locations	138
Table 3-9 Analytical Methods For Analysis Of Ambient Air Quality Parameters	140
Table 3-10 Summaries Of The Average Baseline Concentrations Of Pollutants	142
Table 3-11 Day And Night Equivalent Noise Levels	146
Table 3-12 Test Methods Used For The Analysis Of Water Quality Parameters	149
Table 3-13 Details Of Surface Water Sampling Locations	149
Table 3-14 Physicochemical Parameters Of Surface Water Samples From Study Area (May-July 2021)	152
Table 3-15 Physicochemical Parameters Of Marine Water Samples From Study Area (October 2022)	155
Table 3-16 The Yield And Depth Of Aquifers	159
Table 3-17 Details Of Groundwater Quality Monitoring Locations	161
Table 3-18 Physico-Chemical Analysis Of Ground Water Samples From Study Area (May-July 2021)	163
Table 3-19 Soil Quality Monitoring Locations	166
Table 3-20 Physico-Chemical Parameters Of Soil Samples From The Study Area (May-July 2021)	167
Table 3-21 Soil Classification As Per Icar	168
Table 3-22 Physico-Chemical Parameters Of Sediment Samples From The Study Area (October 2022)	169
Table 3-23 List Of Plant Species Dound In The Study Area	174
Table 3-24 The Detailed List Of Plant Species	175
Table 3-25 Bird Recorded From The Study Area And Conservation Status	177
Table 3-26 Reptiles & Amphibians Recorded From The Study Area	178
Table 3-27 Butterfly Recorded From The Study Area	178
Table 3-28 List Of Most Common Phytoplankton From Adyar River	179
Table 3-29 List Of Most Common Zooplankton From Adyar River	179
Table 3-30 Social Indicators Of Chennai District	182
Table 3-31 Social Indicators Of Kancheepuram District	182
Table 3-32 Social Indicators Of Thiruvallur District	182
Table 3-33 Population Profile Within Study Area	188
Table 3-34 Classification Of Workers Within Study Area	205
Table 3-35 Details Of Literacy Population In The Study Area	229
Table 3-36 Summary Of Socioeconomic Indicators Within The Study Area	251
Table 5-1 Weightage Matrix Of Site Selection	269
Table 6-1 Implementation Schedule	273

Table 7-1 Preliminary Hazard Analysis For Process And Storage Areas	305
Table 7-2 Preliminary Hazard Analysis In General	305
Table 7-3 Seasonal Disaster Mapping	307
Table 10-1 Impact Analysis On Various Parameters With Mitigation Measures	325

LIST OF ABBREVIATIONS

PWD	Public Works Department
EIA	Environmental Impact Assessment Report
CRZ	Coastal Regulation Zone
IRS	Institute of Remote Sensing
DCZMA	District Coastal Zone Management Authority
TNSCZMA	Tamil Nadu State Coastal Zone Management Authority
ToR	Terms of Reference
IMD	India Meteorological Department
ERDMP	Emergency Response & Disaster Management Planning
CPCB	Central Pollution Control Board
PIA	Project Influence Area
HSE	Health, Safety & Environment
H,A&I	Human, Animals & Infrastructure

CHAPTER 1
INTRODUCTION

1. INTRODUCTION

1.1 Purpose of the Report

This is Environmental Impact Assessment (EIA) Report for the Coastal Regulation Zone (CRZ) Clearance, for the “Proposed Construction of Muthamizh Arignar Dr.Kalaignar Pen Monument in Bay of Bengal” off the coast of Marina Beach near Triplicane village, Chennai District. The Pen Monument site falls within CRZ IVA, CRZ IA, and CRZ II. The proposed cost of the project is Rs. 81.0 Crores.

The objectives of this EIA include the following:

- To ensure environmental considerations are explicitly addressed and incorporated in the development decision-making process.
- To anticipate and minimize or offset the adverse significant biophysical, social and other relevant effects of the above project proposal.
- To protect the productivity and capacity of natural systems and the ecological processes.
- To promote sustainable development of project implementation with optimization to use the resources and by implementing management systems.

Tamil Nadu PWD entrusted M/s. Hubert Enviro Care System Pvt. Ltd, Chennai to undertake Environmental Impact Assessment (EIA) studies for assessing the impact of the entire project on various environmental parameters in the study area and to prepare an Environment Management Plan for negating the adverse impacts of the proposed project.

1.2 Identification of Project & Project Proponent

Project Proponent: Executive Engineer PWD, Building Construction Division I, Chepauk, Chennai 600 005, Tamilnadu.

The PWD constructs and maintains all the state owned government buildings of Public and Government utility.

This Pen Monument construction will be implemented for commemorating the Contribution to Eyal, Isai, Nadagam done by Muthamizh Arignar Kalaignar Dr.M.Karunanidhi to the Tamil literature at Kamarajar Salai, Chennai 600 005 is being executed by the Executive Engineer PWD Buildings Constructions Division I, Chepauk Chennai 600 005.

Identification of Project:

Proposed Construction of Muthamizh Arignar Dr.Kalaignar Pen Monument in Bay of Bengal off the coast of Marina Beach near Triplicane village, Chennai -600 005.

The Pen Monument is to be placed in Bay of Bengal off the coast of Marina Beach at a distance of 360 m from the shore line in CRZ-IV (A) area, as per section 4(ii) (j) of CRZ Notification amended on March 22, 2016 for construction of memorials/ monuments and allied facilities by the concerned State.

1.3 Need of the Project

The proposed pen monument requires CRZ Clearance because it involves both onshore and offshore construction. It covers an area about 8551.13sq.m. Therefore, it covers CRZ-IVA, CRZ IA & CRZ II.

The CRZ demarcation map from Anna University will indicate the HTL, LTL, ESA and other regulatory lines with the accordance of Coastal Zone Management Plan.

The Proposed Monument is mainly for commemorating the Contribution to Eyal, Isai, and Nadagam done by Muthamizh Arignar Kalaignar Dr.M.Karunanidhi to the Tamil literature.

1.4 Brief Description of Project

1.4.1 Nature and Size of the Project

Proposed Construction of Muthamizh Arignar Dr.Kalaignar Pen Monument in Bay of Bengal off the coast of Marina Beach near Triplicane Village, Chennai District. Total area is 2.11 Acres. The project details are given in **Table 1-1**.

Table 1-1 Project details

Sr. No.	Description	Details																					
1	Location	Muthamizh Arignar Dr.Kalaignar Pen Monument in Bay of Bengal off the coast of Marina Beach near Triplicane Village Chennai 600 005, Tamilnadu State																					
2	Area Break-up Details	<p>Total Site area -2.11 acres (8551.13 sq.m)</p> <table border="1"> <thead> <tr> <th>S.No.</th> <th>Description</th> <th>Area in sq.m</th> </tr> </thead> <tbody> <tr> <td>1</td> <td>Pen Pedestal</td> <td>2263.08</td> </tr> <tr> <td>2</td> <td>Pedestrian Pathway Above Sea</td> <td>2073.01</td> </tr> <tr> <td>3</td> <td>Lattice Bridge</td> <td>1856.00</td> </tr> <tr> <td>4</td> <td>Pedestrian Pathway Above Beach</td> <td>1610.60</td> </tr> <tr> <td>5</td> <td>Pedestrian Pathway from Muthamizh Arignar Dr. Kalaignar Memorial to Bridge</td> <td>748.44</td> </tr> <tr> <td colspan="2">Total area</td> <td>8551.13</td> </tr> </tbody> </table>	S.No.	Description	Area in sq.m	1	Pen Pedestal	2263.08	2	Pedestrian Pathway Above Sea	2073.01	3	Lattice Bridge	1856.00	4	Pedestrian Pathway Above Beach	1610.60	5	Pedestrian Pathway from Muthamizh Arignar Dr. Kalaignar Memorial to Bridge	748.44	Total area		8551.13
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4	Pedestrian Pathway Above Beach	1610.60																					
5	Pedestrian Pathway from Muthamizh Arignar Dr. Kalaignar Memorial to Bridge	748.44																					
Total area		8551.13																					

3	Site Coordinates	S.No	Latitude	Longitude
		A	13° 3'53.794"N	80°17'9.182"E
		B	13° 3'55.109"N	80°17'11.732"E
		C	13° 3'54.365"N	80°17'16.132"E
		D	13° 3'53.725"N	80°17'19.908"E
		E	13° 3'52.008"N	80°17'30.015"E
		F	13° 3'51.537"N	80°17'32.802"E
4	Project Components	<p>The following are the components of the project:</p> <ul style="list-style-type: none"> ➤ Pen Pedestal ➤ Pedestrian cum Glass Walkway ➤ Lattice Walkway ➤ Elevated Walkway 		
5	Water Requirement	<p>Construction Phase : The total water requirement will be ~ 15 KLD Domestic : ~ 10 KLD Construction purpose : ~ 5 KLD Source of water is through Metro water tankers.</p> <p>Operation Phase : Domestic : ~ 5 KLD Supplied through water dispensers for drinking purposes.</p>		
6	Power Requirement	<p>Construction Phase :</p> <ul style="list-style-type: none"> ➤ 500 kV Sourced from TANGEDCO ➤ 125 kVA of DG set for power backup <p>Operation Phase :</p> <ul style="list-style-type: none"> ➤ Power supply and DG backup for lighting load ➤ 100 kV Sourced from TANGEDCO 		
7	Road connectivity	Site is well connected through Kamarajar Salai, Chepauk.		
8	Proposed Project Cost	Rs. 81 Crores		

1.4.2 Location of the Project

The project site is located within corporation limits of Chennai City. The project site falls in Bay of Bengal off the coast in Marina Beach near Triplicane, Chennai 600 005, Tamil Nadu. The Pen monument site falls within CRZ IVA, CRZ IA, and CRZ II.

The Pen monument is to be placed in Bay of Bengal off the coast of Marina Beach at a distance of 360 m from the shore line in CRZ-IV (A) area, as per section 4(ii) (j) of CRZ Notification amended on March 22, 2016 for construction of memorials/ monuments and allied facilities by the concerned State.

The Index map of the project site is shown in **Figure 1-1** and Google imagery of study area 10 km radius is shown in **Figure 1-2**.

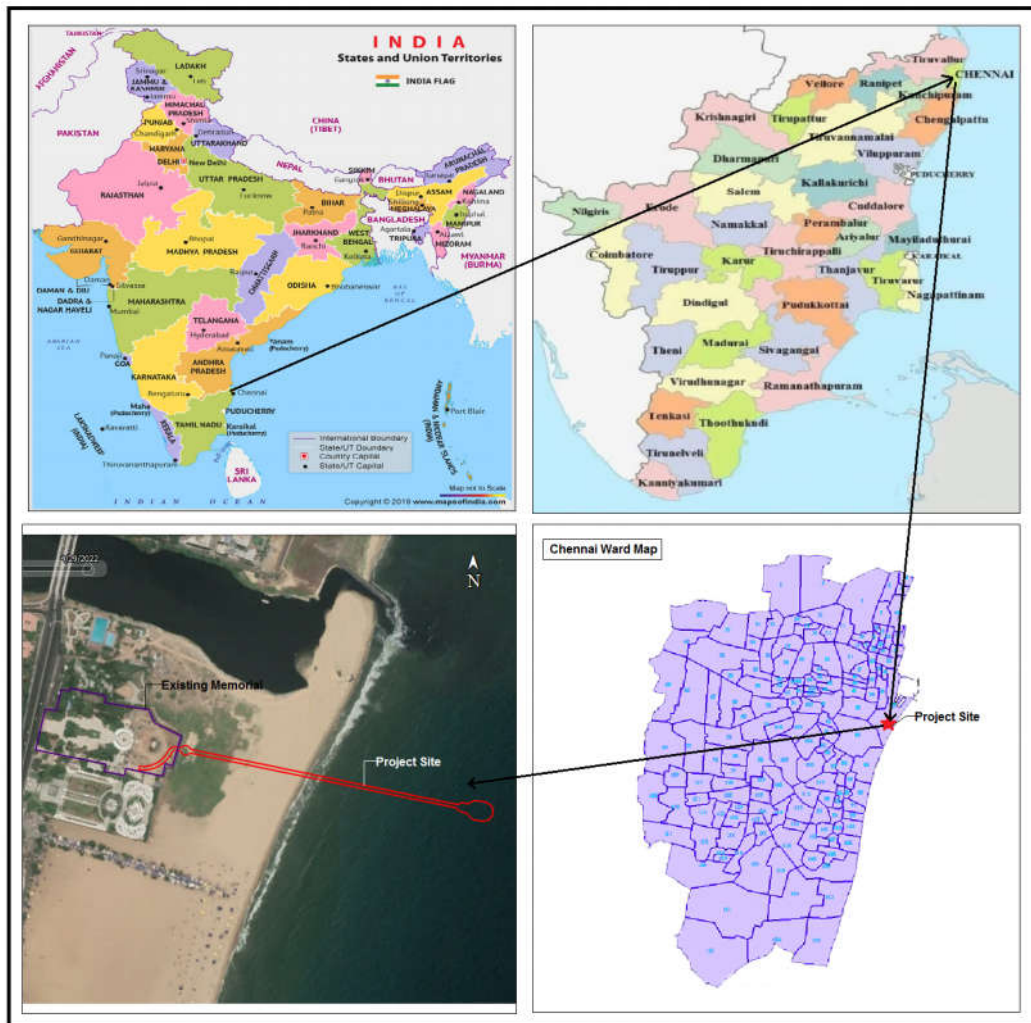


Figure 1-1 Index map of the project site

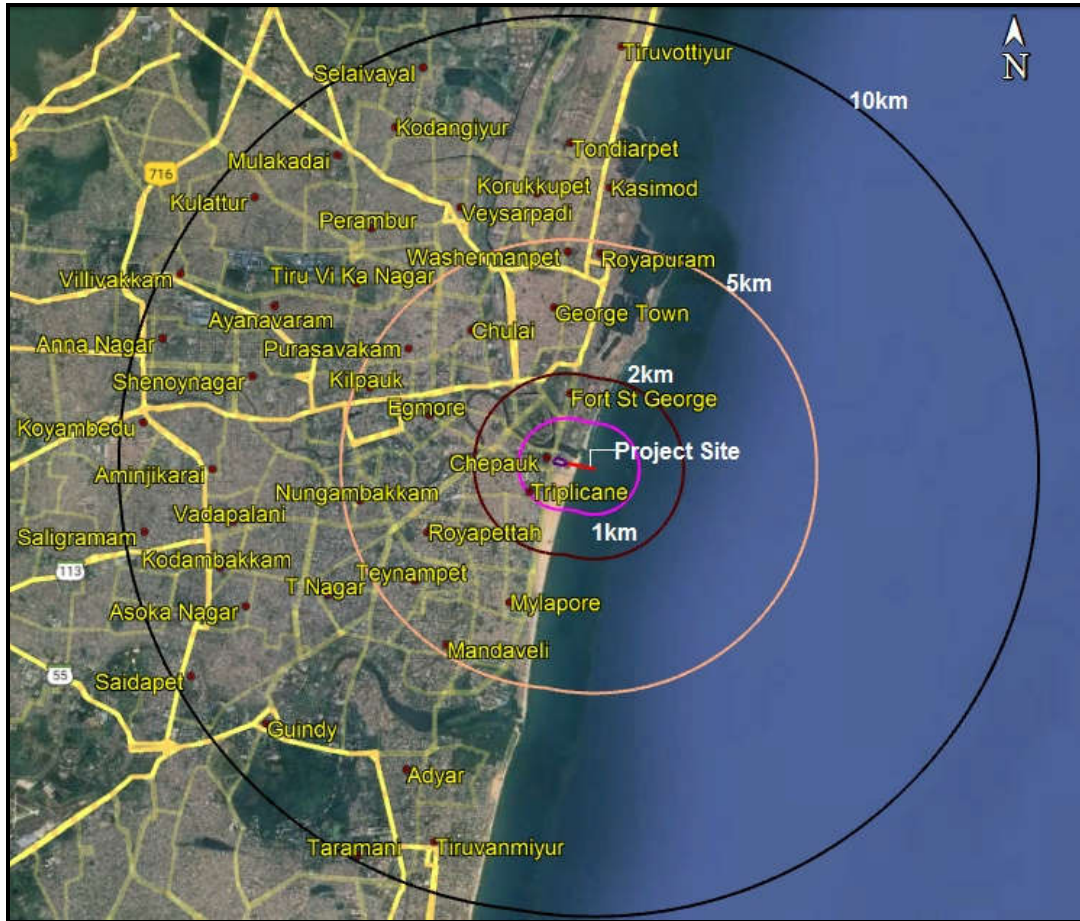


Figure 1-2 Google Imagery Study Area of 10-Km Radius

1.5 Project Cost

The investment required for Proposed Construction of Muthamizh Arignar Dr.Kalaaignar Pen Monument in Bay of Bengal off the coast of Marina Beach near Triplicane village, Chennai -600 005 is expected to be Rs 81 Crore.

1.6 Scope of the study

The Baseline environmental study was carried out during **27th May 2021-28th July 2021**; based on the request of PWD for the construction of memorial and allied works.

Chapter 1: Introduction

Introductory information is presented in this Chapter. The introduction chapter provides background of the project, project proponent and describes the objective of this document. The purpose and organization of the report is also presented in this chapter.

Chapter 2: Project Description

This Chapter includes Project Description and Infrastructure Facilities delineating all the industrial and environmental aspect of the Construction and operation phase activities.

Chapter 3: Description of the Environment

This Chapter provides baseline environmental status of Environmental Components (Primary data) delineating meteorological details of the proposed project and surrounding area.

Chapter 4: Anticipated Environmental Impacts & Mitigation Measures

This Chapter presents the analysis of impacts on the environmental and social aspects of the project as a result of establishment of plan and thereby suggesting the mitigation measures.

Chapter 5: Analysis of Alternatives

This chapter includes the justification for the selection of the project site from Environmental point of view as well as from economic point of view so that the technology will be affordable to the member units of the site area.

Chapter 6: Environmental Monitoring Program

This chapter will include the technical aspects of monitoring, the effectiveness of mitigation measures which will include the measurement methodologies, impact frequency, location, data analysis, reporting schedules etc.

Chapter 7: Additional Studies

This chapter will deal with identification of the risks due to proposed project in relation to the general public and the surrounding environment during construction and operation phases of the project and thereby presents Disaster Management Plan, Social impact assessment and Rehabilitation & Resettlement action plans.

Chapter 8: Project Benefits

This chapter deals with improvement in physical and social infrastructures, employment potential and other tangible benefits.

Chapter 9: Environmental Cost Benefit Analysis

It is not under our scope.

Chapter 10: Summary and Conclusion

This is the key Chapter of the report and presents the mitigation plan, covers the institutional and monitoring requirements to implement environmental mitigation measures and to assess their adequacy during project implementation.

Chapter 11: Summary & Conclusion

This chapter summarizes the information given in Chapters in this EIA/EMP report and the conclusion based on the environmental study, impact identification, mitigation measures and the environmental management plan.

1.7 ToR Compliance

1.7.1 Specific ToR Compliance

Sr.No.	Specific Terms of Reference	Compliance
1	<p>The design shall not be an isolated one from the local architecture and motifs which shall be appropriately incorporated in the design to portray Indian Heritage features in a place of heritage and tourist importance</p>	<p>The Pen Monument has been designed by considering the Tamil culture and architecture. The local architecture, motifs and the design to portray Tamil Heritage features are explained in Section 2.4.1 of the EIA report and the major highlights are given below.</p> <p>The project design is derived from Iyal (Means Poetry/Literature), Isai (Means Music) and Naadagam (Means Drama), the three variations of the Thamizh language.</p> <p><u>Location of the monument:</u> Footed in the sea at 360m away from Marina beach of Chennai, is this 42 m tall PEN MONUMENT in 2.60 m diameter for Kalaaignar Karunanidhi which is accessed from the land through a lattice bridge.</p> <p>The monument can be compared to the Catamaran on the sea, with which Kalaaignar compares himself with it and the location is unique to the city and the state, as it is the world's second-largest urban beach.</p> <p><u>Design concept:</u></p> <ol style="list-style-type: none"> 1. Kalaaignar M. Karunanidhi is also known as Muthamizh Arignar, Because of his Tamil skills and his contributions to Tamil literature. 2. The project capitalizes on the elements of Tamil Cultural Identity (Muthamizh) drawn from its Literature (Iyal), Music (Isai), and Drama (Naadagam) components and merges them with the Kalaaignar's iconic tools and statements. <p><u>Design features:</u></p> <ol style="list-style-type: none"> 1. The Pen: The PEN is a symbol, of his greatest talent and prowess through which he ruled Tamil hearts and grew up to be a mass leader. 2. The Inscriptions: "Writing" is a powerful tool through which Kalaaignar has brought out his creations to the

Sr.No.	Specific Terms of Reference	Compliance
		<p>world and he has been writing throughout his life. Tamil quotes and sayings of the leader carved in the monument pedestal representing the Tamil temple stone inscriptions (Kalvettu).</p> <p>3. The Garden/Landscape: The landscape on the pedestal is laid out in the form of Sikku Kolam, a traditional form of rangoli art done by women usually in Tamil homes and the kolam consists of a pattern in which a stroke runs once around each dot, and returns to the beginning point, thus forming a geometrical figure.</p> <p>4. Material: From history until date Granite is the locally and widely available material in the state.</p> <p>5. The Parapet Walls of the bridge: represent wave patterns relating to the surrounding.</p>
2	The study should lay a strong focus on mitigation plan as well as necessary features relating to safety and security of the Memorial and its visitors	<p>The mitigation plan and necessary features relating to safety and security of the Memorial and its visitors are explained in Section 10.5 of the EIA report and the below paragraphs are the abstract of the same.</p> <p><u>Safety of visitors and monument:</u></p> <p>1. Width of the Bridge: The width of the bridge has been increased from initially designed 7m with two unidirectional walkways of 3.5m each and the width of glass is reduced to 2m.</p> <p>However, in emergency, the entire area will be used for evacuation.</p> <p>2. Hand Rails: Removable hand rails will be provided to separate the glass area and walkways. The movement will be restricted as ‘unidirectional’.</p> <p>3. Flooring of Bridge: The flooring will be constructed with anti-skid materials like semi-polished rough granite stones to reduce the chances of slips even during rainy season.</p> <p>4. Alarm & Public Address System: Alarm system along with Public Address System for communicating in emergency will be installed. The complete area will be under surveillance and the PA system will be utilized to control the crowd and regulate the crowd that will be used for Fire alarm, Tsunami, cyclone, heavy wind and rain announcements and any other natural calamities.</p>

Sr.No.	Specific Terms of Reference	Compliance
		<p>5. Emergency Exit at key points: Emergency exits will be provided in equal intervals with proper signage and emergency lightings.</p> <p>The evacuation plan with necessary instructions, in signages will be kept at the entrance and in walkways to induct the visitors.</p> <p>6. Availability of life rafts and life boats: The life rafts will be made available near by the emergency exists. Life boat will also be kept ready at the proximity of the emergency exists.</p> <p>This will be done with the support of Department of Information and Public Relations and more assistance will be provided by coast guard and police during any emergency /distress.</p> <p>7. Controlled Entry: The entry to the monument will be restricted with check points and automatic counters. The automated gates will be linked with the counters and it will be opened only when it matches the criteria of allowable strength within the project area.</p> <p>The maximum number of visitors will be limited to 800at a time, so as to evacuate them easily in case of any emergencies.</p> <p>8. 24x7 safety surveillance & security system: CC TV system will be installed and the project will be monitored from the control room by the security personnel.</p> <p>Proper communication system will be made between this control room and the Tamil Nadu State Disaster Management Authority. (TNSDMA)</p> <p>The security personnel deployed within the project site will be connected with the control room to pass timely instructions.</p> <p>9. Provision of First Aid kit and competent first aiders: First Aid Kits will be kept at suitable places along</p>

Sr.No.	Specific Terms of Reference	Compliance
		<p>with log books. This will be handled by competent personnel. The emergency management cell will be formed and appointed at site.</p> <p>10. Provision of buggies: Two buggies are proposed at the site to support elderly and specially-abled persons. The same will be utilised to move persons in emergencies and those who need medical care during their visit.</p> <p>However, during Evacuation, this will be used to evacuate the especially abled/vulnerable group, if it feasible.</p> <p>11. Display of meteorological data and warnings at the entrance: Met data will be monitored and displayed at the entrance and nearby the monument.</p> <p>A Display will be kept in control room and warning note will be given by the authorised security personnel, through PA system.</p> <p>12. Display of evacuation routes at equal intervals: Evacuation route will shown with:</p> <ol style="list-style-type: none"> 1. You are here note 2. Easiest way to exit 3. Location of Fire extinguishers, fire hydrant system, first aid kits 4. Emergency numbers will be displayed <p>Both video and schematic emergency route will be displayed.</p> <p>The emergency procedure will continuously be shown during the visiting hours, in Tamil and English.</p> <p>13. Provision of metal detector scanning while entering the monument: Security team will be trained to detect and report to the department concerned, with no time, in any case of threats including terrorist attacks.</p> <p>14. Earthquake resistant construction: The construction of pen monument will be complied with earthquake resistant construction standards, viz:</p>

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		<p>a. IS 1893-2006 for Earthquake resistance b. IS 4651 parts I to V & IS 456</p> <p>15. Provision for Lightning arrester: Proper lightning arrestor will be installed at the top of the pen to protect the monument from the lightning.</p> <p>16. Corrosion resistant construction material: The chances of corrosion are quite high as the pen monument will be located in Bay of Bengal off the Coast of Marina Beach; therefore anti-corrosion materials will be implwmnted to prevent the corrosion.</p> <p>17. Provision of proper inspection and maintenance of the structure: A maintenance team will be appointed to execute this. Periodical review meetings shall be conducted to evaluate the strength of the project and any other issues.</p> <p>18. Provision of shades on the walkway: There will be two shades given in the bridge /walkways to take rest, especially during sunny days.</p> <p>First aid may be facilitated at this place, if needed. Provision of drinking water will also be provided.</p> <p>19. Spiral ladder within the pen monument for maintenance: Entry will be restricted only to the service men with proper Permits to Work and under strict supervision.</p> <p>Strict Permit To Work (PTW) system will be implemented including that for confined space entry.</p> <p>20. Provision of Solar Panel as energy savers: All the lights and other decorative luminaries can utilise the solar energy. Solar panel will be installed at the roof of the shades with proper cleaning system.</p>
3	Risk Assessment study with Disaster Management Plan (DMP) including	Risk Assessment study with Disaster Management Plan (DMP) :

Sr.No.	Specific Terms of Reference	Compliance
	<p>on-site and off-site emergency plan and evacuation plan during emergency, tsunami and cyclones shall be prepared</p>	<p>The risk assessment study during the construction activities are given below:</p> <ul style="list-style-type: none"> • Commuting in site by visitors/ guests • Construction material and machines handling • Handling of glass material • Welding activity • Metal Preparation Works: Cutting, sizing rolling and grinding • Hoisting & Lifting activities • Working at height • Underwater construction work • Operation of Material Handling Equipments • Excavation/Trenching activity <p>The Risk Assessment study during the operation phase are given below:</p> <p>1. Width of the Bridge: The width of the bridge has been increased from initially designed 7m with two unidirectional walkways of 3.5m each and the width of glass is reduced to 2m.</p> <p>However, in emergency, the entire area will be used for evacuation.</p> <p>2. Hand Rails: Removable hand rails will be provided to separate the glass area and walkways. The movement will be restricted as ‘unidirectional’.</p> <p>3. Flooring of Bridge: The flooring will be constructed with anti-skid materials like semi-polished rough granite stones to reduce the chances of slips even during rainy season.</p> <p>4. Alarm & Public Address System: Alarm system along with Public Address System for communicating in emergency will be installed. The complete area will be under surveillance and the PA system will be utilized to control the crowd and regulate the crowd that will be used for Fire alarm, Tsunami, cyclone, heavy wind and rain</p>

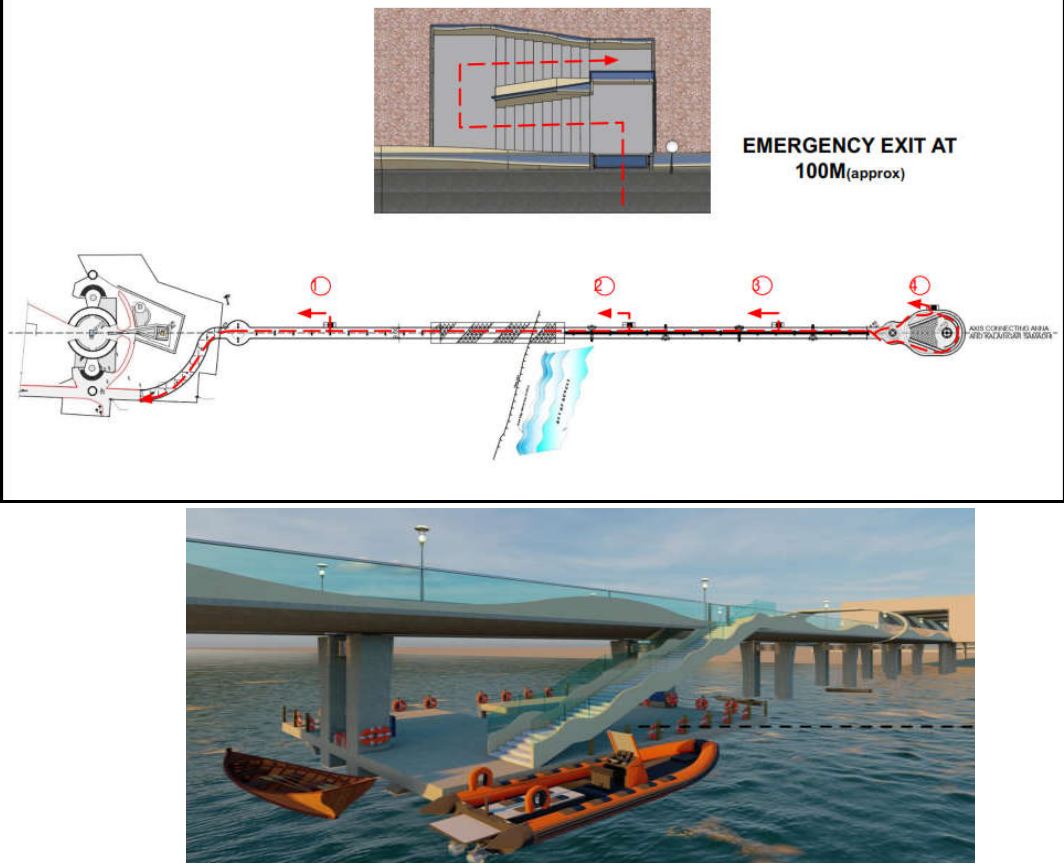
Sr.No.	Specific Terms of Reference	Compliance
		<p>announcements any other natural calamities.</p> <p>5. Emergency Exit at key points: Emergency exits will be provided in equal intervals with proper signage and emergency lightings.</p> <p>The evacuation plan with necessary instructions, in signages will be kept at the entrance and in walkways to induct the visitors.</p> <p>Other considerations like door handles, height and width of the doorway will be given attention in design.</p> <p>6. Availability of life rafts and life boats: The life rafts will be made available near by the emergency exists. Life boat will also be kept ready at the proximity of the emergency exists.</p> <p>This will be done with the support of Department of Information and Public Relations and more assistance will be provided by coast guard and police during any emergency /distress.</p> <p>7. Controlled Entry: The entry to the monument will be restricted with check points and automatic counters. The automated gates will be linked with the counters and it will be opened only when it matches the criteria of allowable strength within the project area.</p> <p>The maximum number of visitors will be limited to ~800 at a time, so as to evacuate them easily in case of any emergencies.</p> <p>8. 24x7 safety surveillance & security system: CC TV system will be installed and the project will be monitored from the control room by the security personnel.</p> <p>Proper communication system will be made between this control room and the Tamil Nadu State Disaster Management Authority. (TNSDMA)</p>

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		<p>The security personnel deployed within the project site will be connected with the control room to pass timely instructions.</p> <p>9. Provision of First Aid kit and competent first aiders: First Aid Kits will be kept at suitable places along with log books. This will be handled by competent personnel. The emergency management cell will be formed and appointed at site.</p> <p>10. Provision of buggies: Two buggies are proposed at the site to support elderly and specially-abled persons. The same will be utilised to move persons in emergencies and those who need medical care during their visit.</p> <p>However, during Evacuation, this will be used to evacuate the especially abled/vulnerable group, if it feasible.</p> <p>11. Display of meteorological data and warnings at the entrance: Met data will be monitored and displayed at the entrance and nearby the monument.</p> <p>A Display will be kept in control room and warning note will be given by the authorised security personnel, through PA system.</p> <p>12. Display of evacuation routes at equal intervals: Evacuation route will shown with:</p> <ol style="list-style-type: none"> 1. You are here note 2. Easiest way to exit 3. Location of Fire extinguishers, fire hydrant system, first aid kits 4. Emergency numbers such as Traffic Police, Ambulance, Fire department Child Help, Accident Helpline, disaster helpline etc., will be displayed 5. Both video and schematic emergency route will be displayed. <p>The emergency procedure will continuously be shown during the visiting hours, in Tamil, English and Hindi.</p>

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		<p>20. Provision of Solar Panel as energy savers: All the lights and other decorative luminaries can utilise the solar energy. Solar panel will be installed at the roof of the shades with proper cleaning system.</p> <p>The alternative energy will be equipped from Solar panels which will be installed on the roof of the Lattice Bridge for all the lightings around the project site.</p> <table border="1"> <thead> <tr> <th>Description</th> <th>Quantity</th> </tr> </thead> <tbody> <tr> <td>Total Roof Area of the Lattice Bridge (Sq.m)</td> <td>1856.00</td> </tr> <tr> <td>Sq.m/ 1KW</td> <td>10</td> </tr> <tr> <td>KW</td> <td>185.60</td> </tr> <tr> <td>Sun hour/day</td> <td>5</td> </tr> <tr> <td>Average units/day</td> <td>928</td> </tr> </tbody> </table> <p>Disaster Management Plan during Construction and Operation Phase, especially for the below, have also been detailed in the report.</p> <ul style="list-style-type: none"> • Natural calamities including cyclone, Tsunami, Earthquake, flood etc. • Structural collapse. • Medical Emergency. • Fire. • Electrical fire/short circuiting. 	Description	Quantity	Total Roof Area of the Lattice Bridge (Sq.m)	1856.00	Sq.m/ 1KW	10	KW	185.60	Sun hour/day	5	Average units/day	928
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4	<p>Detailed crowd management plan with specific reference to the alignment /configuration of bridge /structures.</p> <p>Carrying capacity study vis-à-vis</p>	<p>A detailed Crowd Management has been prepared by Centre for Urbanization, Buildings & Environment [CUBE], Centre of Excellence of Government of Tamil Nadu & IIT Madras and the major points are given below:</p> <ol style="list-style-type: none"> 1. Crowd density is typically measured in terms of the number of people per unit of area, typically per square meter (m²) or per square foot (ft²). In general, crowd densities of less than 0.5 people/ m² are considered sparse, while densities of 1-2 people/ m² are considered average, and densities of 4-5 people/ m² or more are 												

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	safe limit of number of people to be permitted on the monument at a time, keeping in a view emergency evacuation and any unforeseen situation including cyclones/floods	<p>considered high.</p> <ol style="list-style-type: none"> 2. The width of the lattice bridge is 7m with two unidirectional walkways of 3.5 m each. The average distance between the two persons will be ~ 1-1.5 m. 3. The total area of the monument is 8551.13 sq. m and a crowd of ~800 persons at a time is comfortably manageable. 4. Adequate luminance level will be maintained in the entrance and exits, including emergency exits. Other considerations like door handles, height and width of the doorway should be given attention in design. 5. Solicit the suggestions and feed back from the visitors for continual improvement. The same may be invited after each training session, from the staff/attendees. 6. The traffic in nearby roads will continuously monitored and in case of emergencies, maximum care will be taken to avoid any traffic congestion.. 7. During the emergency evacuation/ any unforeseen situation including cyclones/floods period, the people are restricted to enter the monument and the existing people in the bridge will be rescued as per the emergency evacuation plan.

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		<div style="text-align: center;">  <p>The diagram illustrates a tunnel system with an emergency exit. An inset shows a cross-section of a building with a red dashed line indicating an exit path. The main diagram shows a tunnel with a high tide line indicated by a blue wavy line. Red arrows and circled numbers 1, 2, 3, and 4 indicate the direction of flow and emergency exit points. The text 'EMERGENCY EXIT AT 100M(approx)' is present. Below the diagram is a 3D rendering of a bridge structure over water with a boat and a high tide line marked.</p> <p>EMERGENCY EXIT AT 100M(approx)</p> <p>High Tide Line</p> </div>

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		<div> </div> <p>Low Tide Line</p> <p>Crowd management refers to the management of large groups of people at any form of the event and the plan is the safety and security measures put in place to ensure that you are keeping guests and staff safe.</p> <p>The purpose of the plan is to ensure that a large gathering of people is controlled in an orderly and problem free manner.</p> <p>The major causes and triggers of crowd disasters are:</p> <ol style="list-style-type: none"> <li>1. Structural collapse <ul style="list-style-type: none"> <li>➤ Structural collapse of barricades <li>➤ Poor guards railings <li>➤ Absence of emergency exit <li>2. Natural Calamities <ul style="list-style-type: none"> <li>➤ Storm & Cyclone <li>➤ Flood <li>➤ Tsunami <li>➤ Hurricane

Sr.No.	Specific Terms of Reference	Compliance
		<ul style="list-style-type: none"> ➤ Earthquake <p>3. Uncontrolled Entry to the Monument</p> <ul style="list-style-type: none"> ➤ Underestimation of visitors ➤ Limited holding area ➤ Lack of access control <p>4. Crowd Behaviour</p> <ul style="list-style-type: none"> ➤ A wild rush towards entrance/exit ➤ Sudden mass evacuation ➤ Collision between large inward and outward flow. <p>5. Security Issues</p> <ul style="list-style-type: none"> ➤ Lack of CCTV Surveillance ➤ Absence of walky-talkies with security staff ➤ Under deployment of security personnel to regulate crowd. ➤ Chances of Terrorist attacks. <p>The various elements of the crowd management plan are:</p> <p>1. Capacity Planning</p> <ul style="list-style-type: none"> ➤ Entry to the monument will be restricted with automatic counters and gates at different points, in order to avoid, large accumulation of persons at a single point especially nearby the Pen monument. ➤ Duration of the visit will be restricted to maximum 90 minutes by forcing them to move continuously in queue. By deploying security personnel and through CCTV surveillance system. ➤ Guard railings in between the walkways will be installed throughout the bridge. ➤ Alternate manual plan such as physical counters, communication channels, etc., in case of technology failure or unavailability

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		<p>2. Understanding Crowd Behaviour</p> <ul style="list-style-type: none"> ➤ Do's and Don't's to be strictly followed among the individuals ➤ The complete crowd will be monitored from the control room by competent security personnel and time to time instruction will be given through public address system. ➤ Proper signages and instructions notices will be displayed through out the structure. ➤ The evacuation plan with necessary instruction will be displayed using VDUs at the entrance and in walkways to induct the visitors. ➤ In case of emergency, security personnel will guide the visitors to evacuate through suitable nearest emergency exits with minimum time. <p>3. Information System</p> <ul style="list-style-type: none"> ➤ Detailed emergency evacuation routes showing entry/exit, holding areas, location of the emergency services ➤ Evacuation and response plans will be kept ready ➤ Police will be kept incharge for ensuring safety during visiting hours, with a surveillance of 24x7. ➤ Public Addressing (PA) system will be active all the time for conveying relevant instructions and information. ➤ Met data will be monitored and displayed at the entrance and nearby the monument. ➤ A display will be kept in control room and warning note will be given by the authorised security personnel, through PA system. <p>4. Training of security personnel</p> <ul style="list-style-type: none"> ➤ Security personnel shall be trained in crowd management techniques to help maintain order and safety in areas with high tourist traffic. They shall be stationed at key points to monitor the flow of people and ensure that everyone is following safety guidelines.

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		<ul style="list-style-type: none"> ➤ They shall be prepared to intervene if necessary to prevent overcrowding or other safety hazards and also recognize and respond to potential threats, such as theft or terrorism. ➤ Security personnel should be trained in emergency response procedures and have a clear understanding of the evacuation plan for the tourist spot.
5.	Detailed plan for emergency evacuation during natural calamity/ manmade with required infrastructure stating time required for complete evacuation including safe landing under bad weather conditions, facilities etc.	<p>A detailed Evacuation plan has been prepared by Centre for Urbanization, Buildings & Environment [CUBE], Centre of Excellence of Government of Tamil Nadu & IIT Madras and the major points are given below:</p> <ol style="list-style-type: none"> 1. Identification of Potential Emergencies- This involves identifying the types of emergencies that could occur in a particular location or facility, such as fire, flood, severe weather, failure of infrastructure or power outages. The identification process helps in developing an emergency plan that is specific to the potential emergencies in the location. 2. Emergency Notification and Communication- Clear instructions on ways to notify people in the building or location of an emergency and strategies of communicating important information during the evacuation. 3. Capacity and Accessibility- It involves determining the maximum capacity of the facility or location and the accessibility of the exit routes and assembly areas. The plan should ensure that everyone can evacuate safely and quickly, regardless of their physical abilities. 4. Evacuation Equipment and Supplies- It involves identifying the necessary equipment and supplies for the evacuation process such as fire extinguishers, first aid kits and back up power resources. 5. Training and Drills - All employees should be trained on the emergency evacuation plan and procedures. Regular mock drills should be conducted to test the plan's effectiveness and ensure that everyone is prepared and knows what to do in case of an emergency. 6. Continuity of Operations- This involves developing a plan to maintain critical operations during and after an emergency. The plan should outline the procedures for resuming operations and identify necessary resources to restore the facility or location to normalcy.

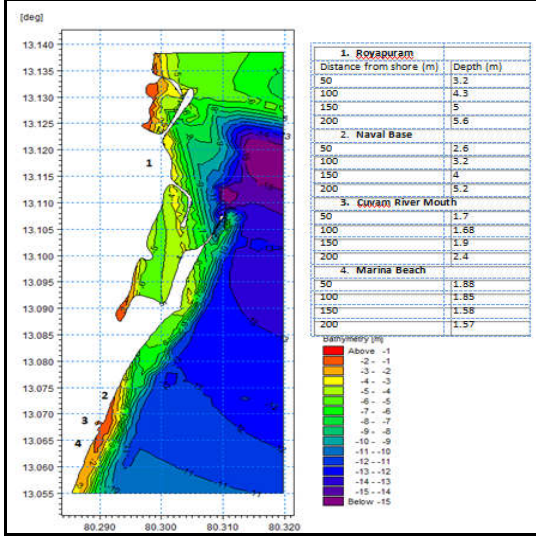
Sr.No.	Specific Terms of Reference	Compliance
		<p>7. Maintenance and Updates - An emergency evacuation plan should be regularly reviewed and updated to ensure that it is current and effective. Regular maintenance checks on emergency equipment, emergency exits, and the evacuation plan itself should be conducted.</p> <p>8. Evacuation Routes, Exits and Assembly Areas - This measure involves identifying the primary and secondary evacuation routes and exits from the facility, and the assembly areas where people can gather after evacuation.</p> <p>9. Evacuation Procedures - This includes setting up the necessary procedures for evacuating people safely and quickly, such as assigning responsibilities to specific people, establishing a clear chain of command, and identifying the specific steps to be taken during the evacuation</p> <p>10. Emergency Response Team - This involves identifying and training a team of individuals who will be responsible for leading the evacuation process and coordinating with emergency responders .</p> <p>11. Coordination with emergency responders- This measures involves establishing a clear line of communication with local emergency responders such as police, fire and medical services and working with them to ensure a coordinated response during an emergency.</p> <p>12. Communication (during the evacuation)- During an evacuation, it is important to maintain clear communication with employees and the public, to ensure that everyone is aware of the situation and knows what to do. This includes using public address systems, social media, and other communication channels to provide updates on the evacuation process.</p>
6.	Details of dredging and disposal of dredged materials	<p>The studies on details of dredging and disposal of dredged materials are carried out by National Centre for Coastal Research (NCCR), the summarized points are given below:</p> <ul style="list-style-type: none"> ➤ As the structure is supported by piles and they are cast in situ bored driven piles, no dredging of sand is not anticipated in this project, however minimal quantity of sand will be bailed out during the boring of pile..

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		<ul style="list-style-type: none"> ➤ Disturbance to bottom sediments and/or destruction of spawning grounds, sediment-resuspension. ➤ The nature of these impacts will last for short period of time. ➤ As there is no major dredging involved, the quantity of dredged materials will also be minimal. 												
7.	Construction details along with timeline and mitigation measures during construction such as piling etc..	<p>The studies on construction details along with timeline and mitigation measures during construction are given below:</p> <table border="1"> <thead> <tr> <th>Description</th> <th>Mitigation Measures during construction phase</th> </tr> </thead> <tbody> <tr> <td>Construction waste</td> <td> <ul style="list-style-type: none"> ➤ Segregate the waste and dispose ➤ The dumping of waste in the site for long period should be avoided ➤ A silt curtain should be given to trap the sediment movement </td> </tr> <tr> <td>Noise Control</td> <td> <ul style="list-style-type: none"> ➤ Providing a noise barrier around the construction site. ➤ The machinery should be well lubricated. ➤ Providing earplugs/ earmuff to the workers. </td> </tr> <tr> <td>Air Quality & Dust control</td> <td> <ul style="list-style-type: none"> ➤ The equipment should be well maintained. ➤ Sprinkling of water would avoid the dust emission. ➤ Vehicle carrying the waste and the construction equipment should be covered. </td> </tr> <tr> <td>Water/Marine Pollution</td> <td> <ul style="list-style-type: none"> ➤ Build an erosion control blanket ➤ Providing debris trap. ➤ Providing marker buoys </td> </tr> <tr> <td>Marine Ecology</td> <td> <ul style="list-style-type: none"> ➤ The unexpected waste disposal is cleared as soon as possible. ➤ Pile driving should be done with noise insulation to avoid noise vibration to </td> </tr> </tbody> </table>	Description	Mitigation Measures during construction phase	Construction waste	<ul style="list-style-type: none"> ➤ Segregate the waste and dispose ➤ The dumping of waste in the site for long period should be avoided ➤ A silt curtain should be given to trap the sediment movement 	Noise Control	<ul style="list-style-type: none"> ➤ Providing a noise barrier around the construction site. ➤ The machinery should be well lubricated. ➤ Providing earplugs/ earmuff to the workers. 	Air Quality & Dust control	<ul style="list-style-type: none"> ➤ The equipment should be well maintained. ➤ Sprinkling of water would avoid the dust emission. ➤ Vehicle carrying the waste and the construction equipment should be covered. 	Water/Marine Pollution	<ul style="list-style-type: none"> ➤ Build an erosion control blanket ➤ Providing debris trap. ➤ Providing marker buoys 	Marine Ecology	<ul style="list-style-type: none"> ➤ The unexpected waste disposal is cleared as soon as possible. ➤ Pile driving should be done with noise insulation to avoid noise vibration to
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			the marine fauna.
		Safety and Health	<ul style="list-style-type: none"> ➤ Pile driving should be done with noise insulation to avoid noise vibration to the marine fauna. ➤ Proper waste disposal system for the working area ➤ Personal protective equipment should be made compulsory ➤ Safety management plan and proper evacuation plan should be done.
		Management Plans	<ul style="list-style-type: none"> ➤ Alternate navigation plans for the vessels during the construction period should be arranged ➤ Environment Impact Assessment should be done ➤ Alternate route for the fishing boats, local community & tourists must be pre-planned during all stages of construction
		Pile Driving Operations	<ul style="list-style-type: none"> ➤ Silt curtains can be provided around the construction area to the transport of the sediment out of the work site ➤ Reducing the sediment outflow from dredger by using green valve technology and ensuring the well-maintained equipment without any leakage.
		Solid Waste Management	<ul style="list-style-type: none"> ➤ When the structure is opened to tourism, a proper solid waste management should be maintained by providing Dust bins in required distance. ➤ A proper screening system can be done for avoiding plastic in to the bridge covering the sea area. ➤ The waste collected is disposed as per the municipal solid waste management
8.	Impact of the proposed structure on shoreline/accretion	As per National Centre for Coastal Research report by Ministry of Earth Sciences, the project location is at Marina beach region and is referred as Low Accretion Zone .	

Sr.No.	Specific Terms of Reference	Compliance
		<div> </div> <p>Impact of the proposed structure on shoreline/accretion will be minimum due to :</p> <ul style="list-style-type: none"> ➤ The structures will be built on piles which will not be obstructing or blocking the natural flow of water in the construction site. ➤ The piles will be designed and positioned to reduce the total surface area affecting the water current. ➤ During construction, piling is proposed to be carried out by use of bored cast-in-situ concrete piles by use of a permanent liner by rotary drilling, which will minimize the dredging activity. ➤ There will be no exploitation of any vegetation.

Sr.No.	Specific Terms of Reference	Compliance
		<p>➤ There is no land reclamation involved, other than construction of bored cast-in-situ concrete piles.</p> <p>The impact of the proposed structure on shoreline/accretion is carried out by the National Centre for Coastal Research (NCCR); the observations are given below:</p> <p>➤ From the analysis of the long-term datasets, it is evident that this stretch is an accreting coast and an accretion is observed in the coastal stretch in the last 28 years.</p> <p>➤ Shoreline studies indicate that since the proposed pedestrian bridge from land to the Proposed Pen Monument is supported on open piles spaced at sufficiently large distance both in longitudinal and lateral direction, it will not have impact on the nearshore currents.</p>
9.	Examination of impact on marine life, fishing vessel movement and marine patrol network due to the proposed project/ activities.	<p>A detailed marine survey has been collected viz:</p> <ul style="list-style-type: none"> • Bathymetry Survey • Marine Water quality • Sediment quality • Marine Pelagic Organisms • Sensitive Marine Species (seagrass, coral reef, exotic fish etc) • Drone survey for identifying fishing boats around the project site • Seabed study with SCUBA diving <p>Bathymetry Study Observations:</p>

Sr.No.	Specific Terms of Reference	Compliance																						
		<div style="text-align: center;">  <p>Interpolated depth measurements</p> </div> <p>The table below shows the distance from sea shore and corresponding depth for considering the suitable location for the monument.</p> <table border="1"> <thead> <tr> <th>Distance from shore (m)</th> <th>Depth (m)</th> </tr> </thead> <tbody> <tr><td>50</td><td>1.88</td></tr> <tr><td>100</td><td>1.85</td></tr> <tr><td>150</td><td>1.58</td></tr> <tr><td>200</td><td>1.57</td></tr> <tr><td>250</td><td>3.40</td></tr> <tr><td>300</td><td>4.50</td></tr> <tr><td>350</td><td>5.77</td></tr> <tr style="background-color: #92d050;"><td>360</td><td>6.00</td></tr> <tr><td>400</td><td>6.80</td></tr> <tr><td>450</td><td>7.80</td></tr> </tbody> </table>	Distance from shore (m)	Depth (m)	50	1.88	100	1.85	150	1.58	200	1.57	250	3.40	300	4.50	350	5.77	360	6.00	400	6.80	450	7.80
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Sr.No.	Specific Terms of Reference	Compliance	
		500	9.10
<p>Marine survey Observations:</p> <ul style="list-style-type: none"> • Seabed was devoid of any sensitive species like coral reefs , seagrass and olive ridley turtles. • The structures will be built on piles, which will be positioned such that it will not disturb any fishing activities. • During the survey, no fishing boat movement was observed throughout the project area as well as in the vicinity of 500m radius of the proposed Pen Monument. • No sensitive marine flora and fauna were found in and around the proposed project site. • The marine water and sediment quality were found to be optimum. • Plastic bags, wrappers, and PET bottles etc were found floating on the surface. • Seabed was found clear with the better visibility from the mid point to bottom of sea bed. • Based on the physical observations, the sea bed sediment texture was sandy nature. 			

Sr.No.	Specific Terms of Reference	Compliance							
10.	<p>Study on the road connectivity to the project site and impact on the existing traffic network due to the proposed project/activities.</p> <p>Detailed traffic management report and study on transport of materials for construction including source and availability</p>	<p>Study on the road connectivity to the project site</p> <p>Marina Beach, being the World's largest second urban beach, is already a tourist spot and the memorials of many National and State Leaders have already been situated in the same area, so, there is enough infrastructure available to accommodate tourist vehicles.</p> <p>Moreover, the project site is well connected with National Highway of Chennai-Srikakulam and State Highway of Chennai-Ennore.</p> <p>However, in order to improve the vehicular movement even after the increased traffic during the operation phase, the following points are recommended.</p> <table border="1"> <thead> <tr> <th>Impacts due to increased traffic</th> <th>Counter Measures/ Suggestions</th> </tr> </thead> <tbody> <tr> <td>Traffic Congestion at signalized intersections</td> <td> <p>Improvement of traffic signal control system</p> <ul style="list-style-type: none"> ➤ Traffic response system on near/over saturated condition ➤ Synchronized system of traffic signals. <p>Improvement at intersections</p> <ul style="list-style-type: none"> ➤ Road marking and signs ➤ Geometric improvement of intersections. <p>Traffic Enforcement for vehicles and crossing pedestrian</p> </td> </tr> <tr> <td>Traffic Conflict between Vehicles and Crossing of Pedestrian</td> <td> <p>Improvement of Traffic Safety Facilities</p> <ul style="list-style-type: none"> ➤ Pedestrian crossing with traffic light ➤ Scramble pedestrian crossing ➤ Pedestrian bridge <p>Improvement of Traffic Safety Education System</p> </td> </tr> </tbody> </table>		Impacts due to increased traffic	Counter Measures/ Suggestions	Traffic Congestion at signalized intersections	<p>Improvement of traffic signal control system</p> <ul style="list-style-type: none"> ➤ Traffic response system on near/over saturated condition ➤ Synchronized system of traffic signals. <p>Improvement at intersections</p> <ul style="list-style-type: none"> ➤ Road marking and signs ➤ Geometric improvement of intersections. <p>Traffic Enforcement for vehicles and crossing pedestrian</p>	Traffic Conflict between Vehicles and Crossing of Pedestrian	<p>Improvement of Traffic Safety Facilities</p> <ul style="list-style-type: none"> ➤ Pedestrian crossing with traffic light ➤ Scramble pedestrian crossing ➤ Pedestrian bridge <p>Improvement of Traffic Safety Education System</p>
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Sr.No.	Specific Terms of Reference	Compliance	
			<ul style="list-style-type: none"> ➤ Pedestrian safety education program <p>Strengthening traffic regulation enforcement</p>
	Traffic Operation		<p>Strengthening traffic police</p> <ul style="list-style-type: none"> ➤ Strengthening of traffic police during peak hours. ➤ Additional establishment of Traffic Operation System <p>Monitoring of road asset usage</p> <ul style="list-style-type: none"> ➤ Additional establishment of road monitoring system ➤ Expansion of monitoring personnel
	Traffic Accidents		<p>Improvement of Traffic Safety Education</p> <ul style="list-style-type: none"> ➤ Conducting regular awareness programme for traffic safety to drivers/public.
	Traffic Conflict near parking		<p>Improvement of Parking System</p> <ul style="list-style-type: none"> ➤ Regularization of parking spaces to control traffic
<p>The summary of Traffic Management Plan has been prepared by Centre for Urbanization, Buildings & Environment [CUBE], Centre of Excellence of Government of Tamil Nadu & Joint Venture of IIT Madras and the major points are given below:</p>			
		Strategy	Description
		Deployment of security personnel	Security personnel shall be trained to help maintain order and safety in areas with highest tourist traffic. They shall be stationed at key points to monitor the flow of people and ensure that everyone is following safety guidelines.
		Crowd control policies	<p>Designating specific entry and exit points to control the flow of pedestrian traffic and reduce congestion</p> <p>Using physical barriers such as fencing or barricades to guide pedestrian flow and prevent overcrowding in certain areas</p>

1.7.2 General ToR Compliance



Sr.No.	General Terms of Reference	Compliance
1.	<p>The State Government shall submit the Environmental Impact Assessment report (EIA) , prepared as per the stipulated ToR, with Environmental Management Plan (EMP), draft Risk Assessment report with Disaster Management Plan (DMP) including on-site and off-site emergency plan and evacuation plan during emergency, to</p>	<p>Environmental Impact Assessment report (EIA), prepared as per the stipulated ToR and Draft Risk Assessment report with Disaster Management Plan (DMP) including on-site and off-site emergency plan along with evacuation plan during emergency have been prepared.</p> <p>The above reports have been submitted to TNPCB to conduct public hearing for the proposed project in accordance with the procedure laid down under the EIA Notification 2006.</p>

Sr.No.	General Terms of Reference	Compliance
	the state pollution control board for conduct of public hearing for the proposed project in accordance with the procedure laid down under the Environmental Impact Assessment (EIA) Notification, 2006	

2. The EIA/EMP report shall follow the general structure/ToR stipulated for the Port/Harbour related project including Marine Studies , as per the EIA Notification, 2006

Sr.No.	Terms of Reference	Compliance
1.	Reasons for selecting the site with details of alternate sites examined/rejected/selected on merit with the comparative statement and reason/basis for selection. The examination should justify site suitability in terms of environmental	<ul style="list-style-type: none"> • Based on the Bathymetry Survey, the minimum depth required for constructing the monument is 6m from HTL to sea bed which is achieved at the 360 m from LTL of the sea • Initially three sites were considered viz., <ol style="list-style-type: none"> 1. Site I- 360m away from the LTL of Cooum River Mouth 2. Site II- 360m from the LTL of Bay of Bengal along the axis of existing Muthamizh Arignar Dr. Kalaingar memorial 3. Site III- Approx. 360m from the LTL of Bay of Bengal near the Loop Road.

Sr.No.	General Terms of Reference	Compliance
	<p>angle, resources sustainability associated with selected site as compared to rejected sites. The analysis should include parameters considered along with weightage criteria for short-listing selected site.</p>	<ul style="list-style-type: none"> • The Site I was rejected due to its proximity to the Cooum River mouth, heavy siltation warrants frequent desiltation, free tidal flow of water in the Cooum River will be affected and laying of new road is required. • The Site II falls in the CRZ IV A, due to its importance, proximity & significance of the existing memorial, no disturbance to any other nearby activities, also there will be no additional traffic congestion, community pollution load since the visitors will be common for all the attractions nearby including Marina Beach & other memorials, laying of new roads does not require and hence this site is considered. • The Site III which falls under CRZ IV A was rejected due to its proximity to Olive Ridelys nesting sites, nearness to the fish market, fishing yard & nearer to Light house. <div style="text-align: center;"> <p>The image is a satellite map from Google Earth showing the coastal area of Site I. It features the Cooum River flowing into the Bay of Bengal. Key landmarks are labeled: 'Cooum River', 'Cooum River Mouth', 'Existing Muthamizh Arignar Dr. Kalaignar Memorial' (a large green area with a circular structure), and 'Muthamizh Arignar Dr. Kalaignar Memorial Site' (a red dot). A north arrow is visible in the top right corner.</p> </div> <p style="text-align: center;">Site I</p>

Sr.No.	General Terms of Reference	Compliance							
				 <p>Site II</p>					
	 <p>Site III</p>								
	Parameters	Brief information of the site	Disturbance to ecological factors	Proximity to the monument	Traffic congestion	Public movement	Tourist Attraction	Navigational impacts	Disturbance to non-ecological factors
Muthamizh Arignar	360 m from LTL on the	Significant impact on	New road formation	Congestions near Nappier	Nearby bus stand	Not condusive	Boat and fishermen	Significant impacts to	Difficult

Sr.No.	General Terms of Reference	Compliance										
			Dr. Kalaigar Pen Monument Site I	axis of Cooum River mouth	tidal flow of water & siltation	and allied facilities are required	Bridge	available	to tourist attraction	movements will be affected	PWD activities, swimming pool	
			Muthamizh Arignar Dr. Kalaigar Pen Monument Site II	360 m from LTL on the axis of Kalaigar memorial	Monument designed in such a way to nullify the impacts	No new requirement as it will be located besides existing Memorial	No significant congestion	Nearby bus stand & parking facilities available	Four memorials are in the same area. So it will enhance tourist attraction	No boat yard existing	No settlements, no significant impact	Easy
			Muthamizh Arignar Dr. Kalaigar Pen Monument Site III	Approx. 360 m from LTL on the axis of Lighthouse	Olive ridley nesting area & overlaps the light house	New road formation and allied facilities are required	Junction to Santhome church, Dr. Radha Krishnan Salai, Parthasarathy Temple more congestion	No bus stand nearby	Not conducive to tourist attraction due to fisherman habitation	Fishermen movements will be affected as there is natural boat movements terrain & yard	Significant impacts to nearby Government Hospital and settlements, visibility of the light house will be affected	Easy

Sr.No.	General Terms of Reference	Compliance											
		Parameters	Brief information of the site	Disturbance to ecological factors	Proximity to the monument	Traffic congestion	Public movement	Tourist Attraction	Navigational Impacts	Disturbance to non-ecological factors	Construction Conditions. i.e, Feasibility in construction	Total (Out of 40)	Percentage (%)
		Muthamizh Arignar Dr. Kalaignar Pen Monument Site I	360 m from LTL on the axis of Cooum River mouth	2	2	3	4	2	3	3	2	21	53
		Muthamizh Arignar Dr. Kalaignar Pen Monument Site II	360 m from LTL on the axis of Kalaignar memorial	4	5	5	5	5	5	4	5	38	95
		Muthamizh Arignar Dr. Kalaignar Pen Monument Site III	Approx. 360 m from LTL on the axis of Lighthouse	2	4	1	2	3	2	2	4	20	50

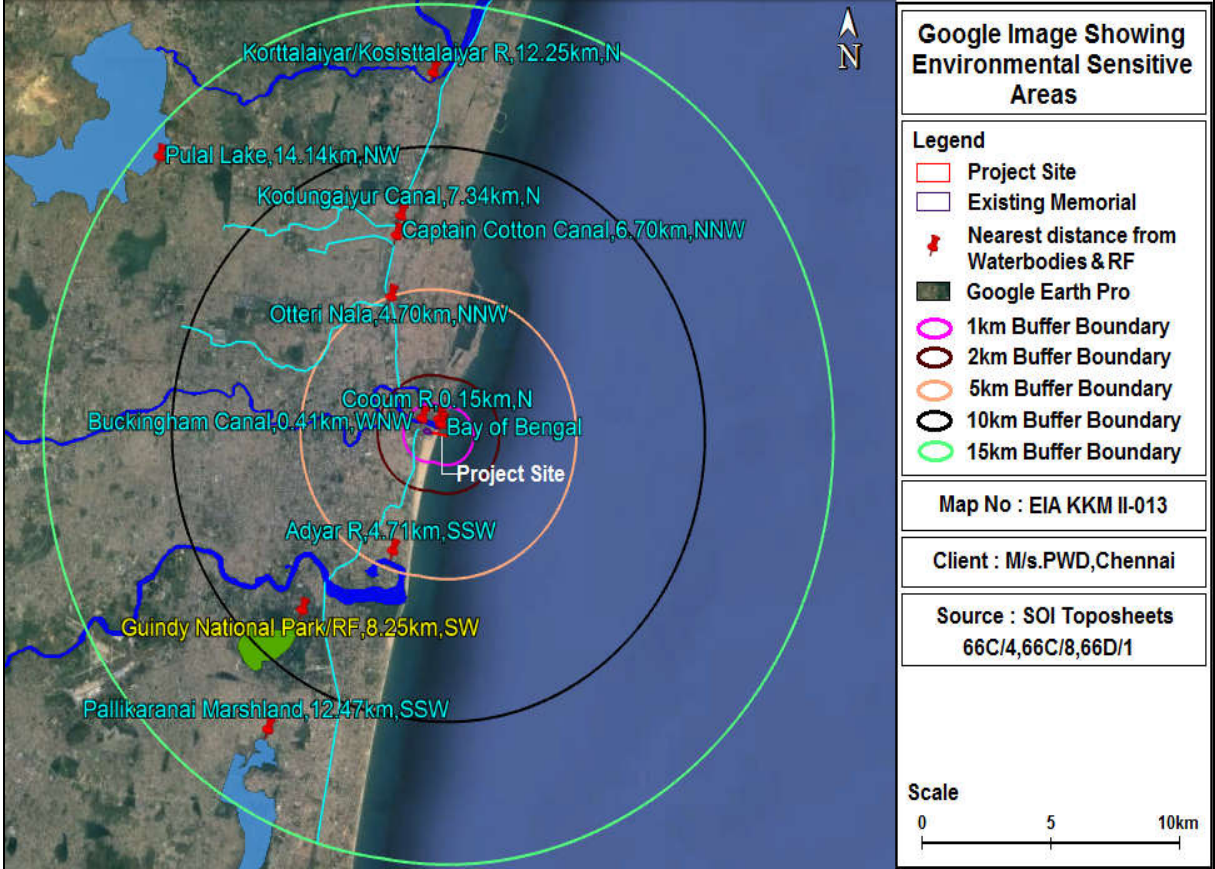
Sr.No.	General Terms of Reference	Compliance																					
2.	<p>Details of the land use break-up for the proposed project. Details of land use around 10 km radius of the project site. Examine and submit detail of land use around 10 km radius of the project site and map of the project area and 10 km area from boundary of the proposed/existing project area, delineating Project areas notified under the wild life (Protection) Act, 1972/critically polluted areas as identified by the CPCB from time to time/notified eco-sensitive areas/interstate boundaries and international boundaries. Analysis should be made based on latest satellite imagery for land use with raw images.</p>	<p>Total Site area -2.11 acres (8551.13 sq.m)</p> <table border="1"> <thead> <tr> <th>S. No.</th> <th>Description</th> <th>Area in sq.m</th> </tr> </thead> <tbody> <tr> <td>1</td> <td>Pen Pedestal</td> <td>2263.08</td> </tr> <tr> <td>2</td> <td>Pedestrian Pathway Above Sea</td> <td>2073.01</td> </tr> <tr> <td>3</td> <td>Lattice Bridge Above Beach & Land</td> <td>1856.00</td> </tr> <tr> <td>4</td> <td>Pedestrian Pathway Above Beach</td> <td>1610.60</td> </tr> <tr> <td>5</td> <td>Pedestrian Pathway from Muthamizh Arignar Dr. Kalaignar Memorial to Bridge</td> <td>748.44</td> </tr> <tr> <td colspan="2">Total area</td> <td>8551.13</td> </tr> </tbody> </table> <p>The Length of the bridge over the land is 290 Mts. (220 Mts in CRZ-II, 70 Mts in CRZ-IA) and over the sea in 360 Mts. (CRZ- IV A), totally covering a travel distance of 650 Mts.</p> <p><u>Land use pattern & Environmentally sensitive areas:</u></p> <p>The proposed project area falls under CRZ-IVA, CRZ IA & CRZ II areas.</p> <p>The details of environmentally/ecologically sensitive areas covering within 15 km from project boundary are given below</p>	S. No.	Description	Area in sq.m	1	Pen Pedestal	2263.08	2	Pedestrian Pathway Above Sea	2073.01	3	Lattice Bridge Above Beach & Land	1856.00	4	Pedestrian Pathway Above Beach	1610.60	5	Pedestrian Pathway from Muthamizh Arignar Dr. Kalaignar Memorial to Bridge	748.44	Total area		8551.13
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Sr.No.	General Terms of Reference	Compliance					
		S. No.	Areas	Distance & Direction from project boundary			
		1.	List of Reserve forest / National Park	Description	Dist. (~km)	Dire.	Coordinates
				Guindy National Park/ Guindy RF	8.25	SW	13° 0'21.35"N 80°14'21.55"E
		2.	List of Water Bodies	Water Bodies		Dist. (~km)	Dire.
				Bay of Bengal		Within the Site	
				Cooum/Kuvam R		0.15	N
				Buckingham Canal		0.41	WNW
				Otteri Nala		4.70	NNW
				Adyar R		4.71	SSW
				Captain Cotton Canal		6.70	NNW
				Kodungaiyur Canal		7.34	N
				Korttalaiyar/Kosisttalaiyar R		12.25	N
				Pallikaranai Marshland		12.47	SSW
				Pulal/Red Hills Lake		14.14	NW
				Madavaram/ Retteri Lake		10.73	NW
				Velachery Lake		11.29	SW
				Korattur Tank		12.20	WNW
				Porur Lake		14.76	WSW
		3.	Nearest Highways	Description		Dist. (~km)	Dire (~)
				Kamarajar Promenade Rd		0.22	W

Sr.No.	General Terms of Reference	Compliance						
					Nearest SH-114(Chennai – Manali – Ennore)	1.95	NNW	
					Nearest NH-(Chennai-Srikakulam)	4.49	NNW	
		4.	Nearest Railway station		Description	Distance (~Km)	Direction (~)	
					Chepauk	0.61	WSW	
					Chennai Central Jn	2.20	NNW	
		5.	List of Monuments/ Heritages	S. No	Monuments	Distance (~km)	Direction	
				1.	Victory War Memorial	0.86	N	
				2.	Chaplain’s house including portion which the northern side of the Old WallIII/1 Fort St.George	1.32	N	
				3.	Wellesley House (Built in 1798) Block No.IV/13 Fort St. George	1.36	N	
				4.	Last house on the left of ‘Snobs Allay’ (oldest house in theFort with carved staircase) – Block No.I/1 Fort St. George	1.38	N	
				5.	Garrisons Engineer’s Depot Block No.IV Fort St. George	1.38	N	
				6.	Fort St. George “Arsenal” between Wellesley house and Clive’s House with shells and cannons piled together near the Gateway Block IV/1-12 and 14-18	1.39	N	
				7.	Nursing Sister’s House (Block 1/3) Fort St. George	1.43	N	
				8.	Big Warehouse south of the Church Library (in Block No.II/7) Fort St. George	1.43	N	
				9.	Clives House built in 1753 Fort St. George	1.45	N	

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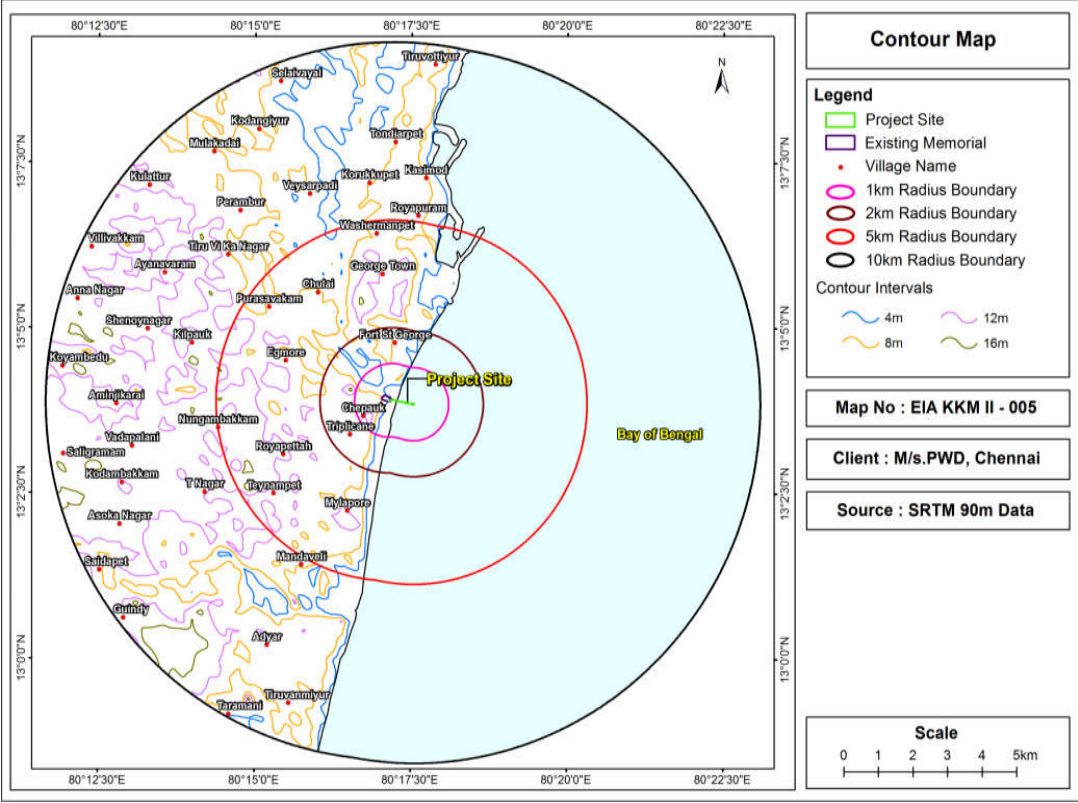
Sr.No.	General Terms of Reference	Compliance					
				Chintadripettai	1.47	WNW	
		Royapettah	1.60	WSW			
		Egmore	1.93	W			
		George Town	2.01	NNW			
		8.	Areas susceptible to natural hazard which could cause the project to present environmental problems, (earthquakes, subsidence, landslides, erosion or extreme or adverse climatic conditions)	<p>The study area falls under Zone-III (Moderate risk) according to the Indian Standard Seismic Zoning Map. Suitable seismic coefficients in horizontal and vertical directions respectively, will to be adopted while designing the structures.</p> <p>The place is also prone for Cyclone and Tsunami.</p>			

Sr.No.	General Terms of Reference	Compliance
		<div style="text-align: center;">  <p>Google Image Showing Environmental Sensitive Areas</p> <p>Legend</p> <ul style="list-style-type: none"> Project Site Existing Memorial * Nearest distance from Waterbodies & RF Google Earth Pro 1km Buffer Boundary 2km Buffer Boundary 5km Buffer Boundary 10km Buffer Boundary 15km Buffer Boundary <p>Map No : EIA KKM II-013</p> <p>Client : M/s.PWD,Chennai</p> <p>Source : SOI Toposheets 66C/4,66C/8,66D/1</p> <p>Scale 0 5 10km</p> </div> <p style="text-align: center;">Environmental Sensitive Areas within 15km from the project boundary</p>

Sr.No.	General Terms of Reference	Compliance																						
3.	Submit the present land use and permission required for any conversion such as forest, agriculture etc. land acquisition status, rehabilitation of communities/ villages and present status of such activities.	<ul style="list-style-type: none"> • The proposed project will be developed in 8551.13sq. m (2.11Acre) at Bay of Bengal off the coast of Marina Beach near Triplicane Village, Chennai District. • The site is devoid of any forest or trees and hence there will be no change in the land use pattern and no land acquisition or conversion is required. • Further, the site is devoid of any human habitations hence evacuation of the project-affected persons is not involved in this project. • Hence, no resettlement and rehabilitation issues are involved in the proposed project. • However, there will be a significant improvement in the aesthetic values of the site • The present land use is majorly ocean and urban. <div style="text-align: center;"> <p>Land Use/Land Cover Pattern of Study Area</p> <table border="1"> <caption>Land Use/Land Cover Pattern of Study Area</caption> <thead> <tr> <th>Category</th> <th>Percentage</th> </tr> </thead> <tbody> <tr> <td>Urban</td> <td>49.66%</td> </tr> <tr> <td>Ocean</td> <td>45.11%</td> </tr> <tr> <td>Rivers/Streams/Canals</td> <td>1.53%</td> </tr> <tr> <td>Deciduous</td> <td>1.30%</td> </tr> <tr> <td>Sandy Area</td> <td>0.66%</td> </tr> <tr> <td>Coastal Wetland</td> <td>0.44%</td> </tr> <tr> <td>Plantation</td> <td>0.42%</td> </tr> <tr> <td>Reservoirs/Lakes/Ponds</td> <td>0.41%</td> </tr> <tr> <td>Fallow land</td> <td>0.19%</td> </tr> <tr> <td>Scrub land</td> <td>0.17%</td> </tr> </tbody> </table> </div> <p style="text-align: center;">Land use/Land cover Pattern of Study Area</p>	Category	Percentage	Urban	49.66%	Ocean	45.11%	Rivers/Streams/Canals	1.53%	Deciduous	1.30%	Sandy Area	0.66%	Coastal Wetland	0.44%	Plantation	0.42%	Reservoirs/Lakes/Ponds	0.41%	Fallow land	0.19%	Scrub land	0.17%
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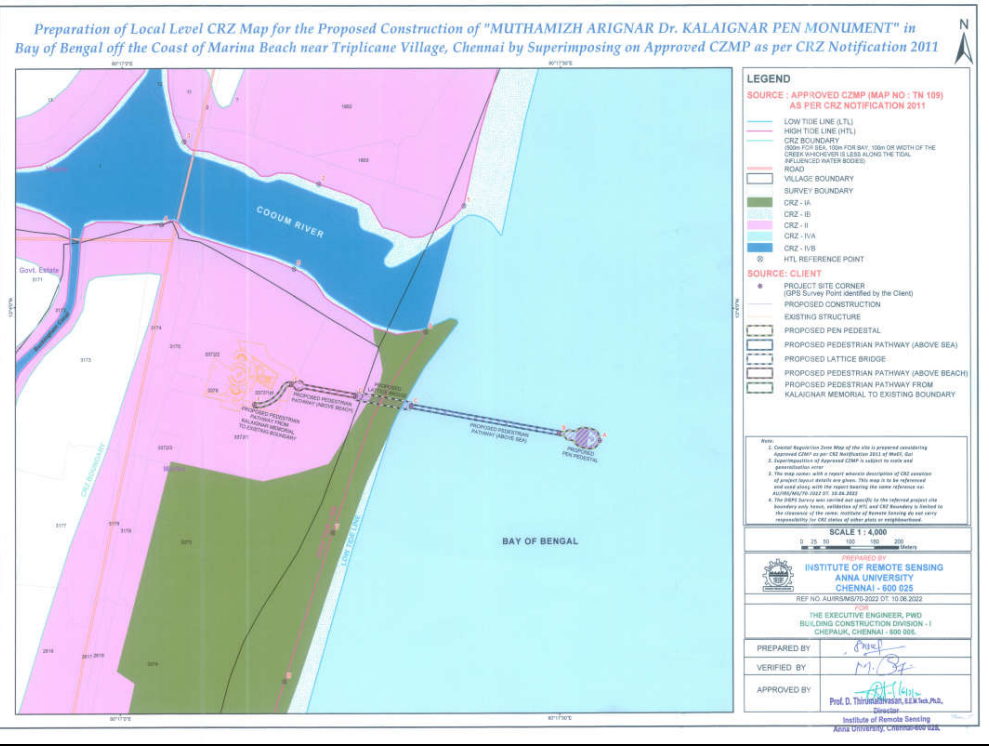
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4.	Examine and submit the water bodies including the seasonal ones within the corridor of impacts along with their status, volumetric capacity, quality likely impacts on them due to the project.	<ul style="list-style-type: none"> • The list of water bodies present around 15km of the project site: <table border="1"> <thead> <tr> <th>Water Bodies</th> <th>Dist. (~km)</th> <th>Dire.(~)</th> </tr> </thead> <tbody> <tr> <td>Bay of Bengal</td> <td colspan="2">Within the Site</td> </tr> <tr> <td>Cooum/Kuvam R</td> <td>0.15</td> <td>N</td> </tr> <tr> <td>Buckingham Canal</td> <td>0.41</td> <td>WNW</td> </tr> <tr> <td>Otteri Nala</td> <td>4.70</td> <td>NNW</td> </tr> <tr> <td>Adyar R</td> <td>4.71</td> <td>SSW</td> </tr> <tr> <td>Captain Cotton Canal</td> <td>6.70</td> <td>NNW</td> </tr> <tr> <td>Kodungaiyur Canal</td> <td>7.34</td> <td>N</td> </tr> <tr> <td>Korttalaiyar/Kosisttalaiyar R</td> <td>12.25</td> <td>N</td> </tr> <tr> <td>Pallikaranai Marshland</td> <td>12.47</td> <td>SSW</td> </tr> <tr> <td>Pulal/Red Hills Lake</td> <td>14.14</td> <td>NW</td> </tr> <tr> <td>Madavaram/ Retteri Lake</td> <td>10.73</td> <td>NW</td> </tr> <tr> <td>Velachery Lake</td> <td>11.29</td> <td>SW</td> </tr> <tr> <td>Korattur Tank</td> <td>12.20</td> <td>WNW</td> </tr> <tr> <td>Porur Lake</td> <td>14.76</td> <td>WSW</td> </tr> </tbody> </table> <p>The major source of impacts on marine water are :</p> <p>Construction Phase:</p> <ul style="list-style-type: none"> • Direct discharge of waste • Pollution from increased vessel traffic or release of contaminants from seabed sediments • Possible contamination of debris from construction activities 	Water Bodies	Dist. (~km)	Dire.(~)	Bay of Bengal	Within the Site		Cooum/Kuvam R	0.15	N	Buckingham Canal	0.41	WNW	Otteri Nala	4.70	NNW	Adyar R	4.71	SSW	Captain Cotton Canal	6.70	NNW	Kodungaiyur Canal	7.34	N	Korttalaiyar/Kosisttalaiyar R	12.25	N	Pallikaranai Marshland	12.47	SSW	Pulal/Red Hills Lake	14.14	NW	Madavaram/ Retteri Lake	10.73	NW	Velachery Lake	11.29	SW	Korattur Tank	12.20	WNW	Porur Lake	14.76	WSW
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		<p>Operation Phase:</p> <ul style="list-style-type: none"> • The water requirement for operation phase is 5 KLD and it is supplied through the water dispensers. • The wastewater will be generated only from the sanitation facilities. As all the sanitation facilities are equipped in the Dr. Kalaignar Karunanidhi Memorial (under construction), no adverse impacts are foreseen. <p>Mitigation Measures</p> <p>The cause and source of pollution of water in the area could be attributed mostly to the surface run-off during rainy season. The following mitigation measures are to be taken in controlling the water contamination:</p> <ul style="list-style-type: none"> ○ Construction activities will be sustained during heavy rains ○ Construction material shall be properly covered to avoid the leakage and spillage. ○ No overburden or loose sediments will be kept in the working benches particularly during monsoon months. ○ Public toiletry will be equipped from the adjacent site (Dr. Kalaignar Karunanidhi Memorial, which got its clearance in 06.01.2022 and its under construction), hence no sewage will be allowed to seep into the land.

Sr.No.	General Terms of Reference	Compliance
5.	Submit a copy of the contour plan, drainage pattern of the site and surrounding area	<p>Contour Plan of the study area</p>  <p>Drainage Pattern of the study area</p> <ul style="list-style-type: none"> • Adyar River originates at the confluence (Thiruneermalai) of two streams that drains the upstream area of Chembarambakkam tank. It is a small river of 42 km length and a catchment of 800 Sq. km.

Sr.No.	General Terms of Reference	Compliance												
		<ul style="list-style-type: none"> • The river carries flow all through 365 days of a year with an average discharge of 89.43 MCM/Year at Kattipara cause way. It drains the southern part of the district and remains flooded during monsoon. • During the high tides, the backwaters from the Bay of Bengal enter inland up to 3 – 4 km. • Cooum is the other main river flowing through the central part of the district and carries only drainage water, which is highly polluted. • It originates from the surplus waters from the Cooum tank in Tiruvallore taluk and the tanks, which are in enroute, discharge their surplus water into the river during flood season. • The flow of Cooum River at Korattur is 40.2 MCM/year for an average duration of 31 days in a year. • Otteri Nulla is another small stream flowing in the northern part of the city. Buckingham canal is the man made one for navigation purposes earlier, but now it act as sewerage carrier in the city. 												
6.	Submit the details of terrain, level with respect to MSL, filling required, source of filling materials and transportation details etc.	Not applicable, as the proposed project is Construction of Muthamizh Arignar Dr.Kalaignar Pen Monument in Bay of Bengal at a distance of 360m from the shore line, CRZ IV (A) Area for promoting tourism.												
7.	Examine road/rail connectivity to the project site and impact on the existing traffic network due to the proposed project/activities. A detailed traffic and transportation study	<p>➤ Road Connectivity</p> <table border="1"> <thead> <tr> <th>Description</th> <th>Dist. (~km)</th> <th>Dire (~)</th> </tr> </thead> <tbody> <tr> <td>Kamarajar Promenade Rd</td> <td>0.22</td> <td>W</td> </tr> <tr> <td>Nearest SH-114(Chennai – Manali – Ennore)</td> <td>1.95</td> <td>NNW</td> </tr> <tr> <td>Nearest NH-(Chennai-Srikakulam)</td> <td>4.49</td> <td>NNW</td> </tr> </tbody> </table>	Description	Dist. (~km)	Dire (~)	Kamarajar Promenade Rd	0.22	W	Nearest SH-114(Chennai – Manali – Ennore)	1.95	NNW	Nearest NH-(Chennai-Srikakulam)	4.49	NNW
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	<p>should be made for existing and projected passenger and cargo traffic.</p>	<p>➤ Rail Connectivity</p> <table border="1"> <thead> <tr> <th>Description</th> <th>Distance (~Km)</th> <th>Direction (~)</th> </tr> </thead> <tbody> <tr> <td>Chepauk</td> <td>0.61</td> <td>WSW</td> </tr> <tr> <td>Chennai Central Jn</td> <td>2.20</td> <td>NNW</td> </tr> </tbody> </table> <p>➤ Impacts on Traffic</p> <ul style="list-style-type: none"> • The rate of traffic would not increase in construction phase. • With the proposed project, the traffic is likely to increase on the existing road network during the operation phase on the nearest road. • Since it is a Pen Monument and attracts more tourism, the impact on Traffic will be more mainly on occasional days compared to normal days. • The major impacts of traffic are: <ul style="list-style-type: none"> ○ Degrading ambient air aquality ○ Over crowding may even lead to accidents. <p>➤ Mitigation Measures of Traffic</p> <ul style="list-style-type: none"> • Reducing local traffic congestion by improving various alternate route options. • Improving parking options • Promoting alternative forms of transportation 	Description	Distance (~Km)	Direction (~)	Chepauk	0.61	WSW	Chennai Central Jn	2.20	NNW
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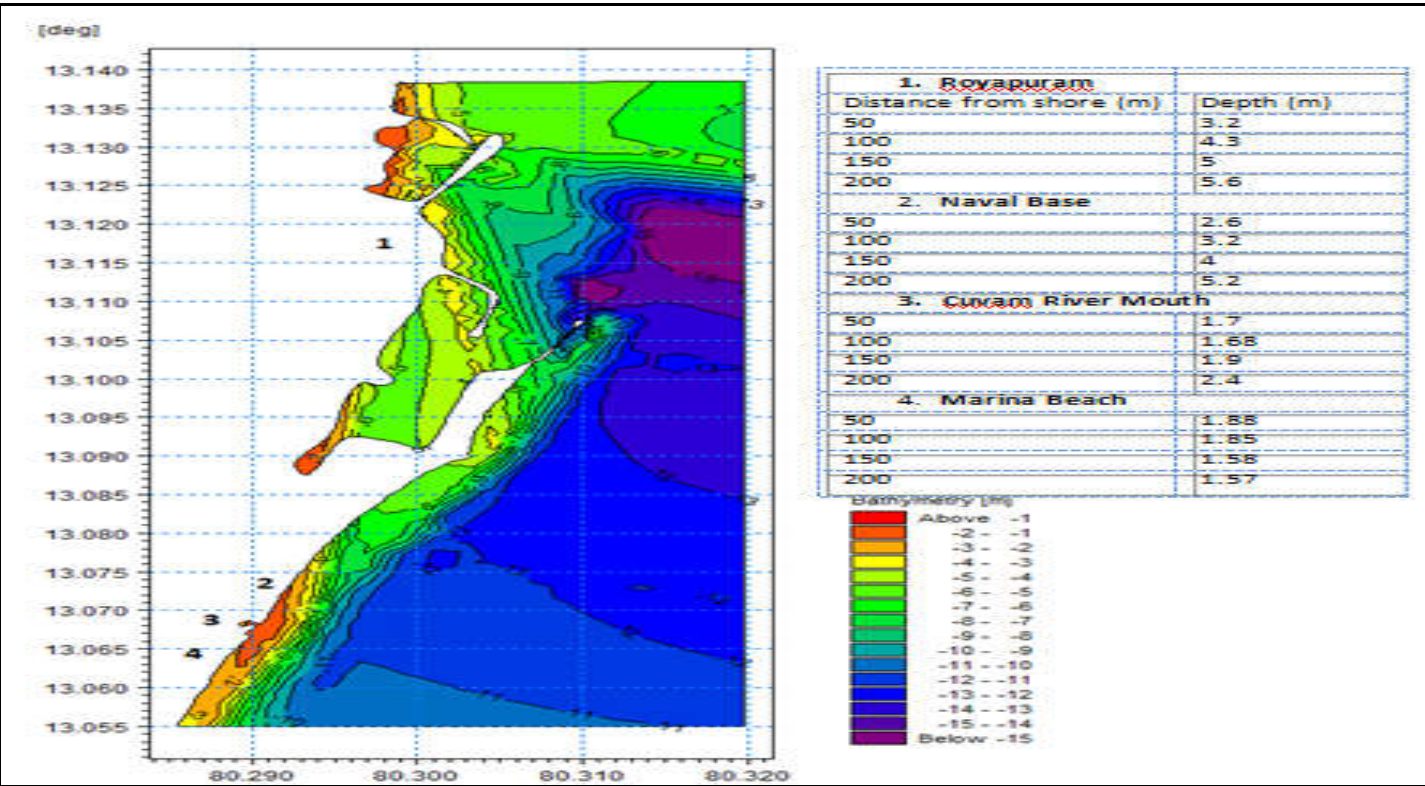
Sr.No.	General Terms of Reference	Compliance
8.	Submit details regarding R&R involved in the project	<ul style="list-style-type: none"> • The site is devoid of any forest or trees and hence there will be no change in the land use pattern and no land acquisition or conversion is required. • Further, the site is devoid of any human habitations hence evacuation of the project-affected persons is not involved in this project. • Hence, no resettlement and rehabilitation issues are involved in the proposed project.
9.	Submit a copy of layout superimposed on the HTL/LTL map demarcated by an authorized agency on 1:4000 scale along with the recommendation of the SCZMA.	 <p style="text-align: center;">Superimposed HTL/LTL map demarcated on 1:4000 scale by IRS, Anna University</p>

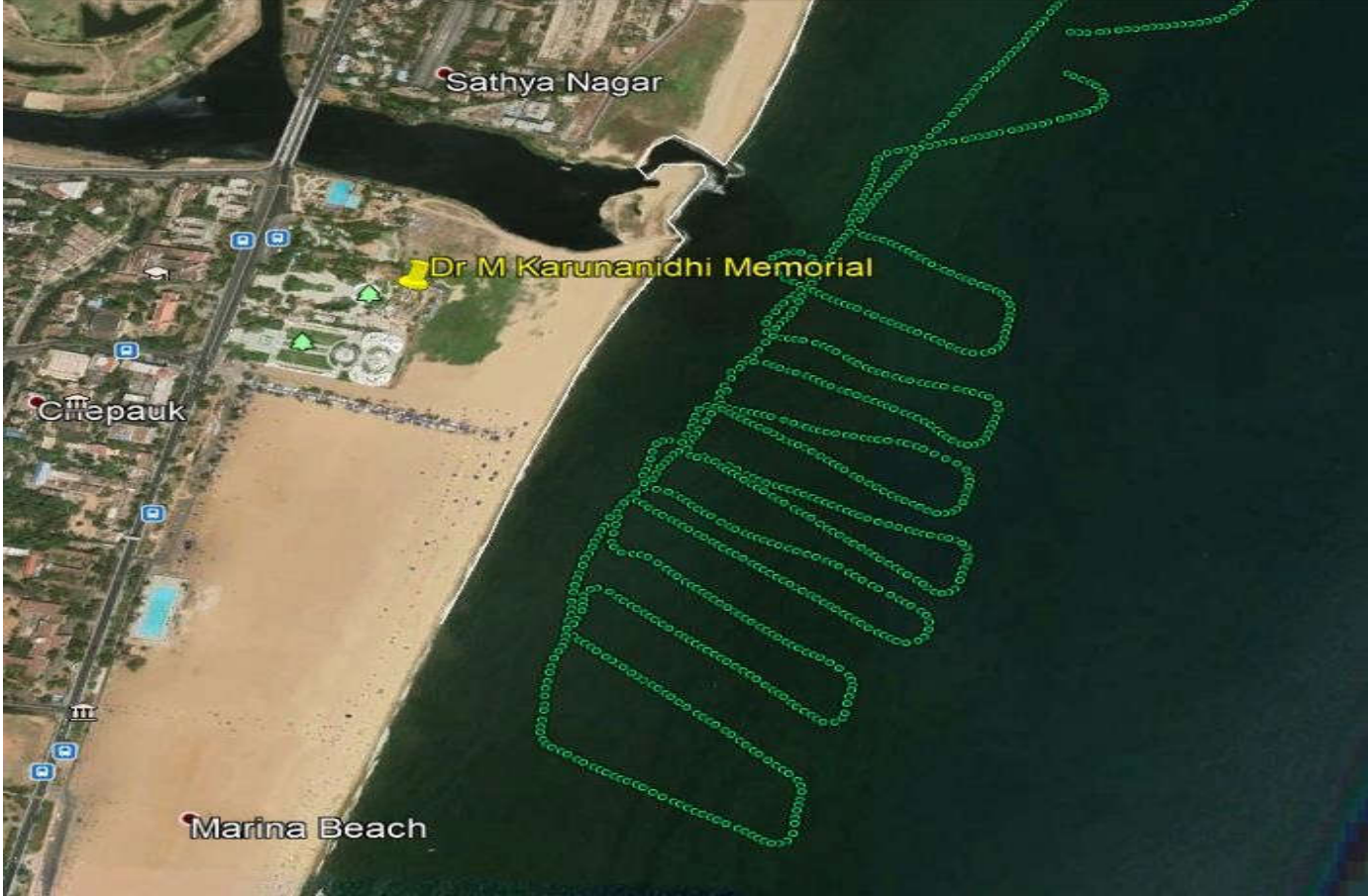
Sr.No.	General Terms of Reference	Compliance
10.	Submit the status of shore line change at the project site	<p>There is no change in the shoreline at the project site.</p> <p>The pen monument is to be placed in Bay of Bengal off the coast of Marina Beach at a distance of 360 m from the shore line in CRZ-IV (A) area, as per section 4(ii) (j) of CRZ Notification amended on March 22, 2016 for construction of memorials/ monuments and allied facilities by the concerned State.</p>
11.	Details of the layout plan including details of channel, breakwaters, dredging, disposal and reclamation.	<div style="text-align: center;"> <p>Total area of the Project- 8551.13 Sq.m</p> </div> <p style="text-align: center;">Site Layout Plan</p> <p>The site is devoid of any forest or trees and hence there will be no change in the land use pattern and no land acquisition or</p>

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		<p>conversion is involved.Hence no land reclamation is required.</p> <p>The list of water bodies present around 15km of the project site:</p> <table border="1"> <thead> <tr> <th>Water Bodies</th> <th>Dist. (~km)</th> <th>Dire.(~)</th> </tr> </thead> <tbody> <tr> <td>Bay of Bengal</td> <td colspan="2">Within the Site</td> </tr> <tr> <td>Cooum/Kuvam R</td> <td>0.15</td> <td>N</td> </tr> <tr> <td>Buckingham Canal</td> <td>0.41</td> <td>WNW</td> </tr> <tr> <td>Otteri Nala</td> <td>4.70</td> <td>NNW</td> </tr> <tr> <td>Adyar R</td> <td>4.71</td> <td>SSW</td> </tr> <tr> <td>Captain Cotton Canal</td> <td>6.70</td> <td>NNW</td> </tr> <tr> <td>Kodungaiyur Canal</td> <td>7.34</td> <td>N</td> </tr> <tr> <td>Korttalaiyar/Kosisttalaiyar R</td> <td>12.25</td> <td>N</td> </tr> <tr> <td>Pallikaranai Marshland</td> <td>12.47</td> <td>SSW</td> </tr> <tr> <td>Pulal/Red Hills Lake</td> <td>14.14</td> <td>NW</td> </tr> <tr> <td>Madavaram/ Retteri Lake</td> <td>10.73</td> <td>NW</td> </tr> <tr> <td>Velachery Lake</td> <td>11.29</td> <td>SW</td> </tr> <tr> <td>Korattur Tank</td> <td>12.20</td> <td>WNW</td> </tr> <tr> <td>Porur Lake</td> <td>14.76</td> <td>WSW</td> </tr> </tbody> </table>	Water Bodies	Dist. (~km)	Dire.(~)	Bay of Bengal	Within the Site		Cooum/Kuvam R	0.15	N	Buckingham Canal	0.41	WNW	Otteri Nala	4.70	NNW	Adyar R	4.71	SSW	Captain Cotton Canal	6.70	NNW	Kodungaiyur Canal	7.34	N	Korttalaiyar/Kosisttalaiyar R	12.25	N	Pallikaranai Marshland	12.47	SSW	Pulal/Red Hills Lake	14.14	NW	Madavaram/ Retteri Lake	10.73	NW	Velachery Lake	11.29	SW	Korattur Tank	12.20	WNW	Porur Lake	14.76	WSW
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Sr.No.	General Terms of Reference	Compliance
	suppression and prevention filters.	
13.	Submit the details of fishing activity and likely impacts on the fishing activity due to the project. Specific study on effects of construction activity and pile driving on marine life.	<ol style="list-style-type: none"> 1. Fishing activity in the project site is comparatively lesser than the surrounding regions. 2. No fishermen will do fishing within 360m from the shore. As the shoals of fishes would be available only in the deep venture of the sea. 3. The lattice bridge is constructed in such a way that the peers of the bridges would have adequate amount of space between them for the locomotion of fishing boats.
14.	Details of oil spill contingency plan.	<p>The dripping of oil occurs only during the construction phase from the vehicles. In accordance with that, the oil drip pan is to be kept below and it will be collected by the Authorized dealers.</p> <p>Therefore, the oil spill contingency plan is not required.</p>
15.	Details of bathymetry study.	<p>HECS conducted a bathymetric survey using a fishing boat on September 2, 2021, at 7 a.m. The bathymetric survey in the sea, proportionate to the Dr.Kalaingnar Karunanithi Monument, near marina beach, has been carried out by a team from the HECS, IITM and Pacific Blu Subsea services. The survey will cover a distance of 500 meters from the shoreline, up to a depth of 17.46 meters and 10-12 bathymetric transects. The bathymetric survey was sub-contracted, using Edgetech 4125 Portable Digital Side Scan Sonar (400/900 KHz).</p>

Sr.No.	General Terms of Reference	Compliance
		<div> <p>The figure is an aerial photograph of a coastal area with overlaid bathymetry data. The land area is shown in shades of brown and tan, while the water is dark blue. Several green contour lines are drawn across the water, representing different depth levels. A yellow arrow points to a specific location on the shore labeled 'Dr. M. Karunanidhi Memorial'. Other labels like 'M', 'E', 'D', 'C', 'B', 'A' are scattered across the land area, and 'olicane' is partially visible at the bottom left. The contours are more densely packed near the shore and become more widely spaced as they move out into the water.</p> </div> <p style="text-align: center;">Bathymetry Survey Transects</p> <p>A depth contour chart was created based on the interpolation, clearly defining changes in bathymetry across the site. The depth varies between 0.92 m and 17.46 m. Up to 200 m, 250 m, 300 m, 400 m, and 500 m from shore, the depth is less than 2 m, 3 m, 4 m, 7.1m, and 9.4m respectively.</p>

Sr.No.	General Terms of Reference	Compliance
		 <p style="text-align: center;">Interpolated depth measurements</p>

Sr.No.	General Terms of Reference	Compliance
		 <p>Bathymetry survey transects (Proposed site)</p>

Sr.No.	General Terms of Reference	Compliance										
		<div> </div> <p style="text-align: center;">Interpolated depth measurements at Marina Beach</p> <p>➤ Findings of Bathymetric Study</p> <p>The table below shows the distance from sea shore and corresponding depth for considering the suitable location for the monument.</p> <table border="1" style="margin-left: auto; margin-right: auto;"> <thead> <tr> <th>Distance from shore (m)</th> <th>Depth (m)</th> </tr> </thead> <tbody> <tr> <td>50</td> <td>1.88</td> </tr> <tr> <td>100</td> <td>1.85</td> </tr> <tr> <td>150</td> <td>1.58</td> </tr> <tr> <td>200</td> <td>1.57</td> </tr> </tbody> </table>	Distance from shore (m)	Depth (m)	50	1.88	100	1.85	150	1.58	200	1.57
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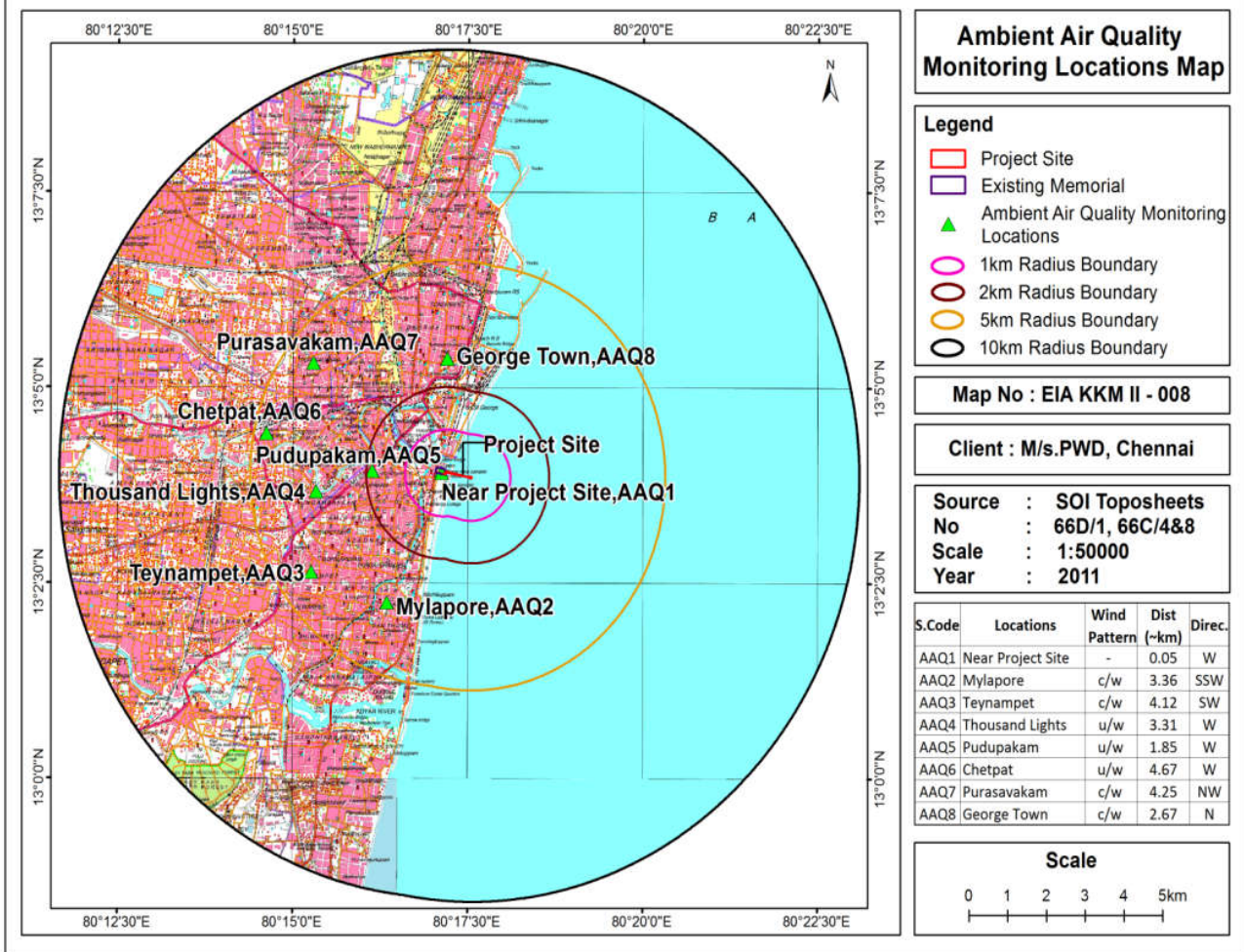
Sr.No.	General Terms of Reference	Compliance	
		250	3.40
		300	4.50
		350	5.77
		360	6.00
		400	6.80
		450	7.80
		500	9.10

Distance from shore (m)	Depth (m)
50	1.88
100	1.85
150	1.58
200	1.57
250	3.4
300	4.5
350	5.77
400	6.8
450	7.8
500	9.1

Distance from sea shore and corresponding depth

Sr.No.	General Terms of Reference	Compliance
16.	Details of ship tranquillity study.	Not applicable, as the proposed project is Construction of Muthamizh Arignar Dr.Kalaignar Pen Monument in Bay of Bengal at a distance of 360m from the shore line, CRZ IV (A) Area for promoting tourism.
17.	Examine the details of water requirement, impact on competitive user, treatment details, use of treated waste water. Prepare a water balance chart.	<p>Construction Phase : The total water requirement will be ~ 15 KLD Domestic : ~ 10 KLD Construction purpose : ~ 5 KLD Source of water is through Metro water tankers.</p> <p>Operation Phase : Domestic : ~ 5 KLD Supplied through water dispensers for drinking purposes.</p>
18.	Details of rainwater harvesting and utilization of rain water.	Not applicable, as the proposed project is Construction of Muthamizh Arignar Dr.Kalaignar Pen Monument in Bay of Bengal at a distance of 360m from the shore line, CRZ IV (A) Area for promoting tourism.
19.	Examine details of Solid waste generation treatment and its disposal.	<p>Construction Phase: Approximately 45.0 kg/day of municipal waste will be generated in premises will be disposed in municipal/corporation bins on daily basis.</p> <p>Operation Phase: Approximately 98.0 kg/day of municipal waste will be generated in the premises shall be disposed through municipal/corporation bins on daily basis.</p>
20.	Details of desalination plant and the study for outfall and intake.	Not applicable, as the proposed project is Construction of Muthamizh Arignar Dr.Kalaignar Pen Monument in Bay of Bengal at a distance of 360m from the shore line, CRZ IV (A) Area for promoting tourism.

Sr.No.	General Terms of Reference	Compliance																																													
21.	Examine baseline environmental quality along with projected incremental load due to the proposed Project/activities.	<p>Baseline environmental quality along with projected incremental load due to proposed activities :</p> <ol style="list-style-type: none"> Sewage Treatment Plant- Existing STP (capacity of 10 KLD which is proposed in Dr. Kalaingar Karunanidhi Memorial; whose CRZ clearance from TNSCZMA had been vide Proc. No. P1/2462/2021 dated 06.01.2021 and 06.01.2022) will be utilized for the proposed project. DG Stack- There is no new DG been proposed; existing DG of capacity 125 kVA will be utilized. <p>Therefore, there will be no incremental load due to proposed activity.</p>																																													
22.	The air quality monitoring should be carried out according to the notification issued on 16th November, 2009	<p>To evaluate the baseline air quality of the study area, Eight (08) monitoring locations have been identified as per annual period wind predominance. The annual wind predominance is from West.</p> <table border="1"> <thead> <tr> <th>Station Code</th> <th>Location</th> <th>Wind Pattern</th> <th>Distance (~km) from Project boundary</th> <th>Directions</th> </tr> </thead> <tbody> <tr> <td>AAQ1</td> <td>Near Project Site</td> <td>-</td> <td>0.05</td> <td>W</td> </tr> <tr> <td>AAQ2</td> <td>Mylapore</td> <td>c/w</td> <td>3.36</td> <td>SSW</td> </tr> <tr> <td>AAQ3</td> <td>Teynampet</td> <td>c/w</td> <td>4.12</td> <td>SW</td> </tr> <tr> <td>AAQ4</td> <td>Thousand Lights</td> <td>u/w</td> <td>3.31</td> <td>W</td> </tr> <tr> <td>AAQ5</td> <td>Pudupakam</td> <td>u/w</td> <td>1.85</td> <td>W</td> </tr> <tr> <td>AAQ6</td> <td>Chetpet</td> <td>u/w</td> <td>4.67</td> <td>W</td> </tr> <tr> <td>AAQ7</td> <td>Purasavakam</td> <td>c/w</td> <td>4.25</td> <td>NW</td> </tr> <tr> <td>AAQ8</td> <td>George Town</td> <td>c/w</td> <td>2.67</td> <td>N</td> </tr> </tbody> </table>	Station Code	Location	Wind Pattern	Distance (~km) from Project boundary	Directions	AAQ1	Near Project Site	-	0.05	W	AAQ2	Mylapore	c/w	3.36	SSW	AAQ3	Teynampet	c/w	4.12	SW	AAQ4	Thousand Lights	u/w	3.31	W	AAQ5	Pudupakam	u/w	1.85	W	AAQ6	Chetpet	u/w	4.67	W	AAQ7	Purasavakam	c/w	4.25	NW	AAQ8	George Town	c/w	2.67	N
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		<div style="text-align: center;">  <p style="text-align: center;">Ambient Air Quality Monitoring Locations Map</p> <p style="text-align: center;">Legend</p> <ul style="list-style-type: none"> Project Site Existing Memorial ▲ Ambient Air Quality Monitoring Locations 1km Radius Boundary 2km Radius Boundary 5km Radius Boundary 10km Radius Boundary <p style="text-align: center;">Map No : EIA KKM II - 008</p> <p style="text-align: center;">Client : M/s.PWD, Chennai</p> <p style="text-align: center;">Source : SOI Toposheets No : 66D/1, 66C/4&8 Scale : 1:50000 Year : 2011</p> <table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th>S.Code</th> <th>Locations</th> <th>Wind Pattern</th> <th>Dist (~km)</th> <th>Dircc.</th> </tr> </thead> <tbody> <tr> <td>AAQ1</td> <td>Near Project Site</td> <td>-</td> <td>0.05</td> <td>W</td> </tr> <tr> <td>AAQ2</td> <td>Mylapore</td> <td>c/w</td> <td>3.36</td> <td>SSW</td> </tr> <tr> <td>AAQ3</td> <td>Teynampet</td> <td>c/w</td> <td>4.12</td> <td>SW</td> </tr> <tr> <td>AAQ4</td> <td>Thousand Lights</td> <td>u/w</td> <td>3.31</td> <td>W</td> </tr> <tr> <td>AAQ5</td> <td>Pudupakam</td> <td>u/w</td> <td>1.85</td> <td>W</td> </tr> <tr> <td>AAQ6</td> <td>Chetpat</td> <td>u/w</td> <td>4.67</td> <td>W</td> </tr> <tr> <td>AAQ7</td> <td>Purasavakam</td> <td>c/w</td> <td>4.25</td> <td>NW</td> </tr> <tr> <td>AAQ8</td> <td>George Town</td> <td>c/w</td> <td>2.67</td> <td>N</td> </tr> </tbody> </table> <p style="text-align: center;">Scale</p> <p style="text-align: center;">0 1 2 3 4 5km</p> </div> <p style="text-align: center;">Map showing Ambient Air Quality Monitoring locations</p>	S.Code	Locations	Wind Pattern	Dist (~km)	Dircc.	AAQ1	Near Project Site	-	0.05	W	AAQ2	Mylapore	c/w	3.36	SSW	AAQ3	Teynampet	c/w	4.12	SW	AAQ4	Thousand Lights	u/w	3.31	W	AAQ5	Pudupakam	u/w	1.85	W	AAQ6	Chetpat	u/w	4.67	W	AAQ7	Purasavakam	c/w	4.25	NW	AAQ8	George Town	c/w	2.67	N
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		Parameters	Impacts on Construction Phase	Impacts on Operation Phase	Mitigation Measures
23.	Examine separately the details for construction and operation phases both for Environmental Management Plan and Environmental Monitoring Plan with cost and parameters.	Air Environment	<ol style="list-style-type: none"> 1. Generation of suspended particles during the site development activities such as levelling of land, transportation of construction materials, drilling etc. 2. Operation of DG sets 3. Increase in vehicular movement which increases the concentration of pollutant level of SO₂, NO_x and CO. 	<p>Only controllable fugitive emissions are noticed.</p> <p>Operation of DG set, in case of power failure.</p>	<p>Regular sprinkling of water will be done at frequent intervals for eliminating the fugitive emissions.</p> <p>Proper maintenance of construction equipments will be done.</p> <p>The vehicles equipped for conveying construction materials will be duly serviced and maintained. During operation phase, no machinery or equipment are to be used anywhere in the project. For that, no chances of air pollution do really exist in the monument complex.</p>
		Water Environment	Water requirement for the construction phase will be of 15KLD.	No major impacts on water environment will be witnessed during the operation phase	<ol style="list-style-type: none"> 1. The proposed project is going to utilize modernized equipment for drilling operations for the foundation of the project, using encased drilling equipment; which would suck out the debris, so that debris could be segregated and collected separately; this would prevent spillage of debris and solid waste into the sea. 2. The impact on various aspects of ecology have been studied in detail by accredited experts and researchers and based on their recommendation; all necessary steps would be taken to completely minimize the impact on ecology due to this project.

Sr.No.	General Terms of Reference	Compliance			
		Noise Environment	The major source of noise will be due to the operation of construction equipments and drilling operations.	During operation phase, no machinery or equipment are to be used anywhere in the project. For that, no chances of noise pollution do really exist in the monument complex	<ol style="list-style-type: none"> 1. In the construction equipments, to minimize the noise level, acoustic enclosure will be installed within. 2. Moreover, all the labourers will be provided with PPEs.
		Land Environment	<p>No major impacts on land are envisaged.</p> <p>The minor impacts may include accumulation of construction debris and other materials.</p>	There will be positive impact in the land environment of the project site, by improvising the aesthetics around the project site.	The proposed project is going to utilize modernized equipment for drilling operations for the foundation of the project, using encased drilling equipment; which would suck out the debris, so that debris could be segregated and collected separately; this would prevent spillage of debris and solid waste in the land.
		Soil Environment	<p>Accumulation of soil due to drilling works</p> <p>Dripping of oil from construction vehicles</p>	The impacts in the soil will be restricted to construction phase only	<p>Continuous monitoring of the soil accumulation will be carried out.</p> <p>The vehicles equipped for conveying construction materials will be duly serviced and maintained.</p>
		Social Environment	<p>Fishermen can engage in their fishing activities even during the construction period.</p> <p>Direct and indirect employment will be generated.</p>	<p>It will be known as the international acclaimed landmark tourism site.</p> <p>Aesthetics of the project site and around the Marina Beach will be improved</p>	The various studies pertaining to the impact of the monument on local ecology, socio-economy and cultural life of the fishermen and other people living around the area are carried out.
		Marine Ecology	<p>Chances of the accumulation of debris and other materials into the sea</p> <p>Construction activities may affect the life of Olive Ridley Turtles and marine</p>	No major impacts during operation phase	The impact on various aspects of ecology including shoreline accretion/erosion among the marine life, life of turtles, prawns etc., have been studied in detail by accredited experts and researchers and based on their recommendation; all necessary steps would be taken to completely minimize the impact on ecology due to this project.

Sr.No.	General Terms of Reference	Compliance			
			ecology.		<p>From the marine survey, it is observed that seabed was devoid of any sensitive species like coral reefs, sea grass and olive ridley turtles at the time of survey conducted. Sea bed sediment was sandy in texture; based on the physical observations.</p> <p>The sensitive species like sea grass, sea weeds, coral reefs and turtle which were not identified at all locations the depth of 2.5m to 9m from the shoreline</p>

Sr.No.	General Terms of Reference	Compliance
24.	Submit details of a comprehensive Risk Assessment and Disaster Management Plan including emergency evacuation during natural and man-made disasters	<p>Risk Assessment :</p> <div> </div> <p>Work domicile hazards can be notorious in a number of ways. Checks /Inspection provide a system of distinguishing hazardous conditions so that those conditions can be corrected. The data collected while performing inspections will be used to identify hazards and barriers to working safely and in an environmentally protective manner so that they can be addressed such as procedure changes or purchasing different PPE. The data also will be tracked as a protective measure of acceptable</p>

Sr.No.	General Terms of Reference	Compliance
		<p>HSE behaviour on the site. Reports and safe work observation information will be shared with employees at toolbox safety meeting</p> <p>Disaster Management Plan :</p> <p>A disaster is a catastrophic situation in which suddenly, people are plunged into helplessness and suffering, as a result, need protection, clothing, shelter, medical and social care and other necessities of life.</p> <p>Disasters can be divided into two main groups. In the first, disasters resulting from natural phenomena like Tsunamis ,earthquakes, volcanic eruptions, storm surges, cyclones, tropical storms, floods, avalanches, landslides, forest fires etc. The second group includes disastrous events created by man, or man’s impact upon the environment. Examples are armed conflict, radiation accidents, campus fires, and river pollution, air, sea, and rail and road transport accidents and can reach catastrophic dimensions in terms of human loss.</p> <div> <pre> graph TD A((Features of Disaster)) --> B[Unpredictability] A --> C[Urgency] A --> D[Unfamiliarity] A --> E[Uncertainty] A --> F[Speed] A --> G[Threat] </pre> </div>

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25.	Submit details of the trees to be cut including their species and whether it also involves any protected or endangered species. Measures taken to reduce the number of the trees to be removed should be explained in detail. Submit the details of	As the proposed project site is devoid of any trees, no cutting of trees is being involved.															

Sr.No.	General Terms of Reference	Compliance
	compensatory plantation. Explore the possibilities of relocating the existing trees.	
26.	Examine the details of afforestation measures indicating land and financial outlay. Landscape plan, green belts and open spaces may be described. A thick green belt should be planned all around the nearest settlement to mitigate noise and vibrations. The identification of species/plants should be made based on the botanical studies.	<p>The proposed structure is a Pen Monument and governed by the Town and Country Planning norms of Government of Tamil Nadu and Building by laws of Chennai Metropolitan Development Authority.</p> <p>About 572.07 Sq.m (6.69 %) areas will be reserved for green cover / lawn development in the proposed. Suitable plant species of local varieties will be planted with adequate spacing and density for their fast growth and survival.</p> <p>The greenbelt helps to capture the fugitive emissions and to attenuate the noise generated in the premises apart from improving the aesthetics of the site. Plantation program is undertaken in all available areas. This would include plantation in the premises.</p> <p>The plant species selected for greenbelt will include the native, saline resistant and wind resistant species. These saplings will be planted in rows. The plantation at the proposed project will be taken into consideration of the existing social forestry in the region.</p>
27.	The Public Hearing should be conducted for the project in accordance with provisions of Environmental Impact Assessment Notification, 2006 and the issues raised by the public	<p>Public Hearing has been carried out as per the provisions of Environmental Impact Assessment Notification, 2006.</p> <p>The issues raised by the Public has been addressed in the Environmental Management Plan.</p> <p>The Public Hearing has been conducted based on the ToR letter issued by the Ministry and not on the basis of Minutes of the Meeting available on the web-site and suitably incorporated in the final EIA/EMP.</p>




Sr.No.	General Terms of Reference	Compliance									
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28.	A detailed draft EIA/EMP report should be prepared in accordance with the above additional TOR and should be submitted to the Ministry in accordance with the Notification.	A detailed draft EIA/EMP report has been prepared in accordance with the above additional TOR and will be submitted to the Ministry in accordance with the Notification.									
29.	Details of litigation pending against the project, if any, with direction /order passed by any Court of Law against the Project should be given.	For the proposed project no litigation /cases are pending or passed by any court of law against the project.									
30.	The cost of the Project (capital cost and recurring cost) as well as the cost towards implementation of EMP should be clearly spelt out.	<p>The cost of the Project (capital cost and recurring cost) is given below</p> <table border="1"> <thead> <tr> <th>Sr.No.</th> <th>Description</th> <th>Amount</th> </tr> </thead> <tbody> <tr> <td>1</td> <td>Ramp from Land memorial, Buggy drop off area & Bridge –Landward side</td> <td>14,60,00,000</td> </tr> <tr> <td>2</td> <td>Provision for Lattice bridge arrangements</td> <td>10,00,00,000</td> </tr> </tbody> </table>	Sr.No.	Description	Amount	1	Ramp from Land memorial, Buggy drop off area & Bridge –Landward side	14,60,00,000	2	Provision for Lattice bridge arrangements	10,00,00,000
Sr.No.	Description	Amount									
1	Ramp from Land memorial, Buggy drop off area & Bridge –Landward side	14,60,00,000									
2	Provision for Lattice bridge arrangements	10,00,00,000									

Sr.No.	General Terms of Reference	Compliance		
		3	Bridge & Pen monument podium area-seaward side	31,25,00,000
		4	Working platform arrangements for construction works in marine environment	8,66,58,400
		5	Provision for Pen Monument	40,00,000
		6	Provision for Buggy Vehicles	16,80,000
		7	Provision for Lightning arrangements & Lamp Post	17,50,000
		8	Provision for Landscaping & Gardening	11,00,000
		9	Provision for SS Handrails & Glass Balustrades	1,00,00,000
		10	Provision for Structural Laminated Glass	1,25,00,000
		11	Provision for Ferrari Roof Canopy	20,00,000
		12	Provision for Electrical , Fire & Service	2,00,00,000
		13	Provision for DPR , Feasibility report, Environmental related works & PMC.	2,50,00,000
		Sub Total		72,31,88,400
		Add 12% GST		8,67,82,208
		Round Off		28,992
		Total Value of Work		81,00,00,000
	The cost towards implementation of EMP :			

Sr.No.	General Terms of Reference	Compliance					
		Sr.No.	Description	EMP Cost (INR Lakhs)			
				Capital cost	Recurring cost 2024-2025	Recurring cost 2025-2026	Recurring cost 2026-2027
		1	Greenbelt	5	3	3	3
		2	Marine Monitoring	10	10	10	10
		3	Terrestrial Monitoring	6	2	2	2
		4	Solid waste Management	5	2	2	2
		Sub Total		26	17	17	17
		Total		77			
3.	Public Hearing shall be conducted as per the procedure laid in the EIA Notification, 2006 with adequate presentation of fishermen community	Public Hearing has been conducted on 31.01.2023 at 10:30 am at Kalaivnar Arangam after the submission of EIA report along with the project presentation to fishermen community to TNPCB DEE as per the procedure laid in the EIA Notification, 2006.					
4.	The State Government after addressing the relevant issues raised by the public during the public hearing	All the Public Hearing issues raised by the public during public hearing has been addressed in Final EIA, EMP, Risk Assessment and DMP reports and will be submitted to State CZMA for their examination and recommendation.					

Sr.No.	General Terms of Reference	Compliance
	shall submit the final EIA, EMP, Risk Assessment and DMP, to the State CZMA for their examination and recommendation	

Sr.No.	General Terms of Reference	Compliance
5.	<p>The concerned State Government shall submit justification for locating the project in CRZ IV(A) area after conducting alternate site analysis and weightage matrix on various parameters</p>	<p>Based on the Bathymetry Survey, the minimum depth required for constructing the monument is 6m from HTL to seabed which is achieved at the 360 m from LTL of the sea.</p> <p>Initially three sites were considered viz.,</p> <ul style="list-style-type: none"> ➤ Site I- 360m away from the LTL of Cooum River Mouth ➤ Site II- 360m from the LTL of Bay of Bengal along the axis of existing Muthamizh Arignar Dr. Kalaighar Karunanidhi Memorial ➤ Site III- Approx. 360m from the LTL of Bay of Bengal near the Loop Road. <p>The Site I was rejected due to its proximity to the Cooum River mouth, heavy siltation warrants frequent desiltation, free tidal flow of water in the Cooum River will be affected and laying of new road is required.</p> <p>The Site II falls in the CRZ IV A, due to its importance, proximity & significance of the existing memorial, no disturbance to any other nearby activities, also there will be no additional traffic congestion, community pollution load since the visitors will be common for all the attractions nearby including Marina Beach & other memorials, laying of new roads are not required and hence this site is considered.</p> <p>The Site III which falls under CRZ IV A was rejected due to its proximity to Nesting sites of Olive Ridleys, fish market, fishing yard and Chennai Lighthouse.</p>

Sr.No.	General Terms of Reference	Compliance
		<div style="display: flex; justify-content: space-around;"> <div style="text-align: center;"> <p>Site I</p>  </div> <div style="text-align: center;"> <p>Site II</p>  </div> </div> <div style="text-align: center; margin-top: 20px;"> <p>Site III</p>  </div>

Sr.No.	General Terms of Reference	Compliance									
Weightage Matrix of the Site Selection											
		Parameters	Brief information of the site	Disturbance to ecological factors	Proximity to the monument	Traffic congestion	Public movement	Tourist Attraction	Navigational impacts	Disturbance to non-ecological factors	Construction Conditions. i.e, Feasibility in construction
Muthamizh Arignar Dr. Kalaignar Pen Monument Site I	360 m from LTL on the axis of Cooum River mouth	Significant impact on tidal flow of water & siltation	New road formation and allied facilities are required	Congestions near Nappier Bridge	Nearby bus stand available	Not conducive to tourist attraction	Boat and fishermen movements will be affected	Significant impacts to PWD activities, swimming pool	Difficult		
Muthamizh Arignar Dr. Kalaignar Pen Monument Site II	360 m from LTL on the axis of Kalaignar memorial	Monument designed in such a way to nullify the impacts	No new requirement as it will be located besides existing Memorial	No significant congestion	Nearby bus stand & parking facilities available	Four memorials are in the same area. So it will enhance tourist attraction	No boat yard existing	No settlements, no significant impact	Easy		

Sr.No.	General Terms of Reference	Compliance											
		Muthamizh Arignar Dr. Kalaigar Pen Monument Site III	Approx. 360 m from LTL on the axis of Lighthouse	Olive ridley nesting area & overlaps the light house	New road formation and allied facilities are required	Junction to Santhome church, Dr. Radha Krishnan Salai, Parthasarathy Temple more congestion	No bus stand nearby	Not conducive to tourist attraction due to fisherman habitation	Fishermen movements will be affected as there is natural boat movements terrain & yard	Significant impacts to nearby Government Hospital and settlements, visibility of the light house will be affected	Easy		
		Parameters	Brief information of the site	Disturbance to ecological factors	Proximity to the monument	Traffic congestion	Public movement	Tourist Attraction	Navigational Impacts	Disturbance to non-ecological factors	Construction Conditions. i.e, Feasibility in construction	Total (Out of 40)	Percentage (%)
		Muthamizh Arignar Dr. Kalaigar Pen Monument Site I	360 m from LTL on the axis of Cooum River mouth	2	2	3	4	2	3	3	2	21	53

Sr.No.	General Terms of Reference	Compliance											
		Muthamizh Arignar Dr. Kalaignar Pen Monument Site II	360 m from LTL on the axis of Kalaignar memorial	4	5	5	5	5	5	4	5	38	95
		Muthamizh Arignar Dr. Kalaignar Pen Monument Site III	Approx. 360 m from LTL on the axis of Lighthouse	2	4	1	2	3	2	2	4	20	50
6.	ToR shall include the additional ToR as proposed by the PP and also the ToR stipulated by the Tamil Nadu CZMA vide letter dated 25/07/2022	<p>ToR will include additional ToR and ToR stipulated by the DCZMA and SCZMA.</p> <p>The DCZMA meeting for the proposed project have been held on 14.06.2022 and it is been recommended to SCZMA with laid conditions given below:</p>											

Sr.No.	General Terms of Reference	Compliance		
		S.No	Conditions	Reply
		1.	Ensuring the proposed activities in CRZ areas are as per provisions of CRZ Notification,2011	<p>Will be complied</p> <p>The proposed pen monument Construction is as per the CRZ Notification, 2011.</p>
		2.	Proposed planning constructions should satisfy the local, town and country planning regulations	<p>Will be complied.</p> <p>The proposed planning constructions will satisfy the local, town and country planning regulations</p>
		3.	Proposed construction shall not disturb the land and marine ecology	<p>Will be complied.</p> <p>The proposed construction will not disturb the land and marine ecology.</p>
		4.	Proposed construction shall not disturb the fishermen, marine patrol & public movement at any point of time.	<p>Will be complied.</p> <p>The proposed construction will not disturb the fishermen, marine patrol and public movement.</p>
		5.	No ground water from CRZ shall be tapped	<p>Will be complied.</p> <p>There will be no extraction of ground water from CRZ areas.</p>

Sr.No.	General Terms of Reference	Compliance		
		6.	The treated water shall be used for greenbelt developed within the existing premises and sludge as manure	<p>Will be complied.</p> <p>Domestic sewage will be sent to 10 KLD capacity STP for treatment and the treated water will be used for green belt.</p>
		7.	All the solid waste shall be handled as per solid waste Management Rules,2016	<p>Will be complied.</p> <p>All the solid waste will be handled as per solid waste Management Rules,2016</p>
		8.	Project shall explore the possibilities of allocation of funds for preserving the ecology and environment	<p>Will be complied.</p> <p>All the possibilities of allocating funds for preserving the ecology and environment will be fulfilled by PWD department through CSR activities.</p>
		9.	Proponent shall comply Environmental Management Plan for both Operation and Construction phase	<p>Will be complied.</p> <p>The detailed EMP for both operation and Construction phase is prepared and will be followed accordingly.</p>
		10.	Construction shall be designed in accordance with the seismic factors applicable to moderate intensity zone.	<p>Will be complied.</p> <p>The Construction will be designed in accordance with the seismic factors applicable to moderate intensity zone</p>

Sr.No.	General Terms of Reference	Compliance		
		11.	Construction shall comply with construction and demolition waste management rules,2016	<p>Will be complied.</p> <p>The construction shall comply with construction and demolition waste management rules,2016</p>
		12.	Project Proponent shall undertake the establishment only after getting required clearances from competent authorities and statutory clearances	<p>Will be complied.</p> <p>The Public Works Department will commence their work only after the necessary clearances are obtained.</p>
		13.	Project Proponent shall install solar panel of ROHs standards for lightning within project premises	<p>Will be complied.</p> <p>Installation of Solar Lights will be Implemented wherever possible.</p>
<p>The SCZMA meeting for the proposed project have been held on 20.06.2022 and it is been recommended to MoEF&CC with the conditions laid by the DCZMA to be followed.</p>				

CHAPTER 2

PROJECT DESCRIPTION

2. PROJECT DESCRIPTION

Proposed Construction of Muthamizh Arignar Dr.Kalaigñar Pen Monument in Bay of Bengal near Triplicane village, Chennai -600 005. The present chapter details the project with respect to building plans, requirements and implementation schedule.

The Pen Monument is to be placed in the Bay of Bengal off the coast of Marina Beach at a distance of 360 m from the shore line in CRZ-IV (A) area, as per section 4(ii) (j) of CRZ Notification amended on March 22, 2016 for construction of memorials/ monuments and allied facilities by the concerned State

2.1 Need of the Project

This Pen Monument construction will be implemented for commemorating the contribution to Eyal, Isai Naadagam done by Muthamizh Arignar Kalaigñar Dr.M.Karunanidhi to the Tamil literature at Kamaraj Salai, Chennai 600 005.

2.2 Project Location

The proposed project will be developed in the Corporation limits of Chennai. The project site location and surrounding features are shown in

Figure 2-1.

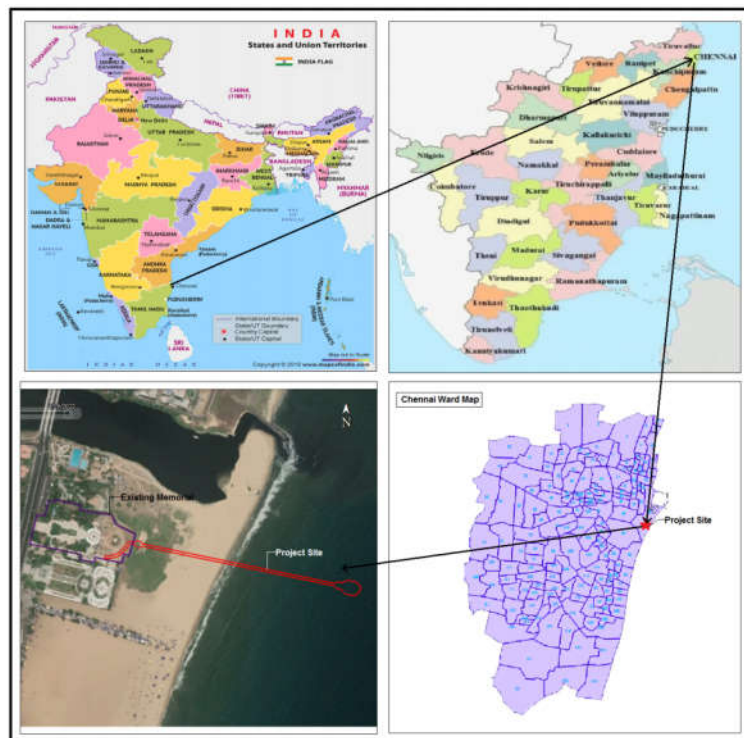


Figure 2-1 Project Site Location



Figure 2-2 Project Site Coordinates

S.No	Latitude	Longitude
1	13° 3'53.95"N	80°17'9.08"E
2	13° 3'55.31"N	80°17'12.31"E
3	13° 3'51.44"N	80°17'30.70"E
4	13° 3'51.69"N	80°17'31.90"E
5	13° 3'50.85"N	80°17'33.05"E
6	13° 3'50.45"N	80°17'31.74"E
7	13° 3'51.21"N	80°17'30.63"E
8	13° 3'54.69"N	80°17'12.27"E
9	13° 3'53.71"N	80°17'9.08"E

Centre Coordinates of Project Components(As per IRS Map):

S.No	Latitude	Longitude
A	13° 3'53.794"N	80°17'9.182"E
B	13° 3'55.109"N	80°17'11.732"E
C	13° 3'54.365"N	80°17'16.132"E
D	13° 3'53.725"N	80°17'19.908"E
E	13° 3'52.008"N	80°17'30.015"E
F	13° 3'51.537"N	80°17'32.802"E

2.3 Size and Magnitude of the Project

The proposed project will be developed in **8551.13 sq. m (2.11 Acres)**. The details of land use and built-up areas of the project are given in the **Table 2-1**.

Table 2-1 Details of Proposed Land use

S.No.	Description	Area in sq.m
1	Pen Pedestal Above Sea	2263.08
2	Pedestrian Pathway Above Sea	2073.01
3	Lattice Bridge Above Beach & Land	1856.00
4	Pedestrian Pathway Above Beach	1610.60
5	Pedestrian Pathway from Muthamizh Arignar Dr. Kalaignar Karunanidhi Memorial to bridge above beach	748.44
Total area		8551.13

2.4 Project Details & Requirement

2.4.1 Design Concept

The proposed project will be developed in 2.11 Acre .To commemorate and celebrate the contribution to Eyal, Isai, Nadagam done by Muthamizh Arignar Kalaignar Dr.M.Karunanidhi to Tamil literature. Hence, his PEN will be converted as a 42-metre tall monument, surrounded by landscaped gardens and located in the Bay of Bengal at a distance of 360 m from the shoreline.

There will be a pedestrian bridge from his Memorial to the *PEN* at an elevation of 6 m from the High Tide Line (HTL).

The length of the bridge over the Land is 290 m and over the Sea is 360 m, totally covering a travel distance of 650 m.

For public convenience, the Bridge will be 9 m wide with a glass flooring of 2 m. The facility was designed to suit the climate of Chennai.

The design concept considered for the proposed project is described below:

- Integration of building interior and surrounding landscaping;
- The design will consider the climatic conditions of Chennai;
- Architectural/Landscape elements will be chosen appropriate to the local context;
- Careful attention to Architectural/Engineering detailing at both macro and micro levels;
- Power generators control the movement of vehicular traffic in the site.

The project design is derived from Iyal (means Poetry/Literature), Isai (means Music) and Nadagam (means Drama), the three elements of the Thamizh language.

Location of the monument:

The monument is footed in the sea at 360m away from Marina beach of Chennai, which is 42 m tall PEN MONUMENT ~ 2.60 m diameter for Dr. Kalaignar M. Karunanidhi which is accessed from the land through a lattice bridge.

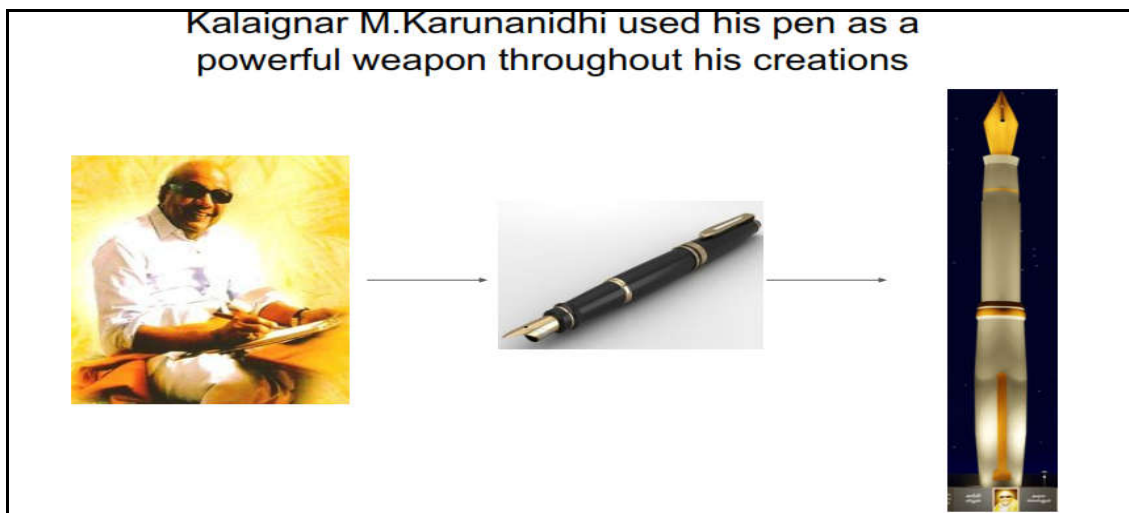
The monument can be compared to the Catamaran on the sea, with which Kalaignar compares himself and the location is unique to the city and the State, as it is the world's second largest Urban beach.

1. Kalaignar M. Karunanidhi is also known as Muthamizh Arignar, because of his Tamil skills and his contributions to Tamil literature.

2. The project capitalizes on the elements of Tamil Cultural Identity (Muthamizh) drawn from its Literature (Iyal), Music (Isai), and Drama (Nadagam) components and merges them with the Kalaignar's Iconic tools and Statements.

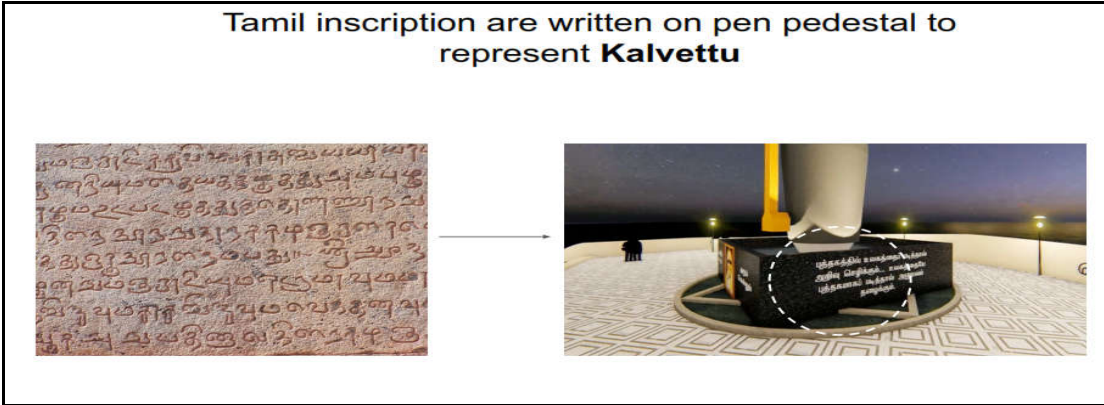
Design features:

1. **The Pen:** The PEN symbolises his greatest talent and prowess through which he ruled Tamil hearts and grew up to be a mass leader.



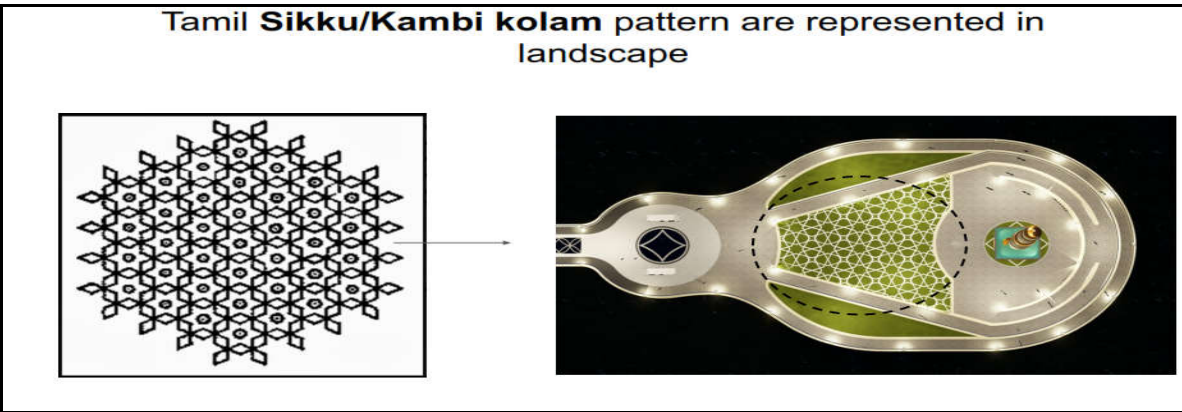
2. **The Inscriptions:** "Writing" is a powerful tool through which Dr.Kalaignar Karunanidhi has brought out his creations to the world and he has been writing throughout his life. Tamil quotes and sayings of the leader are carved in the monument pedestal representing the Tamil temple stone inscriptions (Kalvettu).

Tamil inscription are written on pen pedestal to represent **Kalvettu**



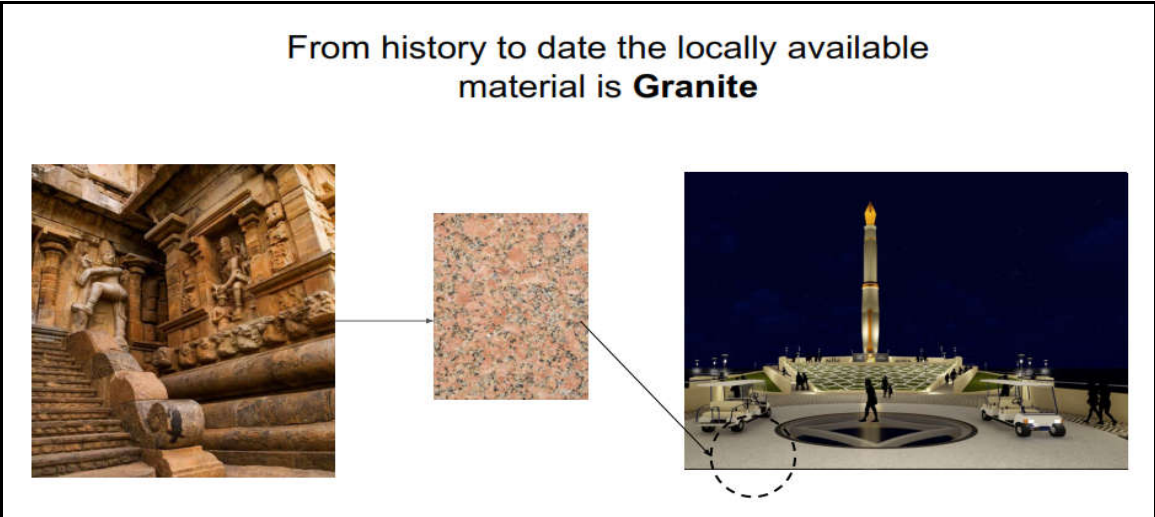
- 3. **The Garden/Landscape:** The landscape on the pedestal is laid out in the form of Sikku Kolam, a traditional form of rangoli art done by women in Tamil homes and the kolam consists of a pattern in which a stroke runs once around each dot, and returns to the beginning point, thus forming a geometrical figure.

Tamil **Sikku/Kambi kolam** pattern are represented in landscape



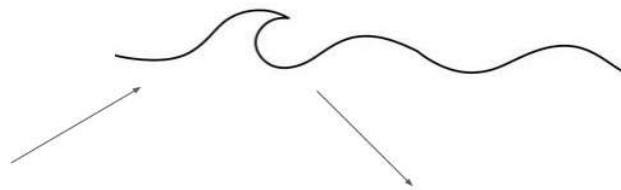
- 4. **Material:** From history until date, Granite is the locally and widely available material in the state.

From history to date the locally available material is **Granite**



- 5. The **Parapet Walls of the bridge** represent the wave patterns relating to the Marina Beach.

Parapet walls represent wave patterns of ocean



2.4.2 Master Plan

The Master Plan is developed in concern with the climatic factors and site conditions. The project site is mostly dry and flat. The Master plan is shown in **Figure 2-3**.

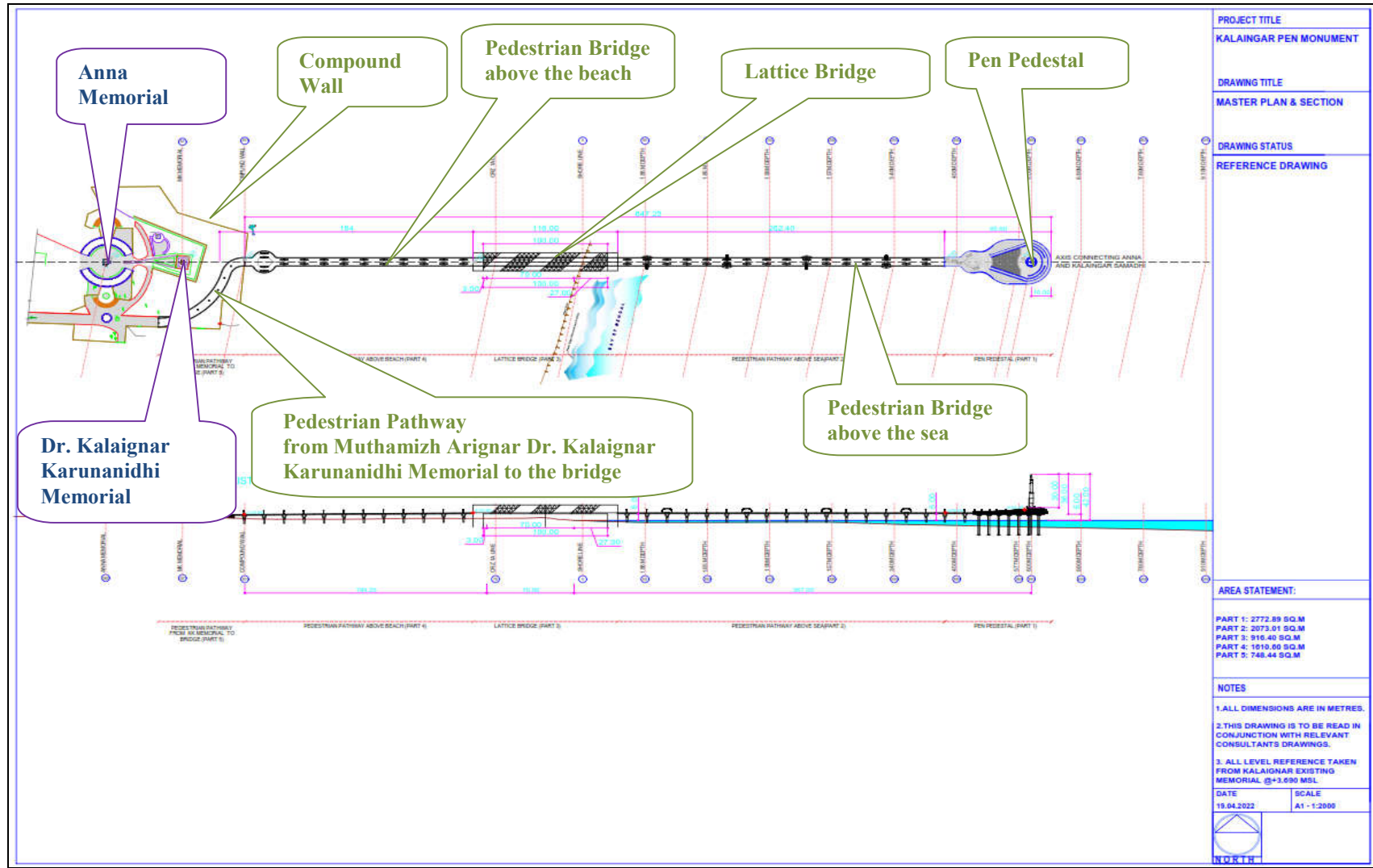


Figure 2-3 Master Plan

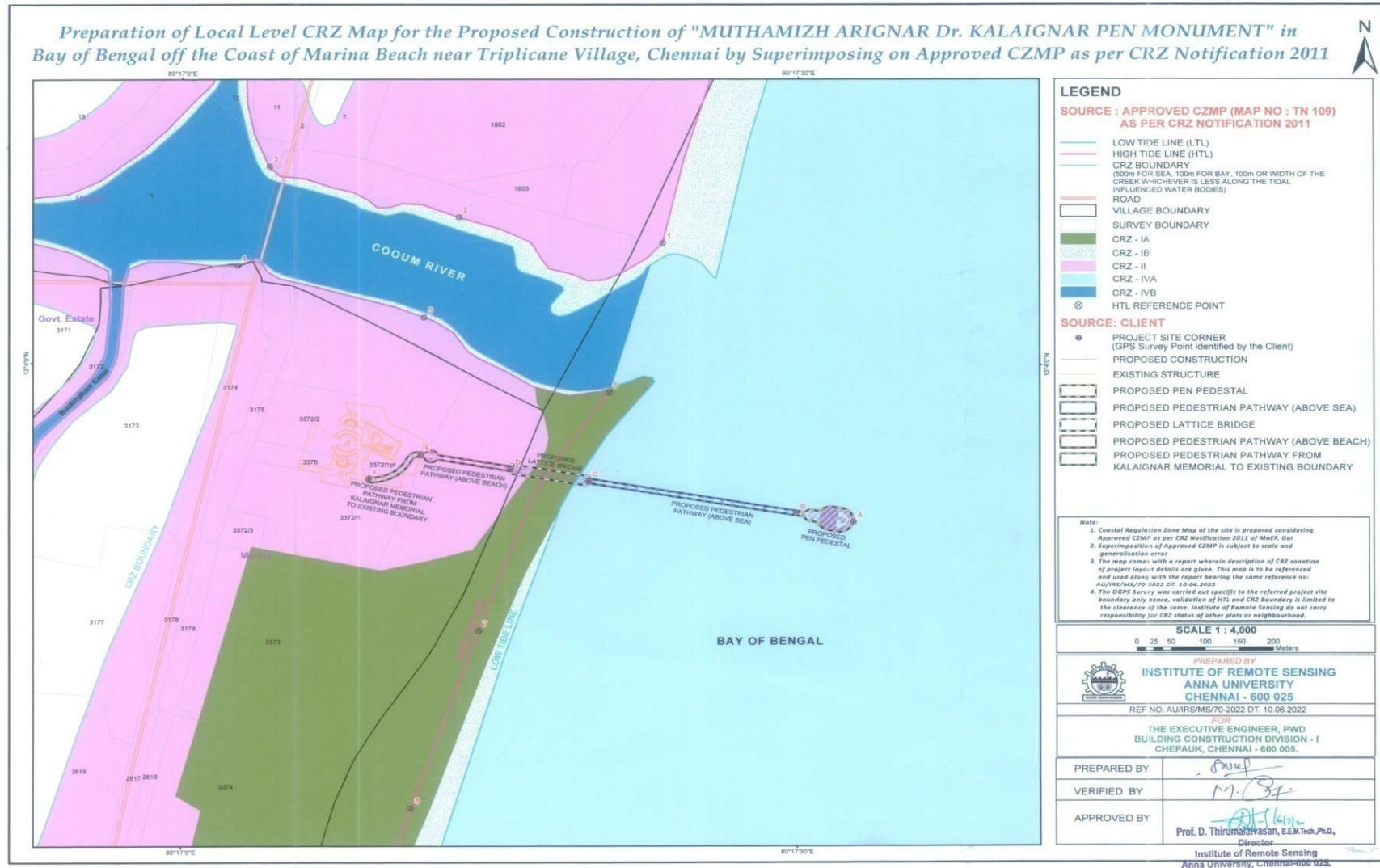


Figure 2-4 HTL and LTL demarcation map by IRS Anna University (1:4000 Scale)

2.4.5 Power Requirement & Source

Construction Phase:

- 500 kV Sourced from TANGEDCO.
- 125 kVA DG set for power backup.

Operation Phase:

- Power supply and DG backup for lighting load.
- 100 kV Sourced from TANGEDCO.

The DG set will be equipped from Dr. Kalaignar Karunanidhi Memorial (which got its clearance from TNSCZMA dated 06.01.2021 and it is under construction).

2.5 Building Materials

The proposed project will be developed while adopting the best available technology and usage of raw materials with appropriate specifications.

2.6 Water Requirement

Construction Phase:

Domestic: ~10 KLD

Construction purpose: ~5 KLD

Source of water is met through Metro water tankers.

Operation Phase:

Domestic: ~5 KLD

Supplied through water dispensers for drinking purposes.

2.7 Wastewater Generation and Treatment

• Sewage Treatment Plant (STP)

All the domestic sewage facilities will be equipped from the Dr. Kalaignar Karunanidhi Memorial, therefore, no individual toilets will be provided for the Pen Monument and the sewage will be treated in the Dr. Kalaignar Karunanidhi Memorial proposed STP, which is under construction. The characteristics of wastewater before and after treatment are shown in **Table 2-2**.

Table 2-2 Wastewater Characteristics

Sr. No.	Parameters	Sewage Before Treatment	Sewage After Treatment
1	pH	6.0 - 8.5	6.5 – 9
2	Bio-Chemical Oxygen Demand (mg/l)	250 – 400	<10
3	Total Suspended Solids (mg/l)	200 – 400	<20
4	Chemical Oxygen Demand (mg/l)	600 – 800	<50
5	Ammoniacal Nitrogen (mg/l)	50	<5
6	Total Nitrogen Detergents (mg/l)	50-100	<10
7	Fecal Coliforms (MPN / 100 ml)	>1600	<100

2.8 Fire- fighting System

Fire-fighting system will be provided as per local norms.

2.9 Solid Waste Management

Construction Phase: Approximately 45.0 kg/day of municipal waste will be generated in premises and shall be disposed in municipal/corporation bins on a daily basis.

Operation Phase: Approximately 98.0 kg/day of municipal waste will be generated in the premises will be disposed through municipal/corporation bins on a daily basis.

➤ Sludge from STP

The sludge generated from the STP which is proposed in the existing Dr. Kalaignar Karunanidhi Memorial of capacity 10 KLD. It will be utilized as manure in the Landscape and Green Belt area.

CHAPTER 3
DESCRIPTION OF THE
ENVIRONMENT

3. Description of Baseline Environment

3.1 Introduction

This chapter depicts the establishment of baseline for valued environmental components, as identified in and around the “**Proposed Construction of Muthamizh Arignar Dr.Kalaignar Pen Monument in the Bay of Bengal off the coast of Marina Beach near Triplicane Village, Chennai District, Tamil Nadu State**”. The primary baseline data monitored covered three (3) months i.e., **27th May 2021-28th July 2021**; based on the request of PWD for the construction of memorial and allied works and validated in **October 2022** and secondary data was collected from the Government and Semi-Government organizations.

The primary baseline data has been generated by M/s. Hubert Enviro Care- Systems (P) Ltd, Chennai, (NABL Accredited and MoEF&CC approved Environmental Testing Laboratory) for the following environmental components.

- **Meteorology:** Temperature, Relative Humidity, Rainfall, Wind Speed & Direction Refer **Section - 3.6**
- **Ambient Air Quality:** Particulate matter <10 micron size (PM₁₀), Particulate matter <2.5 micron size (PM_{2.5}), Sulphur Dioxide (SO₂), Nitrogen Dioxide (NO₂), Carbon Monoxide (CO), Lead (Pb), Ozone (O₃), Benzene (C₆H₆), Benzo (a) pyrene (C₂₀H₁₂), Arsenic (As), Nickel (Ni), Ammonia (NH₃)-Refer **Section - 3.7**
- **Ambient Noise Levels:** Day equivalent noise levels, Night equivalent noise levels Refer **Section - 3.8**
- **Water Quality:** Groundwater Quality, Surface Water Quality - Refer **Section - 3.9**
- **Soil Quality** - Refer **Section - 3.10**
- **Ecology** – Refer **Section – 3.11**
- **Socio economic status** – Refer **Section – 3.12**

3.2 Study Area

A 10 km radial distance with the proposed project site as the epicenter has been identified as the General study area for assessing the baseline environmental status. The core study area is the project site and its immediate surroundings to the tune of 1.0 km radius from the boundary. Further, the Project Impact/Influence Area (PIA) is 10 km from the boundary of the core area covering the off coast of Marina Beach near Triplicane Village, Chennai 600 005. An overall idea of the study area with reference to the physical conditions are presented for better understanding in the following

sections before proceeding into the section on the prevailing environmental conditions of the study area.

3.3 Description of the Study Area

“Proposed Construction of Muthamizh Arignar Dr.Kalaignar Pen Monument in the Bay of Bengal off the coast of Marina Beach near Triplicane village, Chennai -600 005, Tamil Nadu State” is located approximately 1.62 km NNW of Chennai Park Town Railway Station and ~2.20 km NNW of Chennai Central Railway Junction. Chennai International Airport is at a distance of ~12.71 km SW from the site. An overall idea of the study area with reference to the physical conditions are presented for better understanding in the following sections before proceeding into the section on the prevailing environmental conditions.

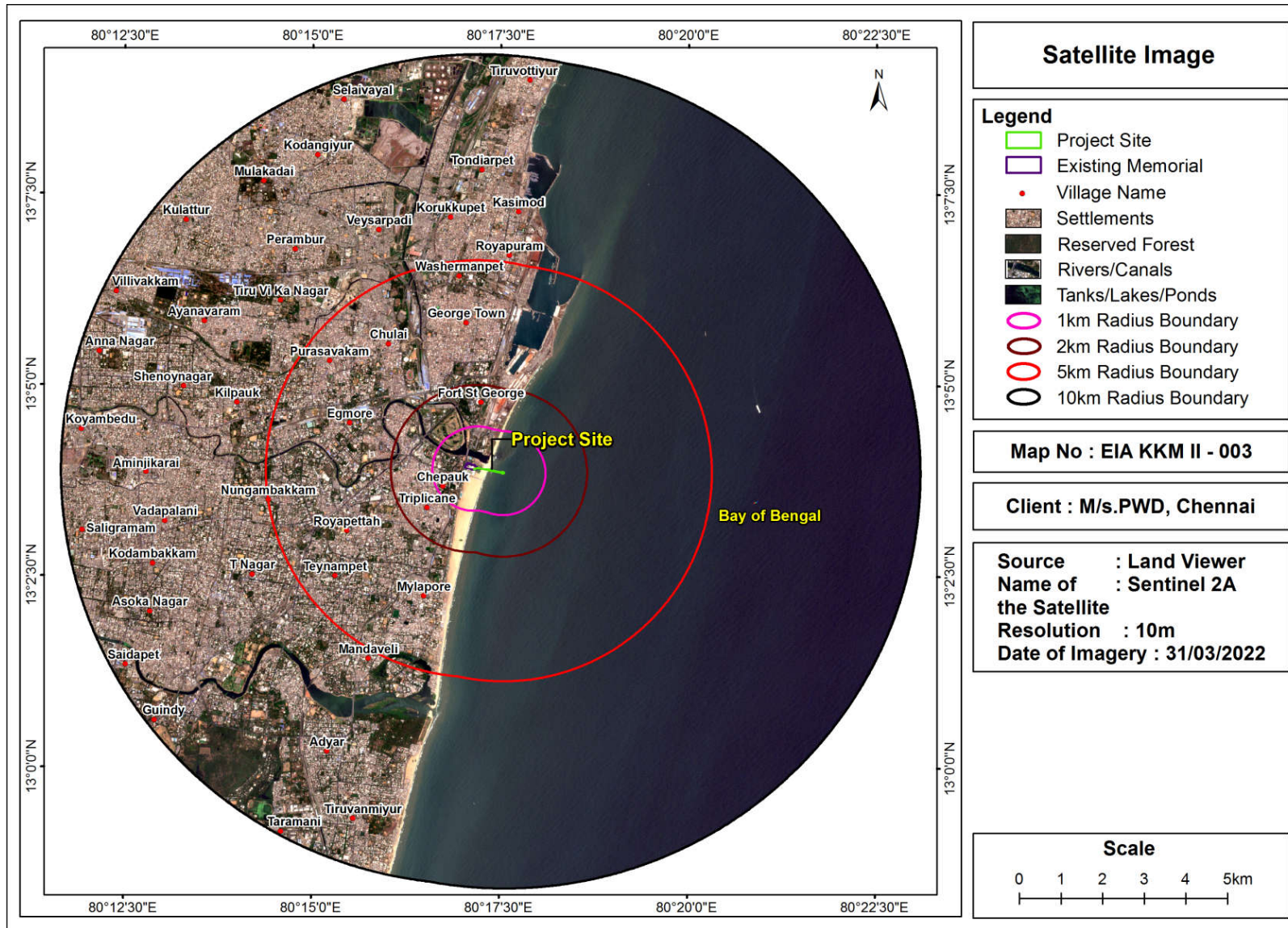


Figure 3-1 Map showing the Satellite Image of the study area

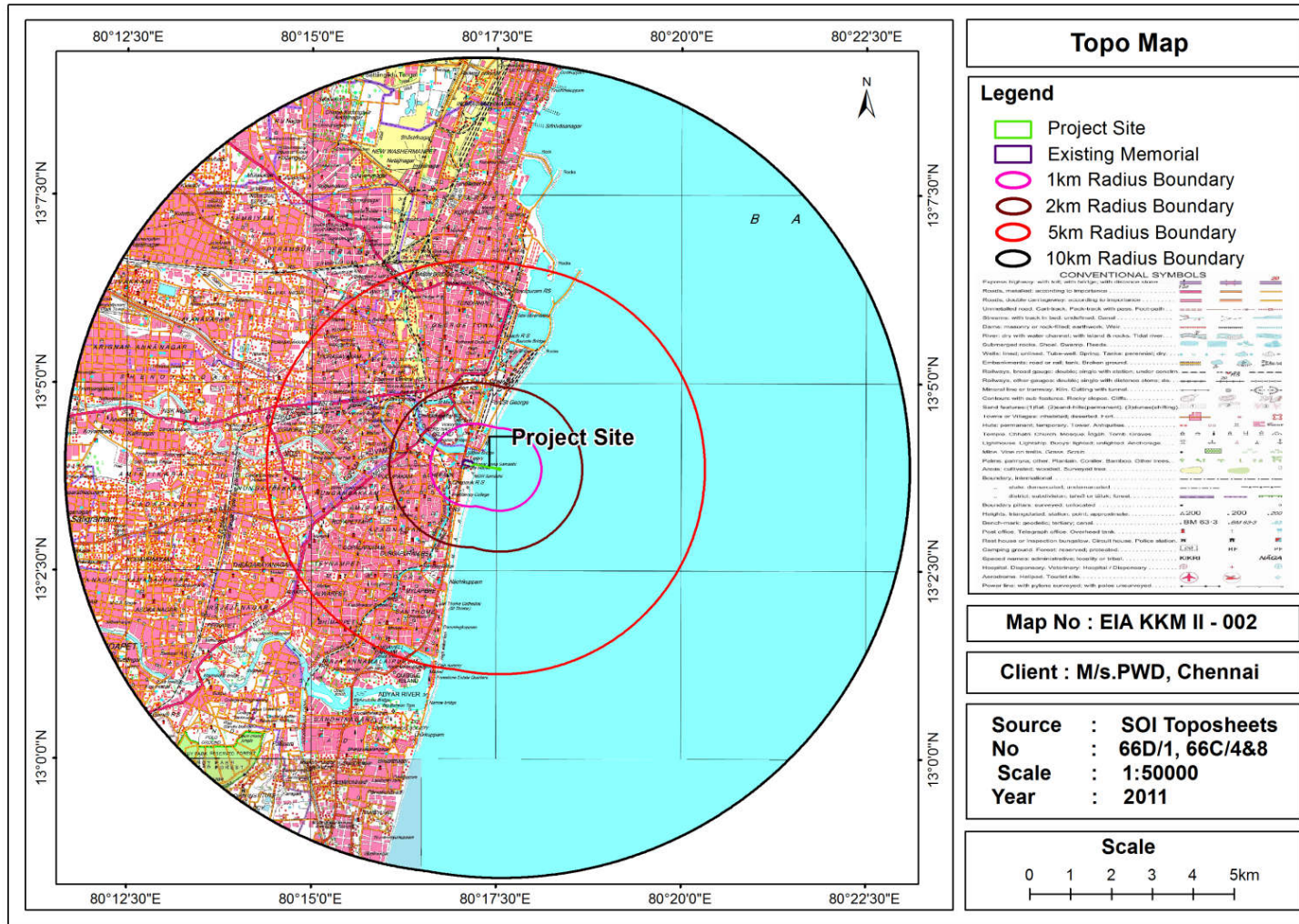


Figure 3-2 Topo Map of the study area

3.4 Environmentally/Ecologically Sensitive areas

The details of environmentally/ecologically sensitive areas covering within 15 km from project boundary are given **Table 3-1**.

Table 3-1 Environmentally Sensitive Areas Within 15km From Project Boundary

Sl.No.	Areas	Distance & Direction from project boundary			
		S. No	Monuments	Distance (~km)	Direction
1.	List of Monuments/Heritages	1.	Victory War Memorial	0.86	N
		2.	Chaplain's house including portion which the northern side of the Old Wall II/1 Fort St.George	1.32	N
		3.	Wellesley House (Built in 1798) Block No.IV/13 Fort St. George	1.36	N
		4.	Last house on the left of 'Snobs Alley' (oldest house in theFort with carved staircase) – Block No.I/1 Fort St. George	1.38	N
		5.	Garrisons Engineer's Depot Block No.IV Fort St. George	1.38	N
		6.	Fort St. George "Arsenal" between Wellesley house and Clive's House with shells and cannons piled together near the Gateway Block IV/1-12 and 14-18	1.39	N
		7.	Nursing Sister's House (Block 1/3) Fort St. George	1.43	N
		8.	Big Warehouse South of the Church Library (in Block No.II/7) Fort St. George	1.43	N
		9.	Clives House built in 1753 Fort St. George	1.45	N
		10.	St. Mary's Church with tablets laid on the ground and enclosed by a compound and a buried wall Fort St. George	1.47	N
		11.	Guard Room Block No.V Fort St. George	1.56	N
		12.	King's Barracks Block No.XXV Fort St. George	1.65	N
		13.	Old British Infantry Officers Mess (Now housing the Fort Museum) Block No.XXXVI/2 Fort St. George	1.68	N
		14.	Ramparts gates bastions Ravelins with vaulted chambers and water cisterns underneath moat and defense walls all round with glacis to the extent of the existing barbed wire fence Fort St. George	1.87	N
		15.	Tomb of David Yale and Joseph	2.42	N

			Hymners in the compound of Law College Muthialpet(George Town)			
		16.	Old Town Wall Tondiarpet	4.25	N	
		17.	Adyar Banyan Tree	6.34	SSW	
		18.	Memorial Pillar Anna Salai	7.38	SW	
		19.	Madras War Cemetery	11.35	WSW	
		20.	Urn burial and megalithic site-St. Thomas Mount	11.99	WSW	
		21.	Semmozhi Poonga	3.95	WSW	
		22.	Gandhi Mandapam	8.15	SW	
2.	List of Reserve forest / National Park	Description		Dist. (~km)	Dire.	Coordinates
		Guindy National Park/ RF		8.25	SW	13° 0'21.35"N 80°14'21.55
3.	List of Water Bodies	Description		Dist. (~km)	Dire.	
		Bay of Bengal		Within the Site		
		Cooum/Kuvam R		0.15	N	
		Buckingham Canal		0.41	WNW	
		Otteri Nala		4.70	NNW	
		Adyar R		4.71	SSW	
		Captain Cotton Canal		6.70	NNW	
		Kodungaiyur Canal		7.34	N	
		Korttalaiyar/Kosisttalaiyar R		12.25	N	
		Pallikaranai Marshland		12.47	SSW	
		Pulal/Red Hills Lake		14.14	NW	
		Madavaram/ Retteri Lake		10.73	NW	
		Velachery Lake		11.29	SW	
		Korattur Tank		12.20	WNW	
		Porur Lake		14.76	WSW	
		Water Bodies:				
		Water Bodies		Dist. (~km)	Dire.	
		Madavaram/ Retteri Lake		10.73	NW	
		Velachery Lake		11.29	SW	
		Korattur Tank		12.20	WNW	
		Porur Lake		14.76	WSW	
4.	Nearest Highways	Description		Dist. (~km)	Dire.	
		Kamarajar Promenade Rd		0.22	W	
		Nearest SH-114 (Chennai – Manali – Ennore)		1.95	NNW	
		Nearest NH- (Chennai-Srikakulam)		4.49	NNW	
5.	Defence installations	Description		Dist. (~km)	Dire.	
		INS Adyar		0.81	N	
		Officers Training Academy (OTA)		11.27	SW	
6.	Nearest Villages	Villages		Dist. (~km)	Dire.	
		Triplicane(Chepauk)		Site is within the Village		
		Chintadripettai		1.47	WNW	
		Royapettah		1.60	WSW	

		Egmore	1.93	W
		George Town	2.01	NNW
7.	Areas susceptible to natural hazard which could cause the project to present environmental problems (earthquakes, subsidence, landslides, erosion or extreme or adverse climatic conditions)	<p>The study area falls under Zone-III (Moderate risk) according to the Indian Standard Seismic Zoning Map. Suitable seismic coefficients in horizontal and vertical directions respectively, will be adopted while designing the structures.</p> <p>The place is also prone to Cyclone and Tsunami.</p>		

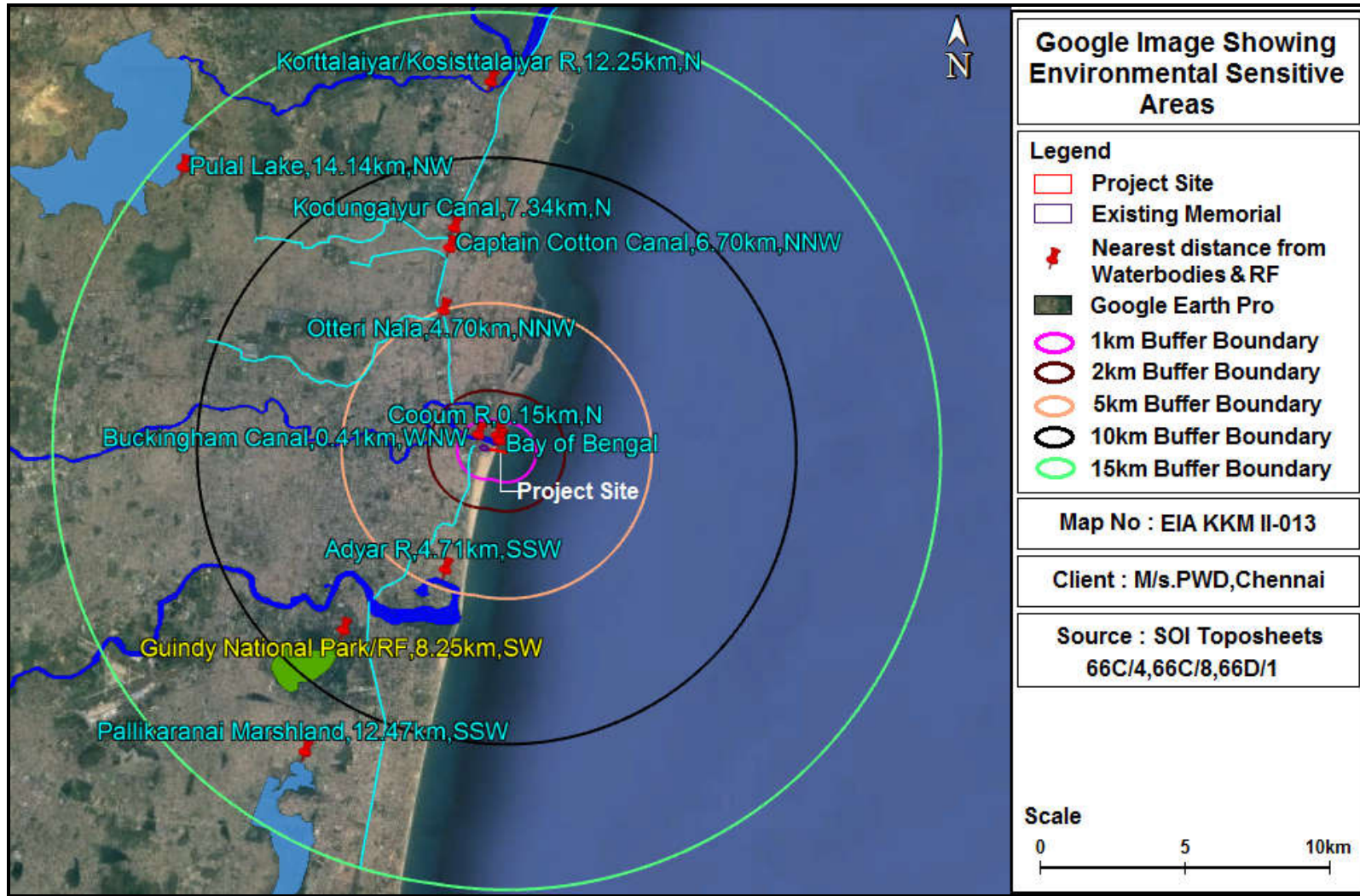


Figure 3-3 Environmentally Sensitive Areas Within 15 km from Project Boundary

3.5 Physical Conditions

In this section, the physical conditions of PIA district are discussed in general and wherever possible references to the conditions prevailing in the study area in particular are provided. The physical conditions are discussed as under:

- District profile
- Drainage, Land use, Geology, Physiography
- Natural resources
- Climatic conditions, Seismic zone characteristics and Natural hazards

3.5.1 PIA District Profile

Chennai is situated in the North Eastern end of Tamil Nadu on the coast of Bay of Bengal. It lies between 12° 9' and 13° 9' North and 80° 12' and 80° 19' East. The total area of the district is 178.2 sq.km. It is bounded by the Bay of Bengal in the East and on the remaining three sides by Kancheepuram and Tiruvallur districts. The topography of the district is almost flat and the ground level in the district slightly rises up to 22 ft above the mean sea level.

Source: <http://tnenvis.nic.in/files/CHENNAI.pdf>

3.5.2 Climatic Conditions

Chennai has a tropical wet and dry climate. The city lies on the thermal equator and is also on the coast, which prevents extreme variation in seasonal temperature. The weather is hot and humid for most of the year. The hottest part of the year is late May to early June, known regionally as Agni Nakshatram ("fire star") or as Kathiri Veyyil, with maximum temperatures around 35–40 °C (95–104 °F). The coolest part of the year is January, with minimum temperatures around 15–22 °C (59–72 °F). The lowest temperature recorded is 13.8 °C (56.8 °F) and the highest recorded temperature is 45 °C (113 °F). The average annual rainfall is about 140 cm (55 inches). The city gets most of its seasonal rainfall during the northeast monsoon period from mid–October to mid–December. Cyclones in the Bay of Bengal sometimes hit the city. The highest annual rainfall recorded is 257 cm (101 inches) in 2005. Prevailing winds in Chennai are usually South-westerly between April and October and North-easterly during the rest of the year. Historically, Chennai has relied on annual monsoon rains to replenish water reservoirs, as no major rivers flow through the area. Chennai has a water table at 2 m for 60 % of the year.

Source: <http://tnenvis.nic.in/files/CHENNAI.pdf>

3.5.3 Natural Resources of Chennai District Forest Resources

3.5.3.1 Flora & Fauna

From the total land area of Chennai, reserved forests cover was 2.71 sq. kms and is concentrated in and around the Guindy National Park region, one of the few National parks in the world located within a city. Among 6 Forest regions in the state, Chennai Region takes care of forest areas in Chennai and Vellore Circles. This region is headed by the Chief Conservator of Forests. There are short elevated hills on the periphery of Chennai, mostly rocky in nature. Besides, there are parks with densely covered with shrubs and different types of trees. In Guindy, there is a National Park and dense forest cover inside Raj Bhavan, Governor's bungalow. Various types of wild animals are found in Children's Park at Guindy. Spotted deer and herds of bucks are reared in Raj Bhavan forests. As Chennai being a coastal district, various types of marine flora and fauna are found in the sea and sandy shore. Different varieties of tiny crabs are found running on the sandy beaches. Various marine species are found in the sea around Chennai. Variety of fauna in the sea include mullets, silver hellies, ribbon fish, white bait, jew fish, seer, pomfrot, sardines, sabre, catfish, synargis, soles, sharks, skates, rays, rockcod, pellona, letrius, engraylish lobster, barracuda, snappers, breams, borito, polynemus etc., Different types of prawns and crabs are also found in the sea. This is headed under Flora and Fauna of PIA in **Section 3.11**.

Source: http://censusindia.gov.in/2011census/dchb/DCHB_A/33/3302_PART_A_DCHB_CHENNAI.pdf

3.5.3.2 Forest Resources

Chennai district is not endowed with many forest resources except the Guindy National Park with an area of 270.57 ha which is under Reserve Forest category. In terms of density of vegetation cover, the area falls under sparse category. The Guindy National Park is classified under tropical dry evergreen forests of the Coromandal coast and is being used for recreational purposes. However, much of this park area represents dry deciduous scrub jungle of the Southern dry zone interspersed with more than 30 species of trees. The entire vegetation looks dry during summer months, but trees acquire a verdant look with the onset of monsoons. The forests are interspersed with open grassland, which is the ideal habitat for black bucks. Besides the terrestrial vegetation different water plants are seen in the lakes and ponds inside the park.

Source: <http://tnenvis.nic.in/files/CHENNAI.pdf>

3.5.3.3 Agricultural Resources

Chennai city today is devoid of any typical agriculture areas but can still be proud of some of the well maintained green belts found in the Peoples park, the Napier park, the Horticulture-gardens, My Lady's Park, Children's Park Guindy, Snake Park, Nehru Park, Nageswara Rao Park, Independence

Park, Anna Square Park, the Raj Bhavan, the Theosophical Society Campus and a number of bungalows and newly developed colonies where provisions for public parks, etc. have been made. The indigenous trees found are *Azadirachta indica*, *Mangifera indica*, *Tamarindus indica*, *Albizia saman*, *Albizia lebbek*, *Ficus benghalensis*, *Cocos nucifera* and *Ficus religiosa*. Stretches of casuarina plantations are available on the sea-coast beyond the mouth of the Adyar River in the South and Tondiarpet in the North.

Source: <http://tnenvis.nic.in/files/CHENNAI.pdf>

3.5.3.4 Mineral Resources

Quartz, silica sand and Bentonite are the available minerals in Chennai district. Geology & Minerals map of Tamil Nadu is given in **Figure 3-4**.

Source: <http://ibm.nic.in/writereaddata/files/09232015123254Tamil%20Nadu.pdf>

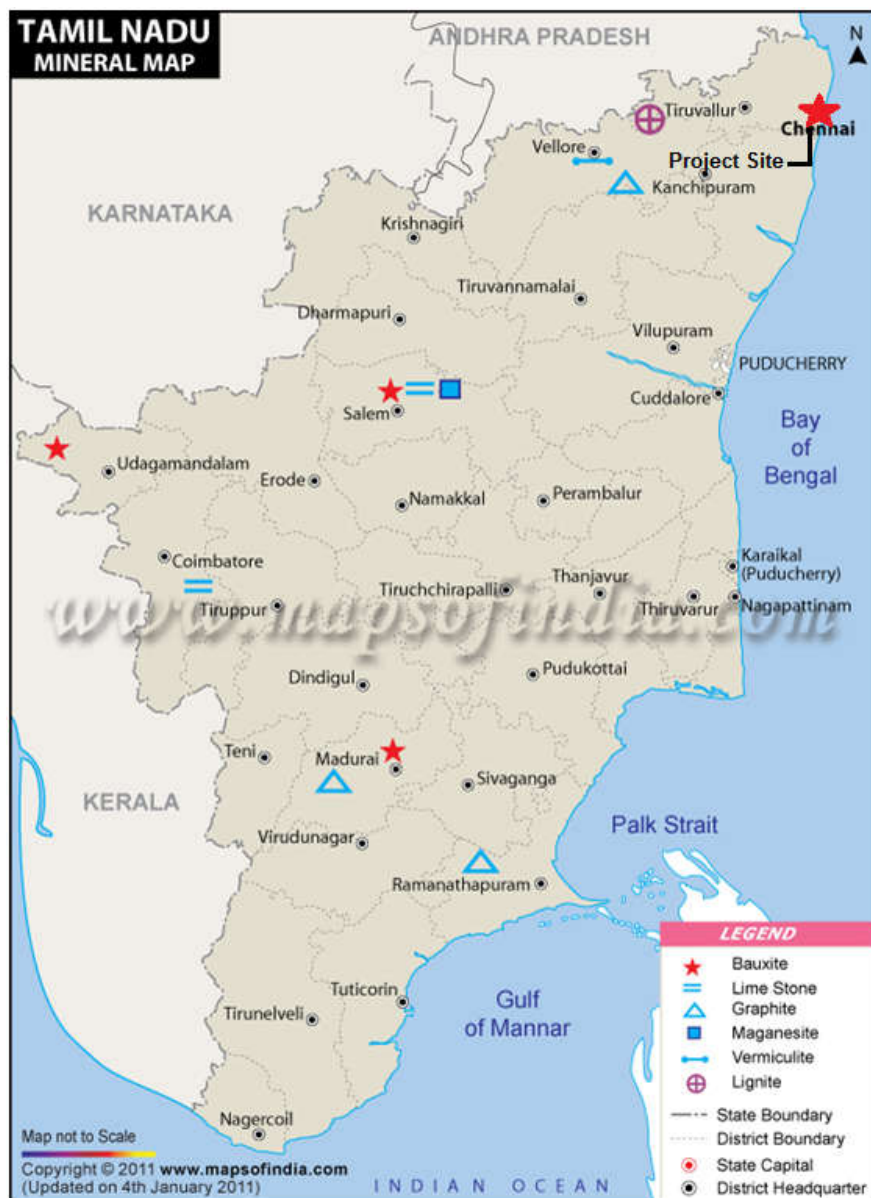


Figure 3-4 Geology & Minerals Map of Tamil Nadu

3.5.4 Land Use & Land Cover

Total geographical area of Chennai district is 171sq.km. Built-up area, Urban is 154.83sq.km. and Built-up area, Rural 0.02 sq.km. Details of district land use/land cover statistics for Chennai district is given **Table 3-2** and Land Use map of Chennai district is given in **Figure 3-5**. Land Use pattern of Chennai district is given in **Figure 3-6**.

Table 3-2 District land use/land cover statistics for Chennai district

S.No	Division of Land Use/Land Cover	Area in Sq.Km	Area in Acres	Area in Ha	Total Area %
1	Builtup,Urban	154.83	38259.27	15483	90.54
2	Builtup,Mining	0.02	4.9421	2	0.01
3	Agriculture,Plantation	0.13	32.12365	13	0.08
4	Forest,deciduous	2.54	627.6467	254	1.49
5	Barren/Unculturable/Wastelands,scrub land	0.33	81.54465	33	0.19
6	Wetlands/Water Bodies,Coastal Wetland	1.21	298.9971	121	0.71
7	Wetlands/water Bodies, Reservoir/lakes/ponds	0.92	227.3366	92	0.54
8	Builtup,Rural	0.02	4.9421	2	0.01
9	Agricultural Crop land	1.72	425.0206	172	1.01
10	Agriculture,Fallow	0.98	242.1629	98	0.57
11	Forest,Swamp/Mangroves	0.76	187.7998	76	0.44
12	Barren/Unculturable/ Wastelands,sandy area	3.26	805.5623	326	1.91
13	Wetlands/water Bodies, River/stream/Canals	4.29	1060.08	429	2.51
	Total	171	42257.4	17101.0	100

Source: <https://bhuvan-app1.nrsc.gov.in/thematic/thematic/index.php>

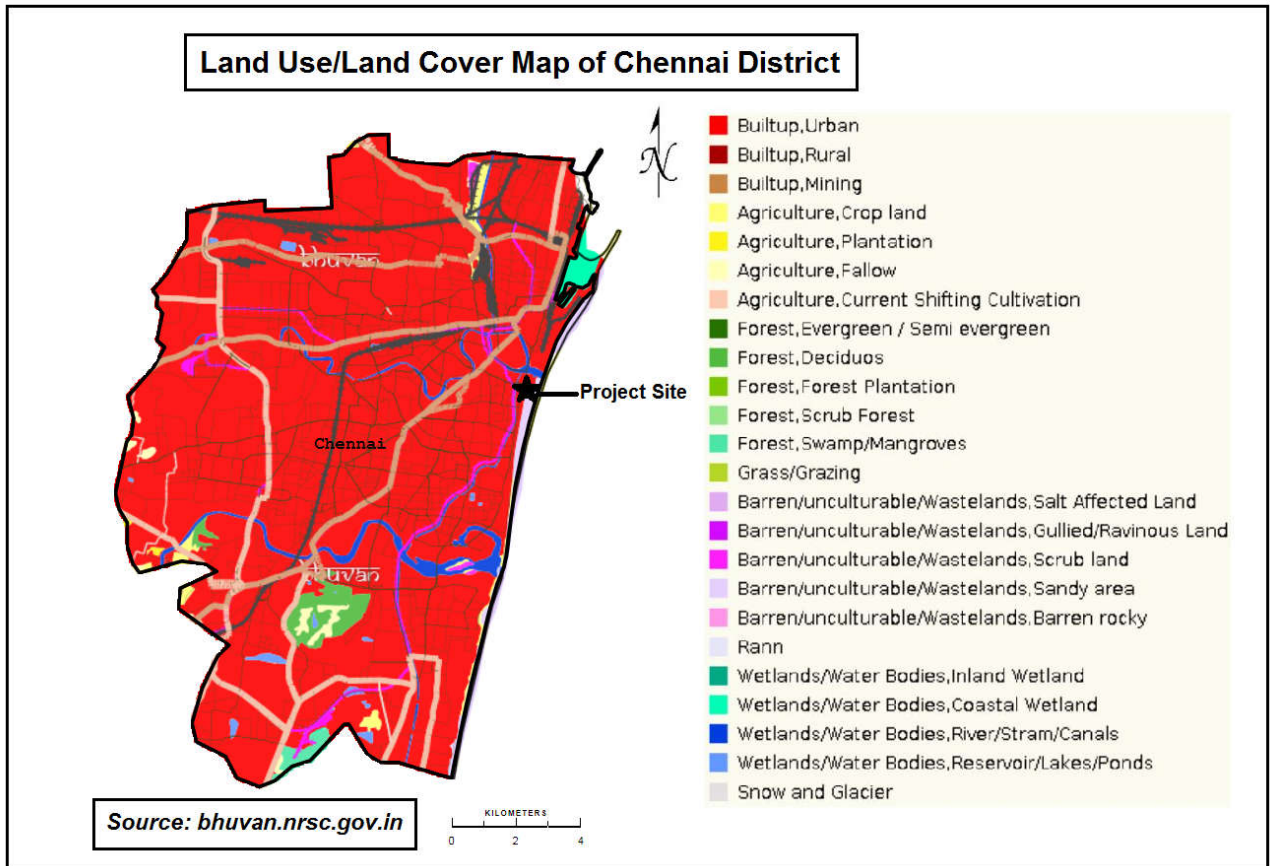


Figure 3-5 Land Use Map of Chennai district

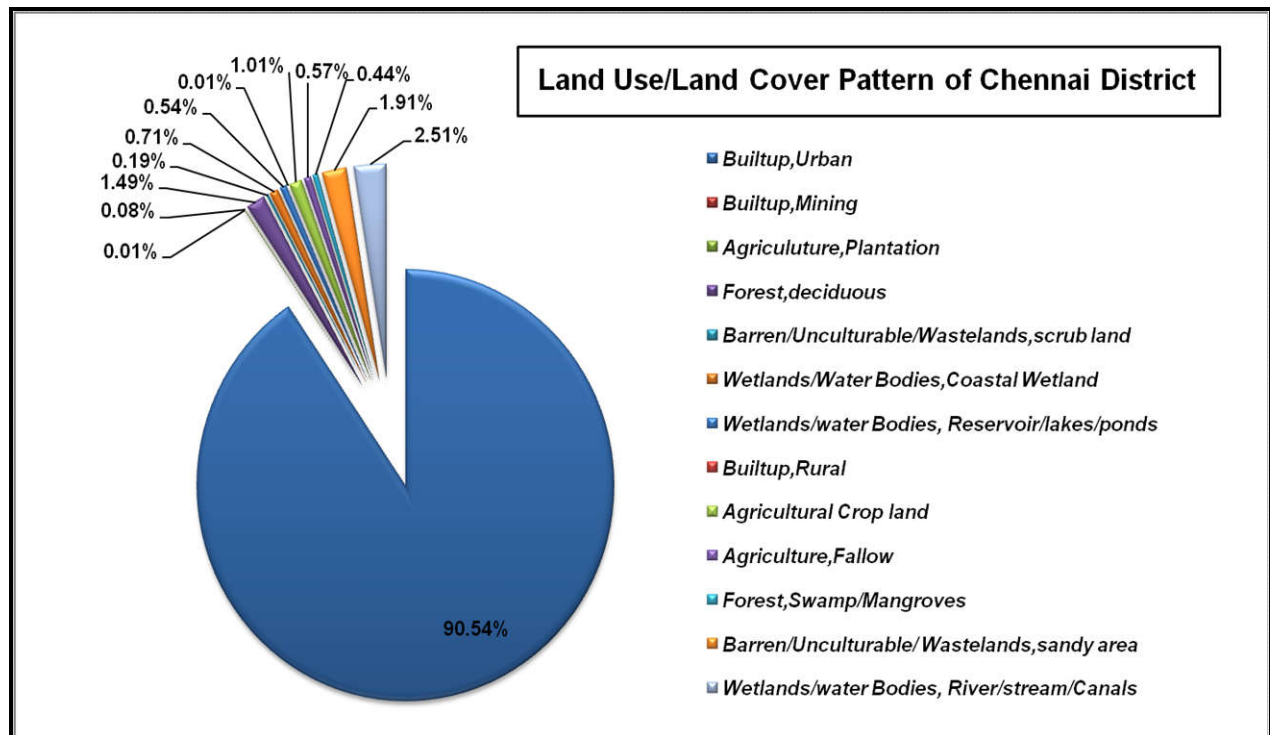


Figure 3-6 Land Use/Land Cover Pattern of Chennai District

Source: <https://bhuvan-app1.nrsc.gov.in/thematic/thematic/index.php>

3.5.5 Land Use Pattern of the Study Area

Total Project Study Area is 325.12sq.km. Land Use /Land Cover statistics of 10 km radius of the Study Area is given in **Table 3-3** and land Use pattern of Study area is given in **Figure 3-7** and LULC map of the Study area is given in **Figure 3-8**.

Table 3-3 Land Use/Land Cover statistics of 10 km radius of the Study Area

Sl.No	Division of Land Use/Land Cover	Area in Sq.Km	Area in Acres	Area in Ha	Total Area %
1.	Urban	161.46	39897.57	16146	49.66
2.	Ocean	146.65	36237.95	14665	45.11
3.	Rivers/ Streams/ Canals	4.98	1230.58	498	1.53
4.	Sandy Area	4.23	1045.25	423	1.30
5.	Deciduous	2.13	526.33	213	0.66
6.	Cropland	1.43	353.36	143	0.44
7.	Coastal Wetland	1.35	333.59	135	0.42
8.	Plantation	1.33	328.65	133	0.41
9.	Reservoirs/ Lakes/ Ponds	0.62	153.21	62	0.19
10.	Fallow land	0.55	135.91	55	0.17
11.	Scrub land	0.39	96.37	39	0.12
		325.12	80338.78	32512	100.00

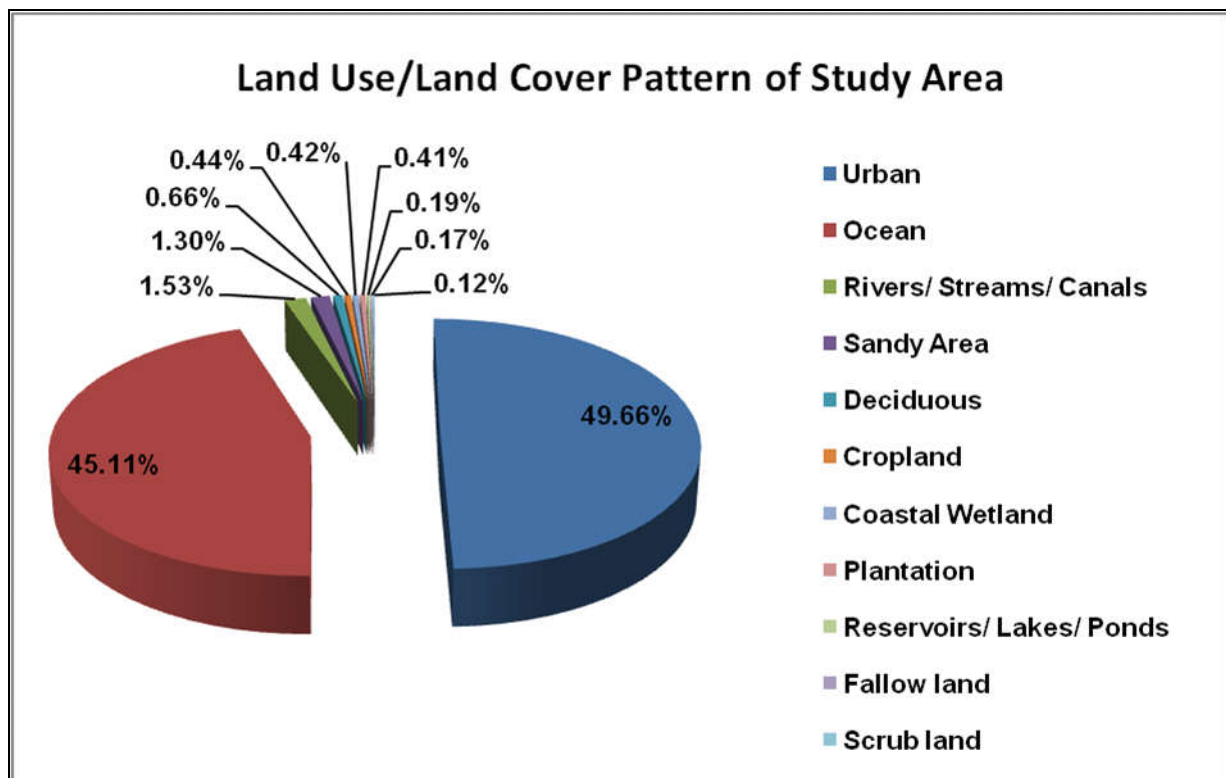


Figure 3-7 Land Use/Land Cover Pattern of the Study Area

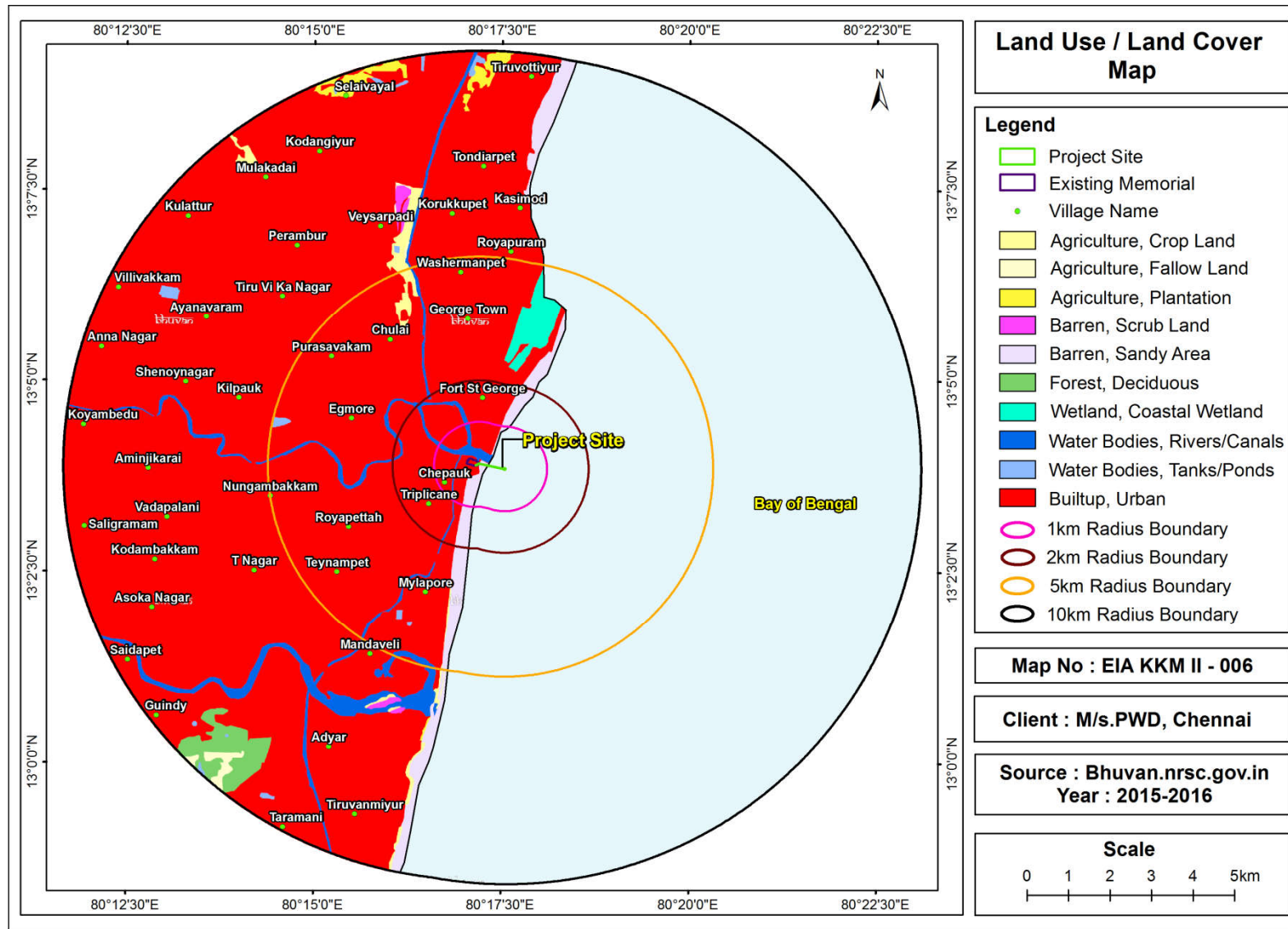


Figure 3-8 Land use/Land cover map of the Study Area

3.5.6 Topography

Chennai is a low-lying area and the land surface is almost flat like a pancake. The even topography of the land throughout the district renders sub-divisions into natural regions rather difficult. It rises slightly as the distance from the sea-shore increases but the average elevation of the city is not more than 22' above mean seal-level, while most of the localities are just at sea-level and drainage in such areas remains a serious problem. The city is intersected by two streams, viz, Cooum River and the Adyar. The Cooum River runs through the heart of the city and enters the sea. The Adyar runs through the south part of the city and enters the sea. The Buckingham canal which runs through the states of Tamil Nadu and Andhra Pradesh is a navigation canal. This canal runs almost parallel to the Coromandel coast within the limits of 5 kms from the coast. It joins up a series of natural backwaters and connects all the coastal districts from Guntur to Chennai. Physical map of Tamil Nadu is given in **Figure 3-9**. Contour map of the Study area is given in **Figure 3-10**.

Source: <http://dcmsme.gov.in/dips/2016-17/DIP.CHENNAI.2015.16.pdf>

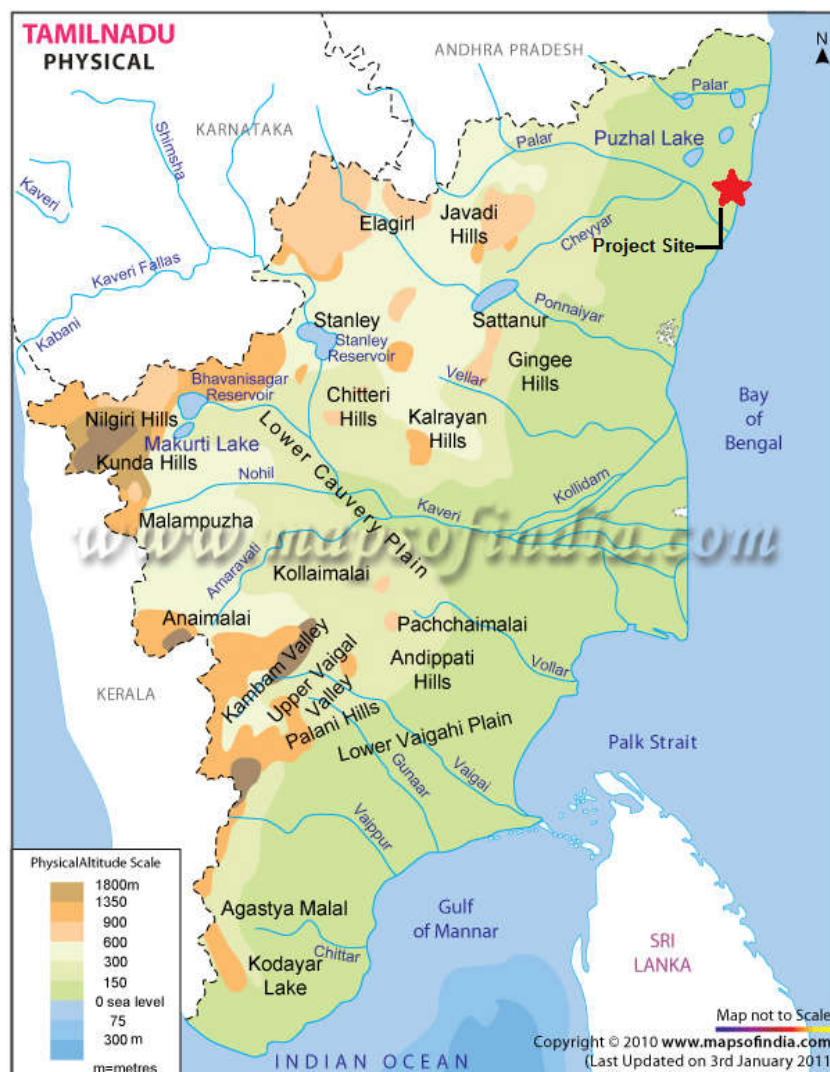


Figure 3-9 Physical map of Tamil Nadu State

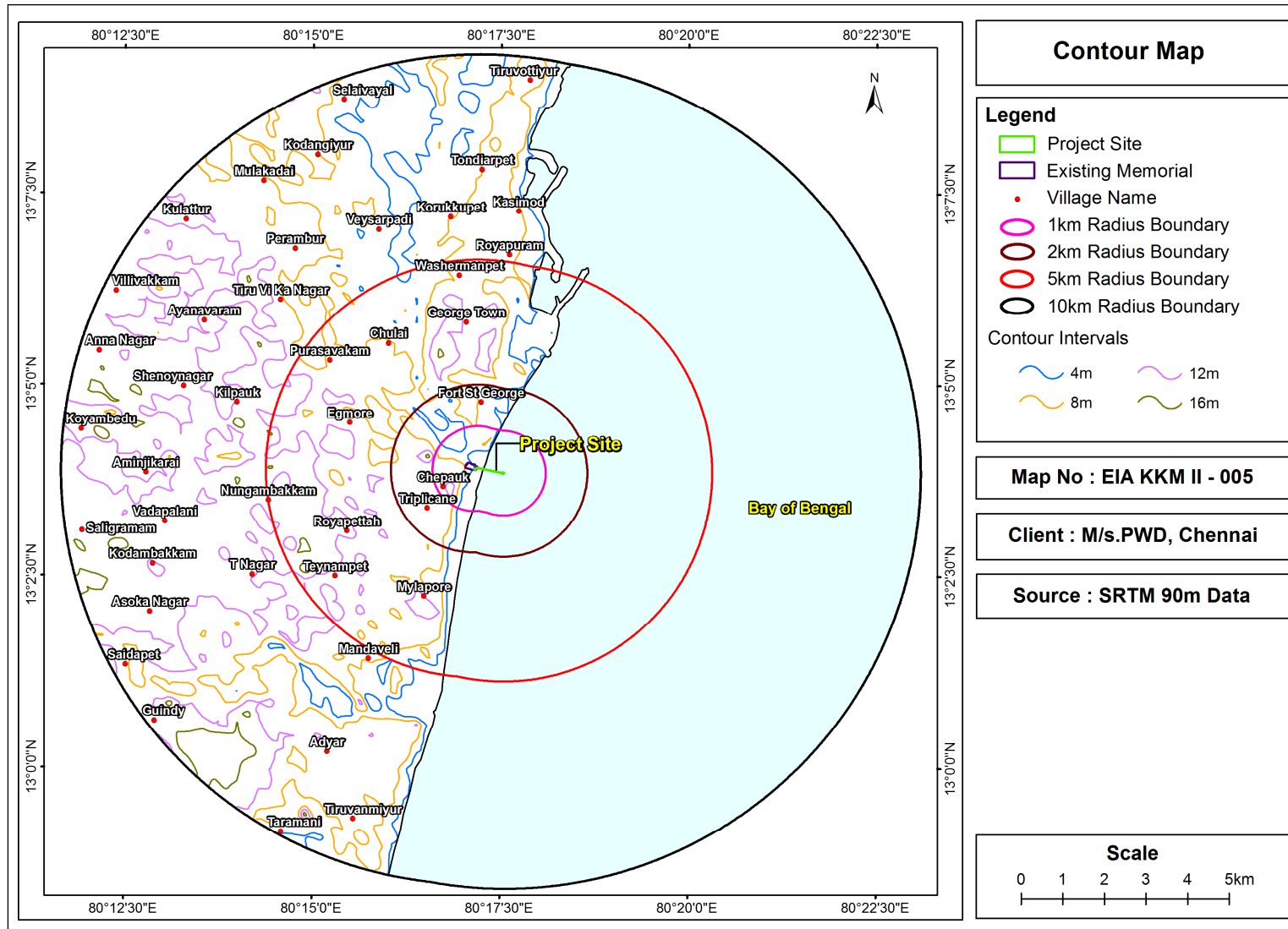


Figure 3-10 Contour map of Study Area

3.5.7 Geology of PIA District

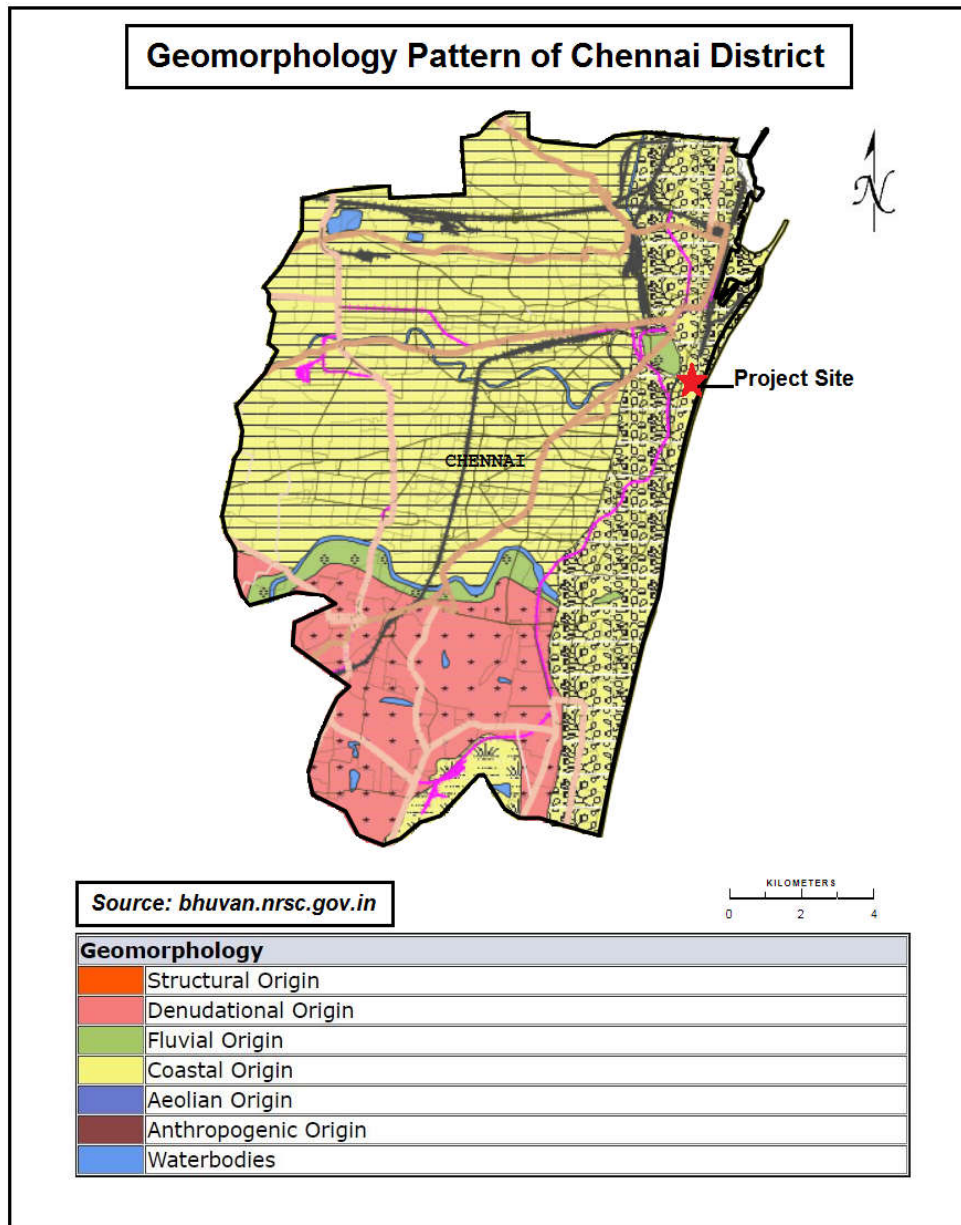
Chennai district is built on marine, estuarine and fluvial alluvium overlying Precambrian gneisses and Charnockites. The hard rock includes granite, gneissic complex, schist's and charnockites associated with basic and ultra-basic intrusive. The geological formations of the district can be grouped into three units, namely i) Archaeans crystalline comprising charnockites, gneisses and associated basic intrusive; ii) Consolidated gondwana and tertiary sediments comprising sandstone, shales and clays; and iii) Recent alluvium sediments consisting of sand, silt, clay and their admixtures.

Source: http://shodhganga.inflibnet.ac.in/bitstream/10603/196883/11/11_chapter%203.pdf

3.5.8 Geomorphology of PIA District

Chennai district forms part of coastal plains of Tamil Nadu. Major part of the district is having flat topography with very gentle slope towards east. The altitudes of land surface vary from 10 m above MSL in the west to sea level in the east. Fluvial, marine and erosional landforms are noticed in the district. Marine transgression and regressions and neotectonic activity during the recent past have influenced the morphology and resulted in various present landforms. Meandering streams with small sand bars are present along the course of Adyar River. The pediment and buried pediment in Guindy area in and around the reserved forest, is the only area where the ecological system is less disturbed, while the other areas are completely disturbed by built up area with large-scale human interference and pollution. Marina beach is the most natural beach in the world with a width varying from 150 to 600 m and a length of 5.6 km, also encroached by human activity. Theosophical society, located on the banks of Adayar river mouth is the only area with well-preserved natural coastal morphology, sand dunes, beach ridges, flora etc. Geomorphology Map of Chennai District is given in **Figure 3-11**. Geomorphology Map of study area is given **Figure 3-13**. The Geomorphology of the study area is given in **Table 3-4** and Geomorphology pattern is given in **Figure 3-12**.

Source: http://cgwb.gov.in/District_Profile/TamilNadu/chennai.pdf



Source: http://cgwb.gov.in/District_Profile/TamilNadu/chennai.pdf

Figure 3-11 Geomorphology Map of Chennai District

Table 3-4 Geomorphology of the study area

S.No	Description	Area in sq.km	Area in Acres	Area in Ha	Area in %
1.	Ocean	11.37	2809.58	1137	3.50
2.	Coastal Origin-Older Deltaic Plain	101.02	24962.55	10102	31.07
3.	Coastal Origin-Younger Coastal Plain	158.81	39242.75	15881	48.85
4.	Denudational Origin-Pediment-PediPlain Complex	48.20	11910.46	4820	14.83
5.	Fluvial Origin - Active Flood Plain	2.15	531.28	215	0.66
6.	Water Bodies	3.57	882.16	357	1.10
	Total	325.12	80338.78	32512	100.00

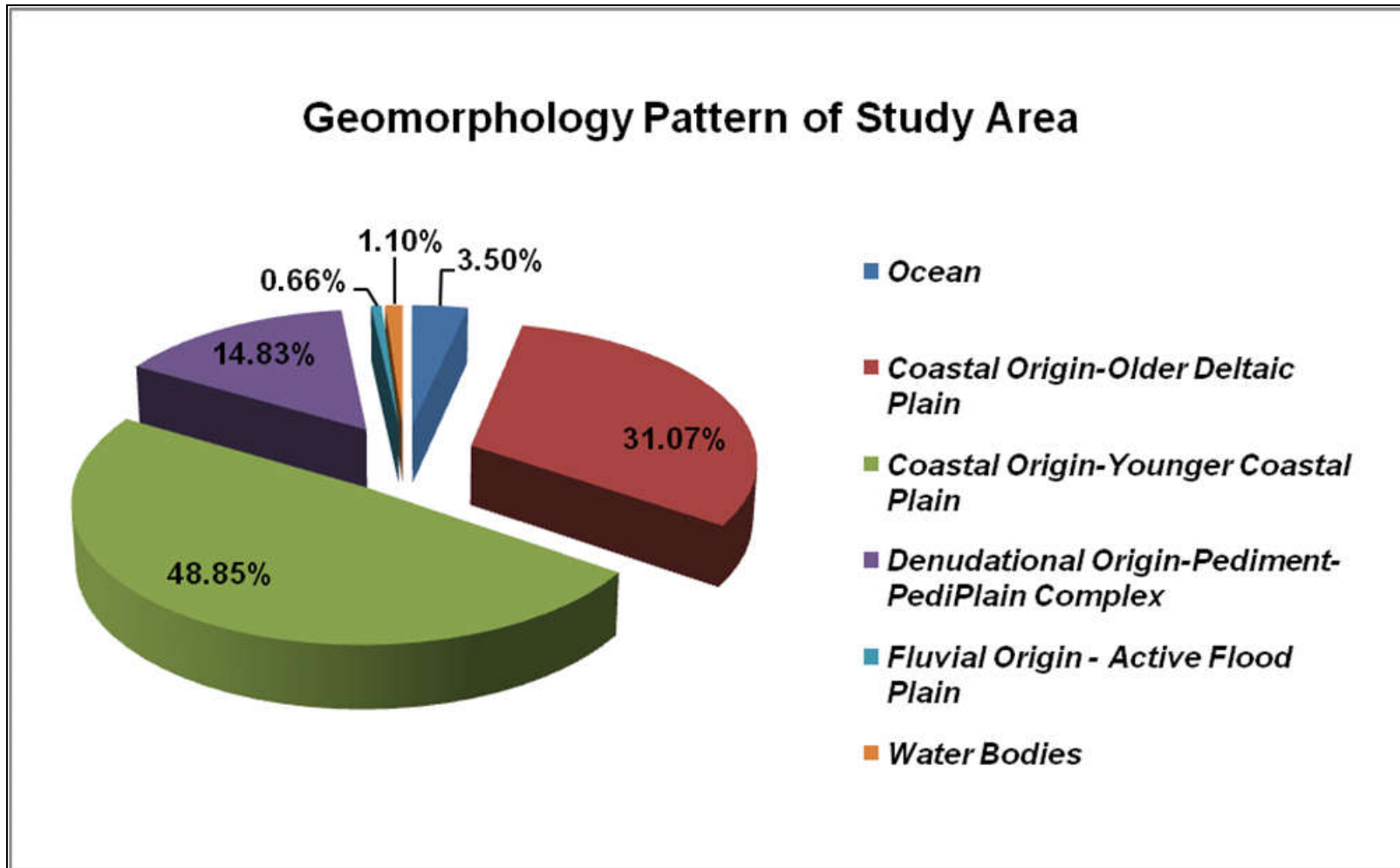
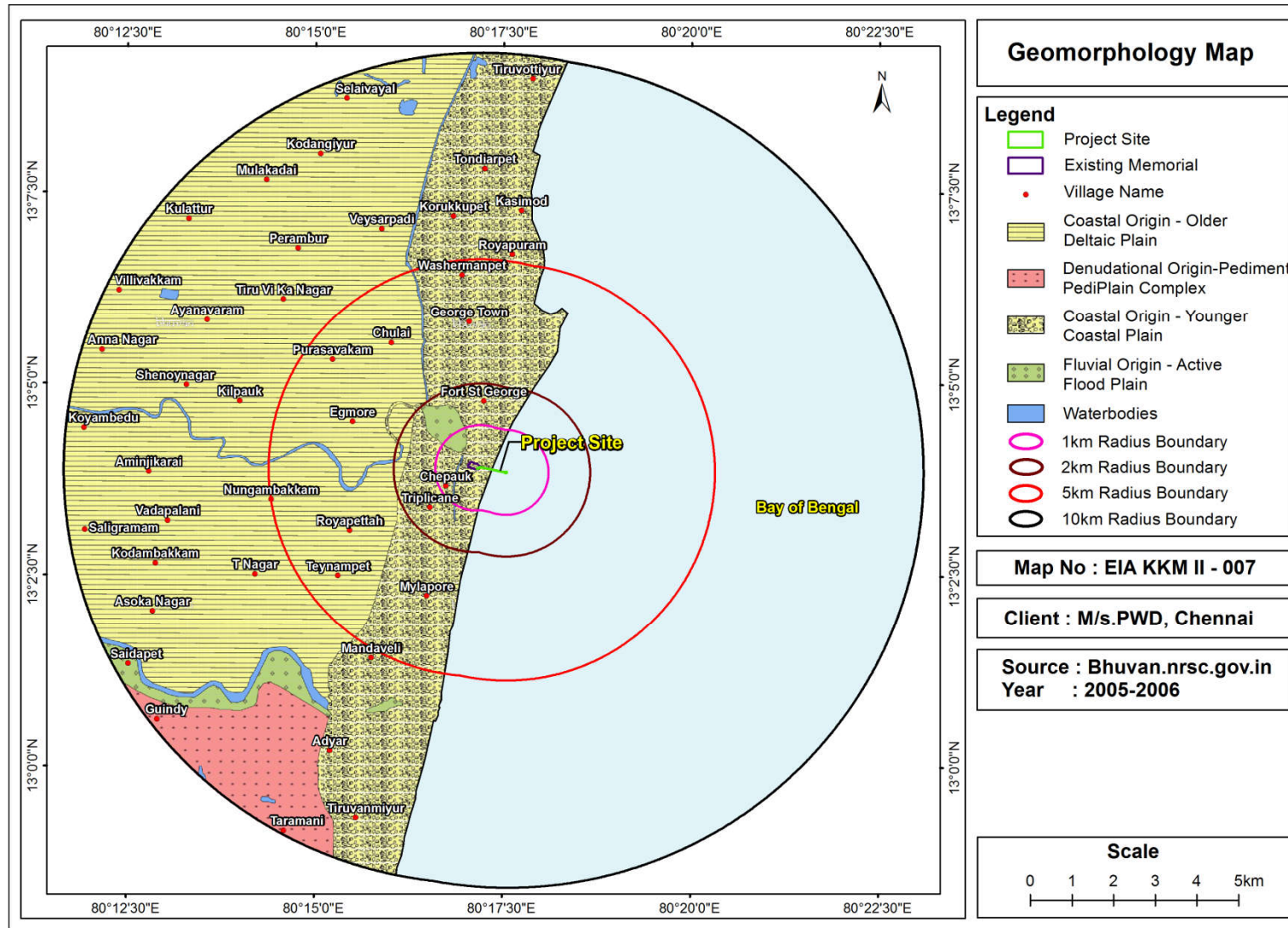


Figure 3-12 Geomorphology Pattern of the Study Area



3.5.9 Hydrogeology of PIA District

Chennai district is underlain by various geological formations from ancient Archaean to the Recent Alluvium. The geological formations of the district can be grouped into three units, namely i) the Archaean crystalline rocks ii) consolidated Gondwana and Tertiary sediments and iii) the Recent Alluvium. The Archaean crystalline rocks of the district comprise chiefly of charnockites, gneisses and the associated basic and ultra basic intrusive. A map showing the hydrogeology of the district is given as Plate-II. The crystalline rocks are weathered and jointed/fractured. The degree and depth of weathering varies from place to place and the thickness of weathered mantle varies from less than a metre to about 12 m in this district. The successful bore wells drilled tapping the deeper fractured aquifers in Saidapet, Adyar, Kasturba nagar, Gandhi nagar and Ashok nagar revealed the existence of fracturing down to depth of 60 m below ground level. The Gondwana shale is black to dark grey in colour and is jointed/ fractured. They are encountered in a number of boreholes and their thickness varies from 24 m in Kilpauk area through 20 m in Ashok Nagar area to more than 130 m in Koyambedu area. The occurrence of Tertiaries in Chennai district is not well demarcated. However, the sandstones encountered in some of the boreholes below alluvium in Binny Road, Poes Garden, Anna Nagar and Rayapuram areas, which belong to Tertiary group. The granular zones below the Kankar layer in the depth range of 20-28 m bgl in Poes Garden probably represent Tertiary sandstones and tube wells tapping these granular zones yield 2 to 3 litre per second (LPS). Ground water in Chennai district occurs in all the geological formations viz., the Archaean crystallines, Gondwanas, Tertiaries and alluvium and is developed by means of ring wells, dug wells, filter point wells, bore wells and tube wells. The Hydrogeology map of PIA district is given in **Figure 3-14**

Source: http://cgwb.gov.in/District_Profile/TamilNadu/chennai.pdf

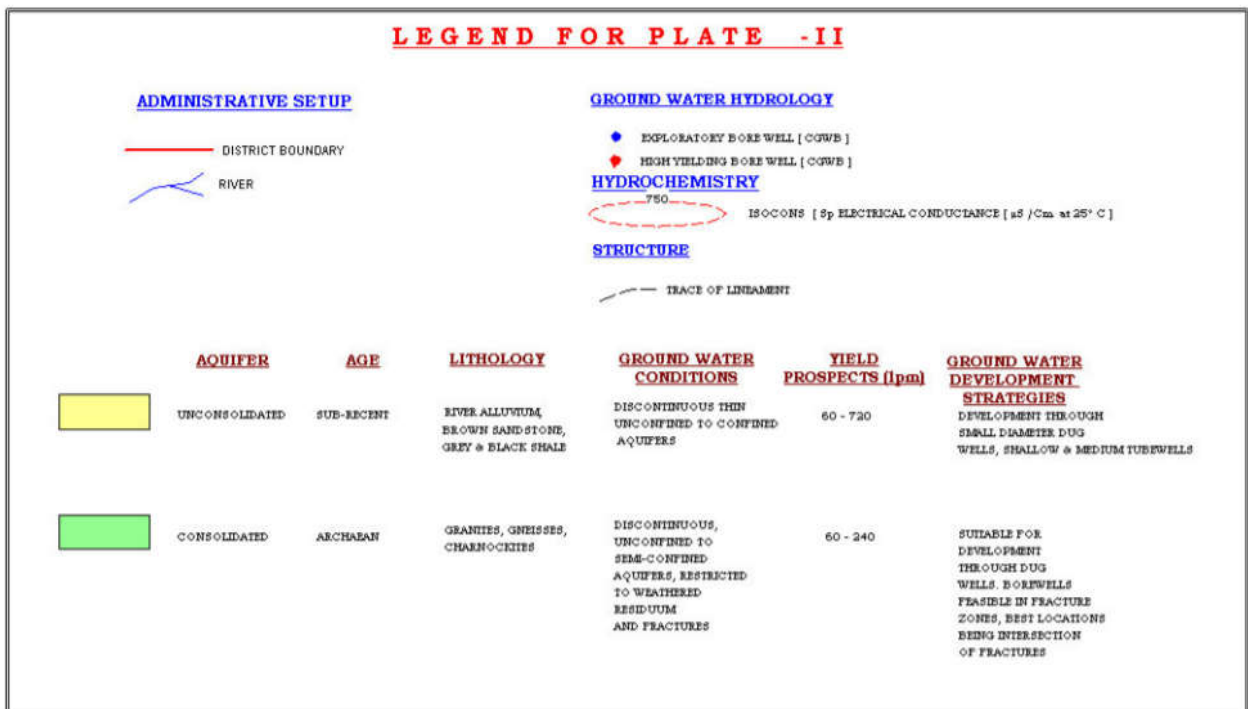
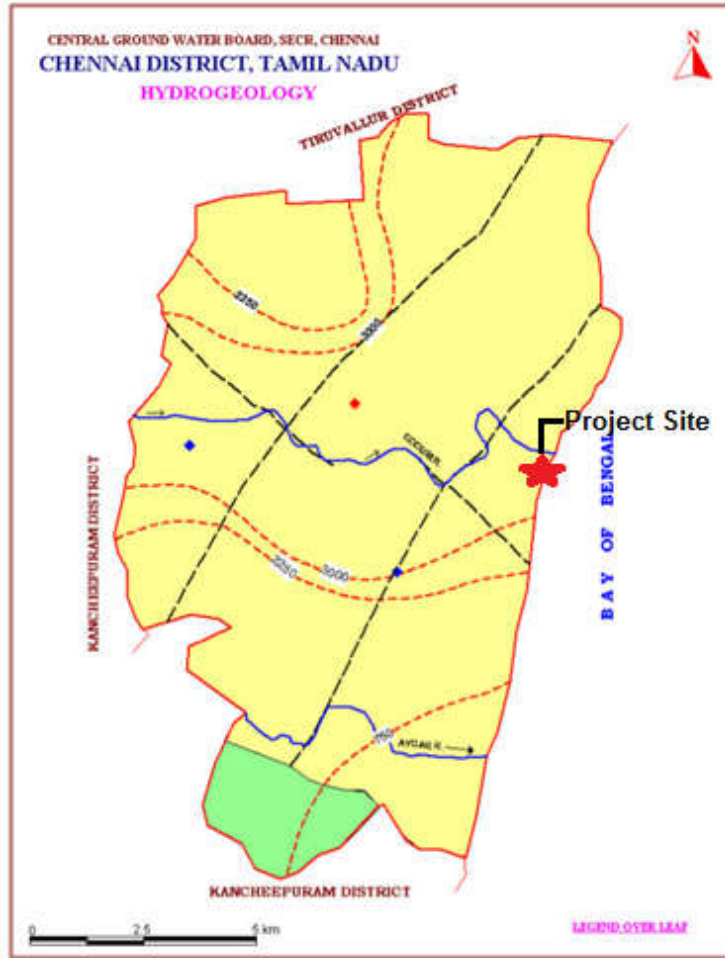


Figure 3-14 Hydrogeology Map of PIA district

Source: http://cgwb.gov.in/District_Profile/TamilNadu/chennai.pdf

3.5.10 Drainage Pattern in PIA District

Adyar River originates at the confluence (Thiruneermalai) of two streams that drains the upstream area of Chembarambakkam tank. It is a small river of 42 km length and a catchment of 800 Sq. km. The river carries flow all through 365 days of a year with an average discharge of 89.43 MCM/Year at Kattipara cause way. It drains the southern part of the district and remains flooded during monsoon. During the high tides, the backwaters from the Bay of Bengal enter inland up to 3 – 4 km. Cooum is the other main river flowing through the central part of the district and carries only drainage water, which is highly polluted. It originates from the surplus waters from the Cooum tank in Tiruvallore taluk and the tanks, which are in enroute, discharge their surplus water into the river during flood season. The flow of Cooum River at Korattur is 40.2 MCM/year for an average duration of 31 days in a year. Otteri Nulla is another small stream flowing in the northern part of the city. Buckingham canal is the man made one for navigation purposes earlier, but now it act as sewerage carrier in the city. Drainage map of the study area is given in **Figure 3-15**.

Source: http://cgwb.gov.in/District_Profile/TamilNadu/chennai.pdf

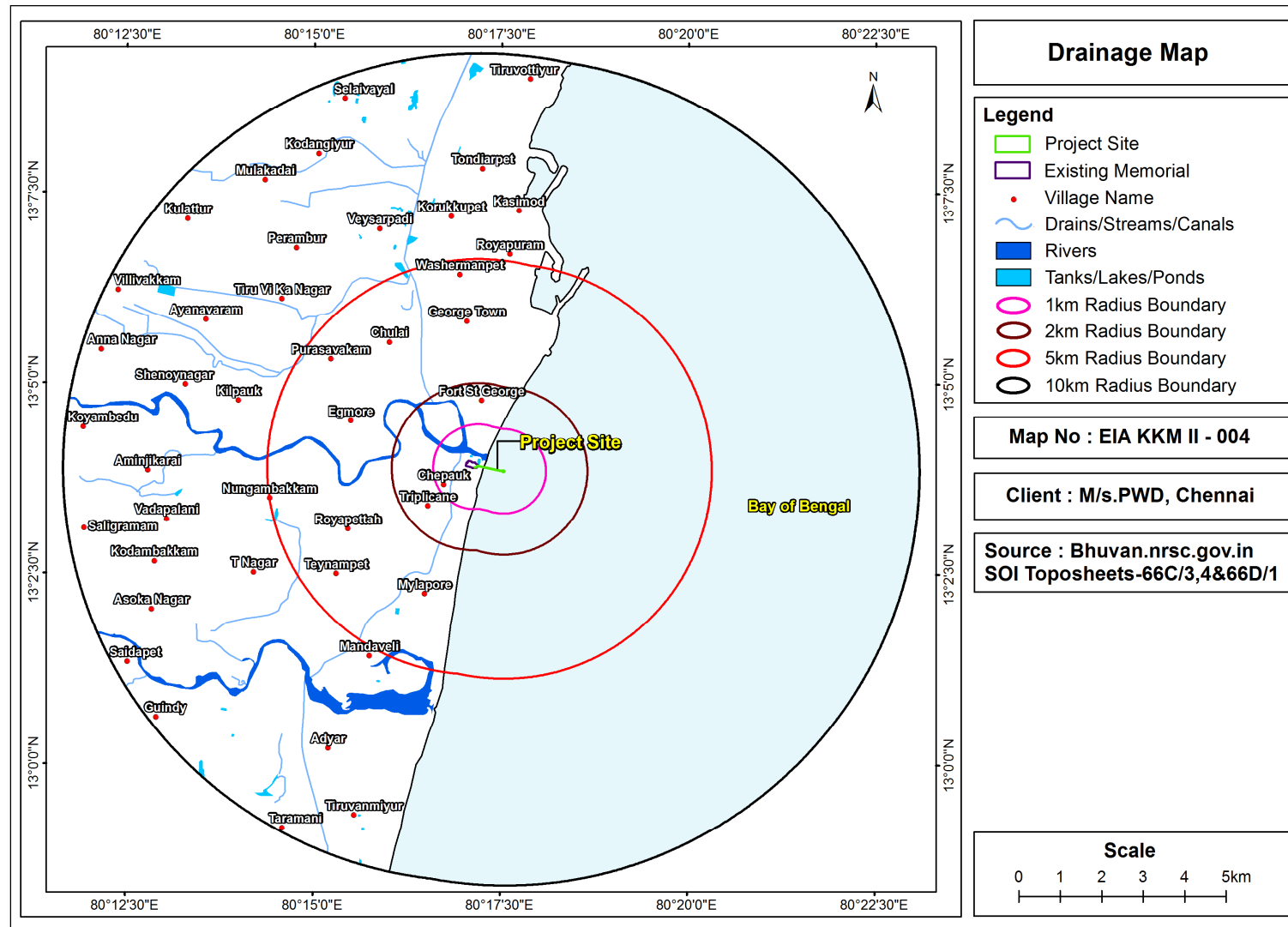


Figure 3-15 Drainage map of the study area

3.5.11 Soils in PIA District

The soil of Chennai City falls broadly into three types, viz., alluvial, laterite and red soil. Sandy coastal alluvium is found along the coastal areas; red soil is found in the North West and clay in the West and North of Chennai City. The aquifer of Chennai City can be broadly classified into hard crystallines and prong formations. In the hard crystallines, the degree of weathering and the presence of rocks vary gradually. However, the general zones of weathering do not extend beyond 12.0 meters below ground level. The data on existing bore wells indicate that wells show a moderate yield of 40 to 150 litres per minutes from the fractures encountered at a depth between 25 meters and 50 meters. The study falls in the soil order of recent alluvium soil. Soil Map of Tamil Nadu is given **Figure 3-16**.

Source: <http://shodhganga.inflibnet.ac.in/bitstream/10603/192874/6/chapter%203.pdf>



Figure 3-16 Soil Map of India

3.5.12 Cyclones & Depressions, Winds and Coastal Erosion in PIA District

The city gets most of its seasonal rainfall from the north-east monsoon winds, from mid-October to mid-December. Cyclones in the Bay of Bengal sometimes hit the city. The highest annual rainfall recorded is 2208 mm in 2005. Prevailing winds in Chennai are usually south-westerly between April and October and north-easterly during the rest of the year. Wind Hazard Map of Tamil Nadu is given in **Figure 3-17**.

Source: <http://shodhganga.inflibnet.ac.in/bitstream/10603/198369/6/chapter%203.pdf>

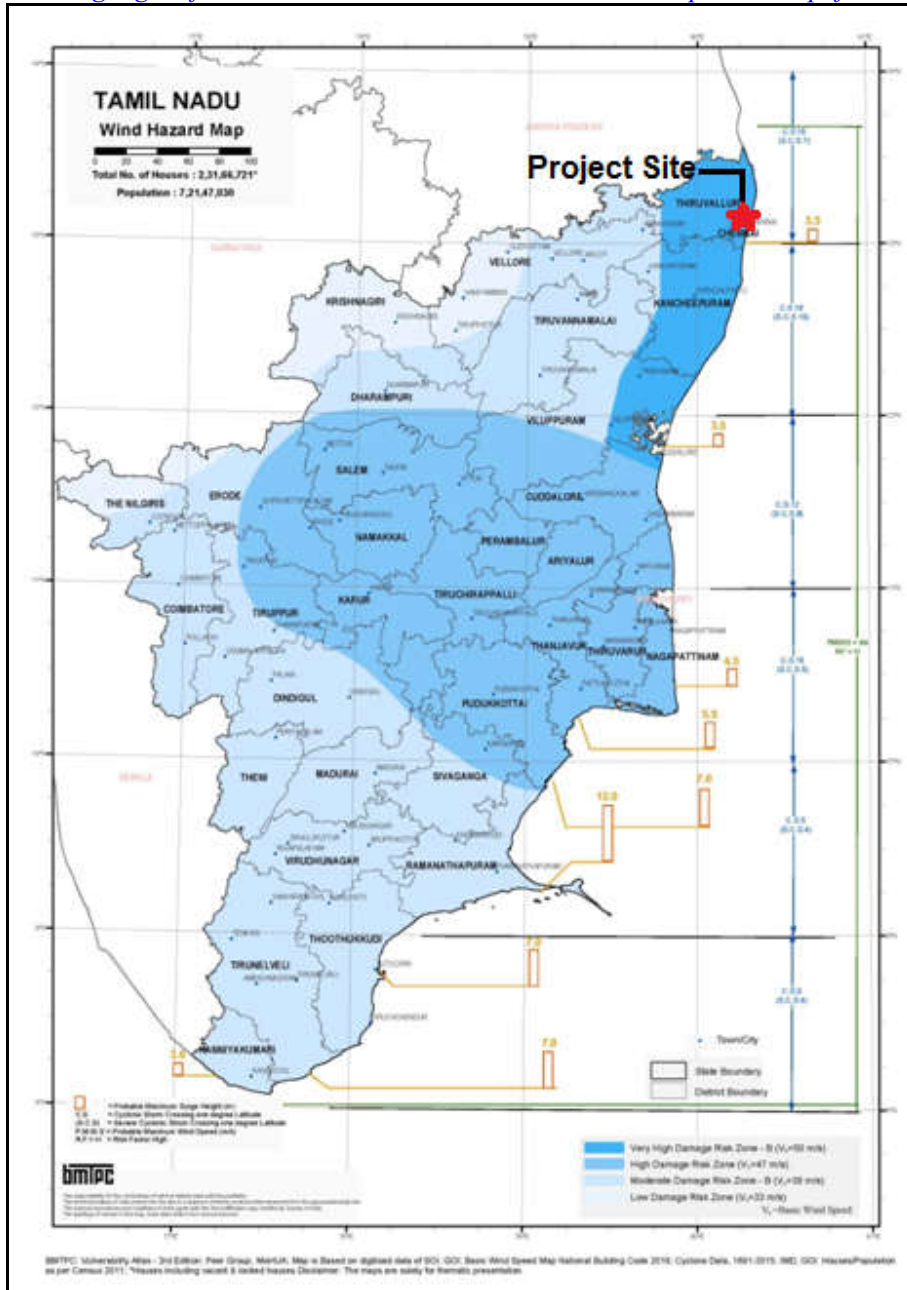


Figure 3-17 Wind Hazard Map of Tamil Nadu

3.5.13 Seismicity

As per Vulnerability Atlas of India – 3rd Edition, the project location/study area falls in Zone III, indicating a moderate damage risk zone. The seismicity map of Tamil Nadu is shown **Figure 3-18**.

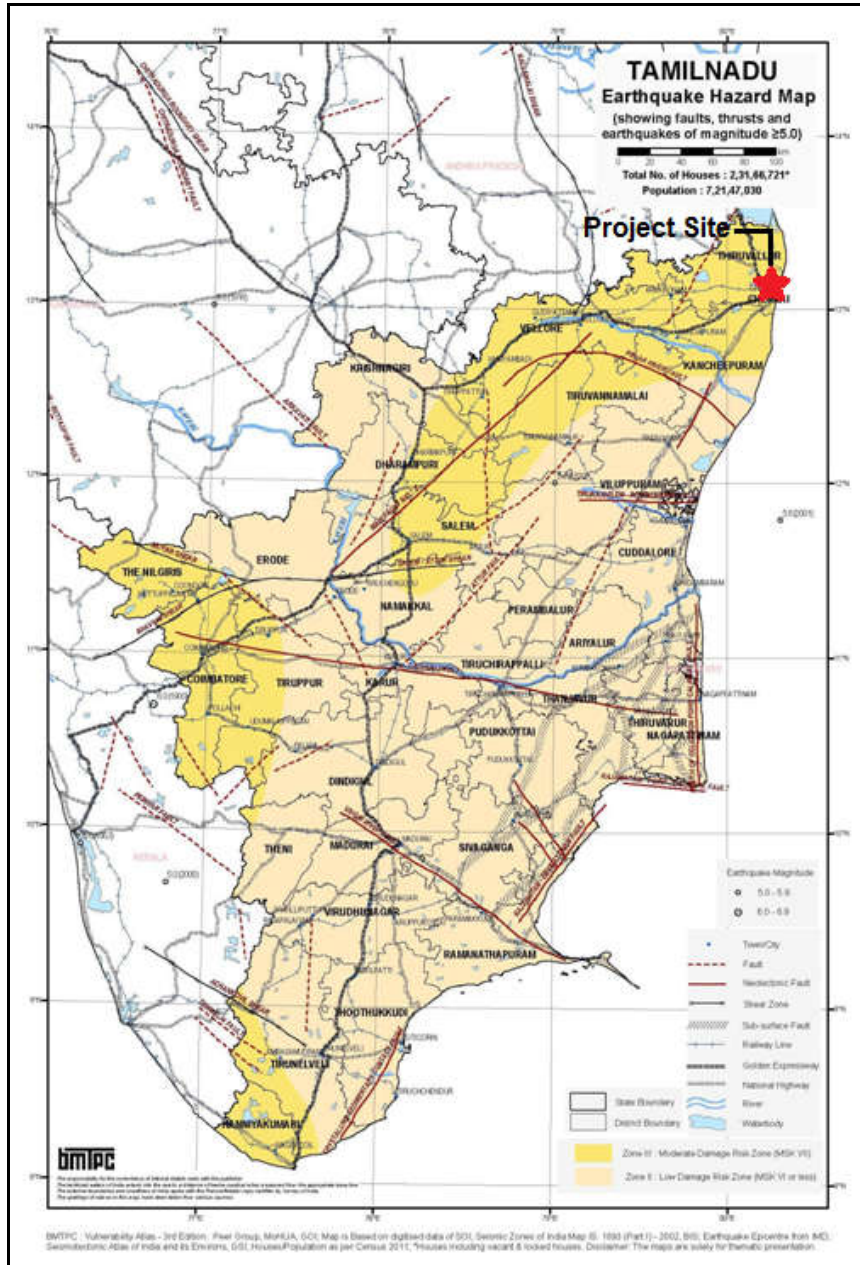


Figure 3-18 Seismicity Map of Tamil Nadu

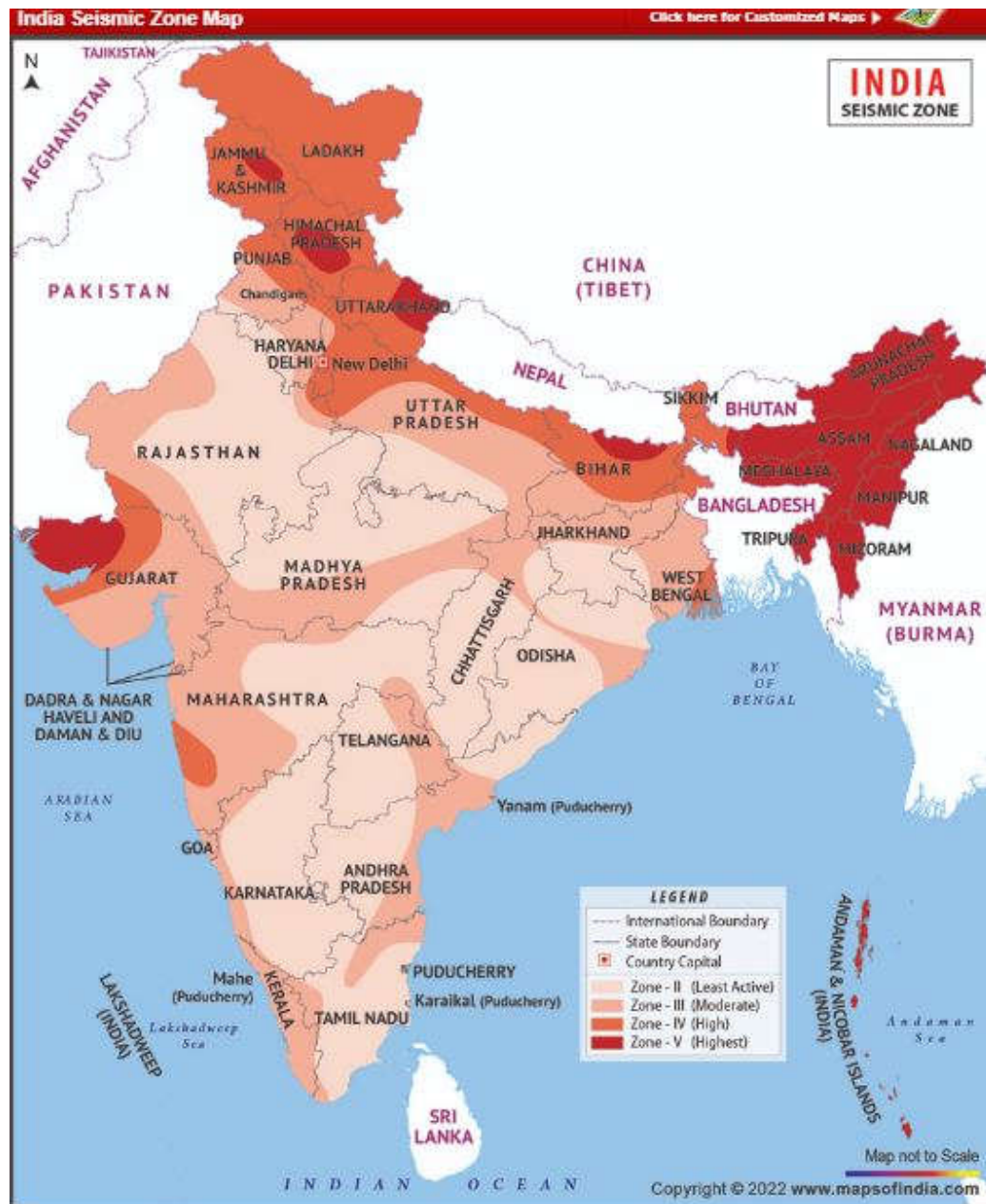


Figure 3-19 Seismicity Map of India

3.6 Air Environment

Baseline ambient air quality assessment gives the status in the vicinity of site and is an indispensable part of environmental impact assessment studies. Significant changes, in predominant winds and weather conditions are observed in winter, summer and post-monsoon seasons apart from the local topographic

influences. The baseline status of air environment in the study area is assessed through a systematic air quality surveillance program.

3.6.1 Meteorological Conditions

The regional air quality is influenced by the meteorology of that region. The principal weather parameters that influence the concentration of the air pollutants in the surroundings are wind speed, wind direction and temperature. The meteorological data is useful for proper interpretation of the baseline data. It is used as input for air quality dispersion models for predicting the post project environmental scenario i.e. ground level concentrations due to proposed DG sets, etc.

3.6.2 Meteorological Data Collection

Available secondary data pertaining to the meteorological parameters was obtained from the IMD Climatological tables. In addition, baseline meteorological data (primary data) was generated during the Pre-monsoon Season (27th May-28th July 2021). The methodology adopted for monitoring surface observations is as per the standard norms laid down by Bureau of Indian Standards (BIS) i.e. IS:8829 and Indian Meteorological Department (IMD).

3.6.3 General Meteorological Scenario based on IMD Data

The nearest Indian Meteorological Department (IMD) station located to project site is Chennai (Minambakkam). The Climatological data for Chennai (Minambakkam) (13° 00' N and 80° 11' E), published by the IMD, based on daily observations at 08:30 and 17:30 hour IST for a 30-year period, is presented in the following sections on the meteorological conditions of the region. The monthly variations of the relevant meteorological parameters are reproduced in **Table 3-5**.

Table 3-5 Climatological Summary – Chennai (Minambakkam) Region (1971-2000)

Month	Temp (°C)		Rainfall (mm)		Relative Humidity (%)		Vapour Pressure hPa		Mean Wind Speed (Km/hr)	Predominant Wind Directions (From)*	
	Daily Max.	Daily Min.	Total	No. of days	08:30	17:30	08:30	17:30		08:30	17:30
Jan	29.0	20.5	28.2	1.4	83	64	23.8	22.0	5.5	N	E
Feb	31.0	21.7	4.0	0.4	80	63	25.3	23.6	6.8	W	E
Mar	33.4	23.5	3.3	0.2	76	63	27.7	26.1	8.2	S	SE
Apr	35.7	26.1	11.2	0.7	71	66	30.6	30.2	10.4	S	SE
May	38.0	27.7	46.6	1.7	63	62	29.0	30.2	11.1	SW	SE
Jun	37.4	27.3	74.7	4.9	59	56	26.1	27.6	11.6	W	SE
Jul	35.4	26.2	130.5	7.7	67	60	26.8	27.9	9.9	W	S
Aug	34.5	25.6	145.8	8.4	71	63	27.3	28.4	9.4	W	SE,S

Month	Temp (°C)		Rainfall (mm)		Relative Humidity (%)		Vapour Pressure hPa		Mean Wind Speed (Km/hr)	Predominant Wind Directions (From)*	
	Daily Max.	Daily Min.	Total	No. of days	08:30	17:30	08:30	17:30		08:30	17:30
Sep	34.2	25.3	169.2	8.5	74	68	28.8	29.3	7.9	W	SE
Oct	32.0	24.4	293.9	10.0	81	74	29.5	28.9	5.8	W	E
Nov	29.7	22.9	361.6	10.4	83	74	27.5	26.2	5.7	N	N
Dec	28.6	21.5	173.0	6.2	82	69	25.1	23.3	5.9	N	NE
Max.	38	27.7	361.6	10.4	83	74	30.6	30.2	11.6	Annual predominant wind pattern is WEST	
Min.	28.6	20.5	3.3	0.2	59	56	23.8	22	5.5		
Avg/Total	33.2	24.4	1441.9	60.5	74.2	65.2	27.3	27.0	8.2		

As per the **Table 3-8** Climatological data provided observations drawn for the study period are the following.

As per the above IMD Climatological the observations drawn are the following.

- Daily maximum temperature is 38°C and the daily minimum temperature is 20.5°C were recorded in the months of May and January respectively.
- Maximum and minimum relative humidity of 83% and 56% were recorded in the months of January, November and June respectively.
- Maximum and minimum rainfall of 361.6mm and 0.2mm was recorded in the months of November and March respectively.
- Maximum and minimum Mean wind speed is 11.6 Km/hr and 5.5 Km/hr was recorded in the months of June and January respectively. According to the above IMD data, Annual predominant wind pattern is from **West**.

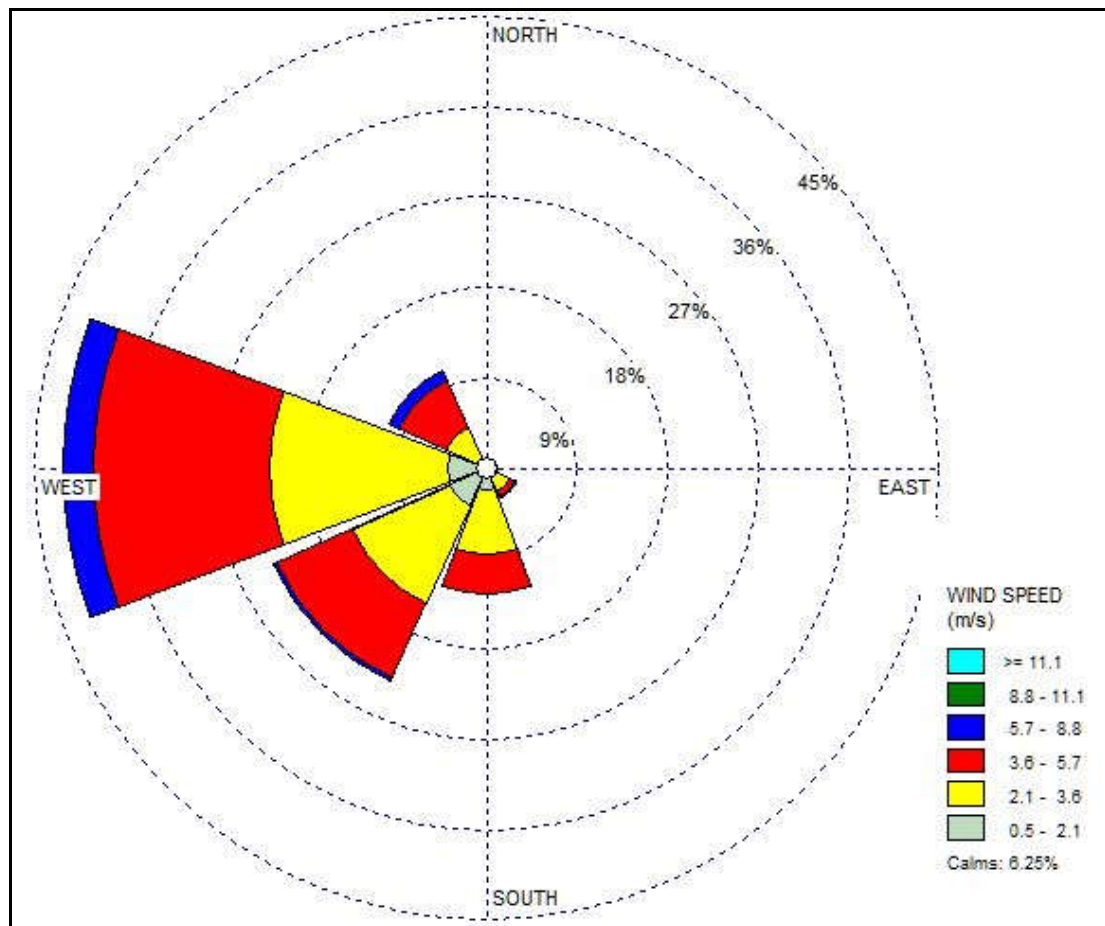


Figure 3-20 Wind Rose during Study period (27th May-28th July 2021-July 2021)

Table 3-6 Meteorology Data for the Study Period (27th May-28th July 2021-July 2021)

S. No	Parameter	Observation
1.	Temperature	Max Temperature: 37.0°C Min Temperature: 24.0°C Avg Temperature: 29.96°C
2.	Average Relative Humidity	72.49%
3.	Average Wind Speed	3.11 m/s
4.	Predominant Wind Direction	From WEST

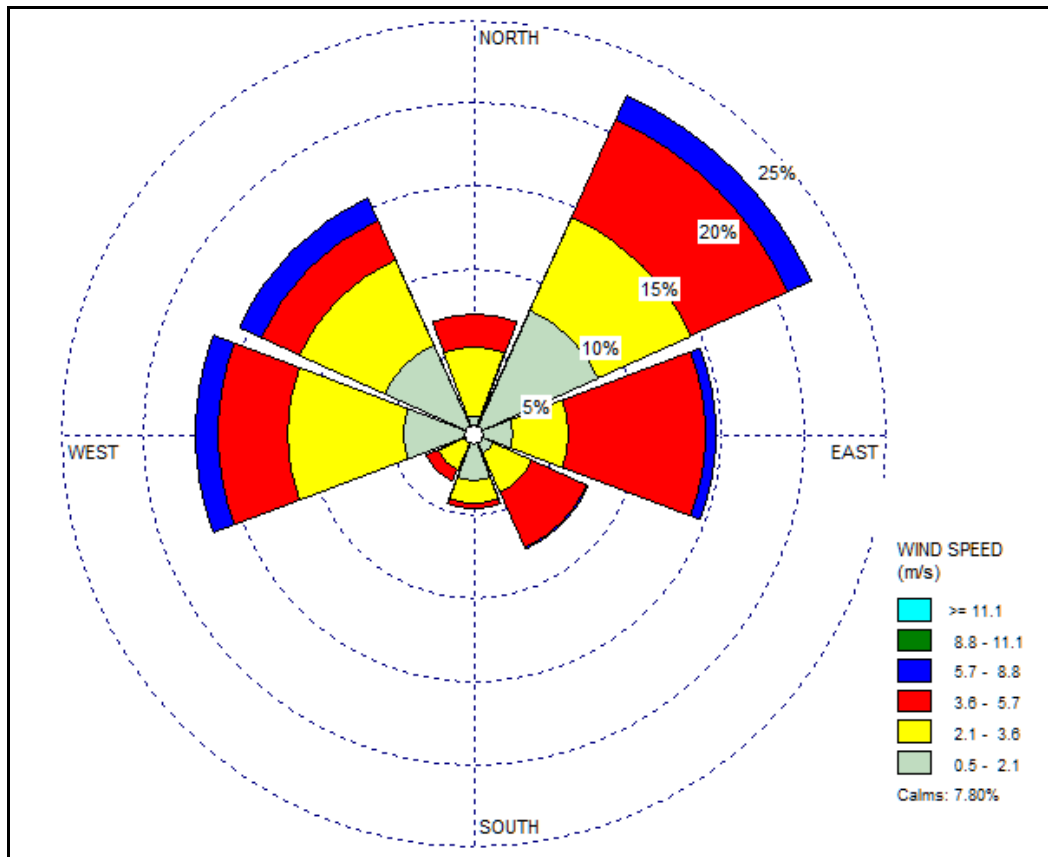


Figure 3-21 Wind Rose during Study period (October 2022)

Table 3-7 Meteorology Data for the Study Period (October 2022)

Sr. No	Parameter	Observation
1.	Temperature	Max Temperature: 35°C Min Temperature: 23.0°C Avg Temperature: 29.17°C
2.	Average Relative Humidity	75.59%
3.	Average Wind Speed	2.73 m/s
4.	Predominant Wind Direction	From North East

3.6.4 Ambient Air Quality

The selection criteria for monitoring locations are based on the following:

- Topography/Terrain
- Meteorological conditions
- Residential and sensitive areas within the study area
- Representatives of regional background air quality/pollution levels and
- Representation of likely impacted areas

3.6.4.1 Ambient Air Quality Monitoring Stations

To evaluate the baseline air quality of the study area, Eight (08) monitoring locations have been identified as per annual period wind predominance. The annual wind predominance is from West. Map showing the AAQ monitoring locations is given in **Figure 3-22** and the details of the locations are given in **Table 3-8**.

Table 3-8 Details of Ambient Air Quality Monitoring Locations

Station Code	Location	Wind Pattern	Distance (~km) from Project boundary	Directions
AAQ1	Near Project Site	-	0.05	W
AAQ2	Mylapore	c/w	3.36	SSW
AAQ3	Teynampet	c/w	4.12	SW
AAQ4	Thousand Lights	u/w	3.31	W
AAQ5	Pudupakam	u/w	1.85	W
AAQ6	Chetpet	u/w	4.67	W
AAQ7	Purasavakam	c/w	4.25	NW
AAQ8	George Town	c/w	2.67	N

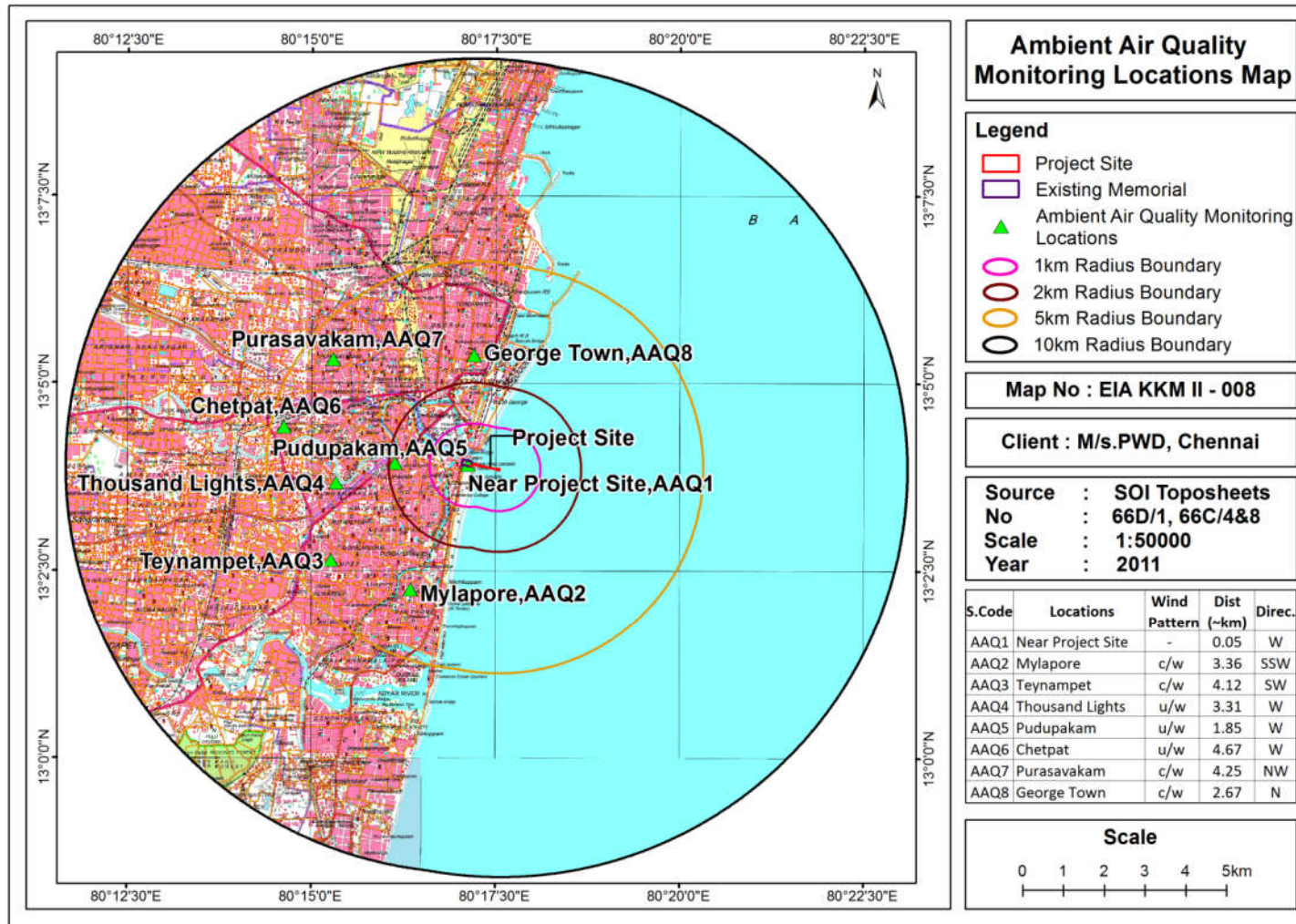


Figure 3-22 Map showing the Ambient Air Quality monitoring locations

3.6.4.2 Ambient Air Quality Monitoring Techniques and Frequency

Ambient air quality was monitored twice in a week for three (03) month (27th May- 28th July 2021), and validated in **October 2022** i.e. during pre-monsoon period. PM₁₀, PM_{2.5}, SO₂, NO_x, CO, O₃, Pb, NH₃, C₆H₆, C₂₀H₁₂, As & Ni were monitored. Sampling was carried out as per Central Pollution Control Board (CPCB) monitoring guidelines at each location. Analytical methods used for analysis of parameters are given in **Table 3-9**.

Table 3-9 Analytical Methods for Analysis of Ambient Air Quality Parameters

S. No	Parameters	Analytical method	NAAQ standards: 2009		Sampling Time
1	Sulphur Dioxide (SO ₂), µg/m ³	IS 11255 (part 2)/ USEPA method 6	50 (Annual)	80(24 Hours)	24 Hours
2	Nitrogen Dioxide (NO ₂), µg/m ³	IS: 5182 (Part - 6): 2006	40 (Annual)	80 (24 Hours)	24 Hours
3	Particulate Matter (PM _{2.5}), µg/m ³	In house method(Gravimetric Method)	40 (Annual)	60 (24 hours)	24 Hours
4	Particulate Matter (PM ₁₀), µg/m ³	IS:5182 (Part– 23): 2006	60 (Annual)	100 (24 hours)	24 Hours
5	CO mg/m ³	IS:5182(Part–10):1999 (Reaff:2006)	2 (8 hours)	4 (1hour)	1 Hours
6	Pb µg/m ³	IS:5182(Part–22):2004 (Reaff:2006)	0.5(Annual)	1(24 hours)	24 Hours
7	O ₃ , µg/m ³	In house method (Spectrophotometric Method)	100(8hours)	180 (1hour)	8 Hours
8	NH ₃ , µg/m ³	In house method (Spectrophotometric Method)	100(Annual)	400(24 hours)	24Hours
9	Benzene, µg/m ³	GC FID/ GC MS Based on IS 5182: part 11	5 (Annual)	5 (Annual)	24 Hours
10	Benzo (a) pyrene, ng/m ³	In house validated Method by HPLC,UV&GC MS Based on IS 5182: part 12	1 (Annual)	1 (Annual)	24 Hours
11	Arsenic, ng/ m ³	In house method (AAS Method) Based on CPCB guidelines Volume 1.	6 (Annual)	6 (Annual)	24 Hours
12	Nickel, ng/ m ³	In house method (AAS Method) Based on CPCB guidelines Volume 1.	20 (Annual)	20 (Annual)	24 Hours

3.6.4.3 Results and Discussions

The variations of the pollutants PM₁₀, PM_{2.5}, SO₂, NO₂, CO, Pb, O₃, NH₃, C₆H₆, C₂₀ H₁₂, and As & Ni are compared with National Ambient Air Quality Standards (NAAQS), MoEF&CC Notification, and November 2009. The Ambient Air Quality Monitoring Data (27th May-28th July 2021) for the study area

is given in **Table 3-10** and trends of measured ambient concentration in the study area were graphically represented in **Figure 3-23**.

Table 3-10 Summaries of the average baseline concentrations of pollutants

Parameters	Conc.	NAAQ Standards	Locations							
			Near Project Site	Mylapore	Teynampet	Thousand Lights	Pudupakam	Chetpet	Purasavakam	George Town
			AAQ1	AAQ2	AAQ3	AAQ4	AAQ5	AAQ6	AAQ7	AAQ8
PM ₁₀ Conc. (µg/m ³)	Min.	100 (24 Hours)	44.2	48.6	41.9	45.4	42.4	50.1	49.3	47.4
	Max.		59.7	65.7	56.6	61.4	57.3	67.6	66.6	64.0
	Avg.		50.3	55.3	47.7	51.7	48.3	57.0	56.1	53.9
	98th 'tile		59.57	65.48	56.44	61.19	57.13	67.45	66.41	63.86
PM _{2.5} Conc. (µg/m ³)	Min.	60 (24 Hours)	18.1	21.2	16.3	19.1	17.8	22.7	22.1	20.6
	Max.		24.5	28.6	22.0	25.8	24.1	30.7	29.9	27.9
	Avg.		20.7	24.1	18.5	21.7	20.3	25.8	25.2	23.5
	98th 'tile		24.45	28.51	21.90	25.73	23.99	30.60	29.78	27.81
SO ₂ Conc. (µg/m ³)	Min.	80 (24 Hours)	7.1	8.4	6.6	7.3	7.1	9.1	8.8	8.3
	Max.		9.6	11.3	8.9	9.9	9.6	12.3	11.8	11.1
	Avg.		8.1	9.6	7.5	8.4	8.1	10.3	10.0	9.4
	98th 'tile		9.61	11.32	8.86	9.89	9.58	12.23	11.81	11.12
NO ₂ Conc.(µg/m ³)	Min.	80 (24 Hours)	14.7	17.1	13.2	15.5	14.4	18.4	17.9	16.7
	Max.		19.9	23.2	17.8	20.9	19.5	24.8	24.2	22.6
	Avg.,		16.7	19.5	15.0	17.6	16.4	20.9	20.4	19.0
	98th 'tile		19.81	23.09	17.74	20.84	19.43	24.78	24.13	22.53
Pb (µg/m ³)	Avg.	1 (24 hour)	BLQ (LOQ 0.05)	BLQ (LOQ 0.05)	BLQ (LOQ 0.05)	BLQ (LOQ 0.05)	BLQ (LOQ 0.05)	BLQ (LOQ 0.05)	BLQ (LOQ 0.05)	BLQ (LOQ 0.05)
CO (mg/m ³)	Avg.	4 (1hour)	0.67	0.83	0.57	0.72	0.65	0.91	0.88	0.80
O ₃ (µg/m ³)	Avg.	180 (1hour)	10.4	11.6	9.6	10.8	10.2	12.2	12.0	11.4
C ₆ H ₆ (µg/m ³)	Avg.	5	BLQ (LOQ	BLQ (LOQ	BLQ (LOQ	BLQ (LOQ	BLQ (LOQ	BLQ (LOQ	BLQ (LOQ	BLQ (LOQ

Parameters	Conc.	NAAQ Standards	Locations							
			Near Project Site	Mylapore	Teynampet	Thousand Lights	Pudupakam	Chetpet	Purasavakam	George Town
			AAQ1	AAQ2	AAQ3	AAQ4	AAQ5	AAQ6	AAQ7	AAQ8
		(Annual)	1)	1)	1)	1)	1)	1)	1)	1)
C₂₀H₁₂ (a) , (ng/m³)	Avg.	1 (Annual)	BLQ (LOQ 1)	BLQ (LOQ 1)	BLQ (LOQ 1)	BLQ (LOQ 1)	BLQ (LOQ 1)	BLQ (LOQ 1)	BLQ (LOQ 1)	BLQ (LOQ 1)
As (ng/ m³)	Avg.	6 (Annual)	BLQ (LOQ 2)	BLQ (LOQ 2)	BLQ (LOQ 2)	BLQ (LOQ 2)	BLQ (LOQ 2)	BLQ (LOQ 2)	BLQ (LOQ 2)	BLQ (LOQ 2)
Ni (ng/m³)	Avg.	20 (Annual)	BLQ (LOQ 10)	BLQ (LOQ 10)	BLQ (LOQ 10)	BLQ (LOQ 10)	BLQ (LOQ 10)	BLQ (LOQ 10)	BLQ (LOQ 10)	BLQ (LOQ 10)
NH₃ (µg/m³)	Avg.	400 (24hours)	7.72	8.74	8.13	8.45	7.83	8.24	8.91	8.69

Note: BLQ (Below Limit of Quantification); LOQ (Limit of Quantification)

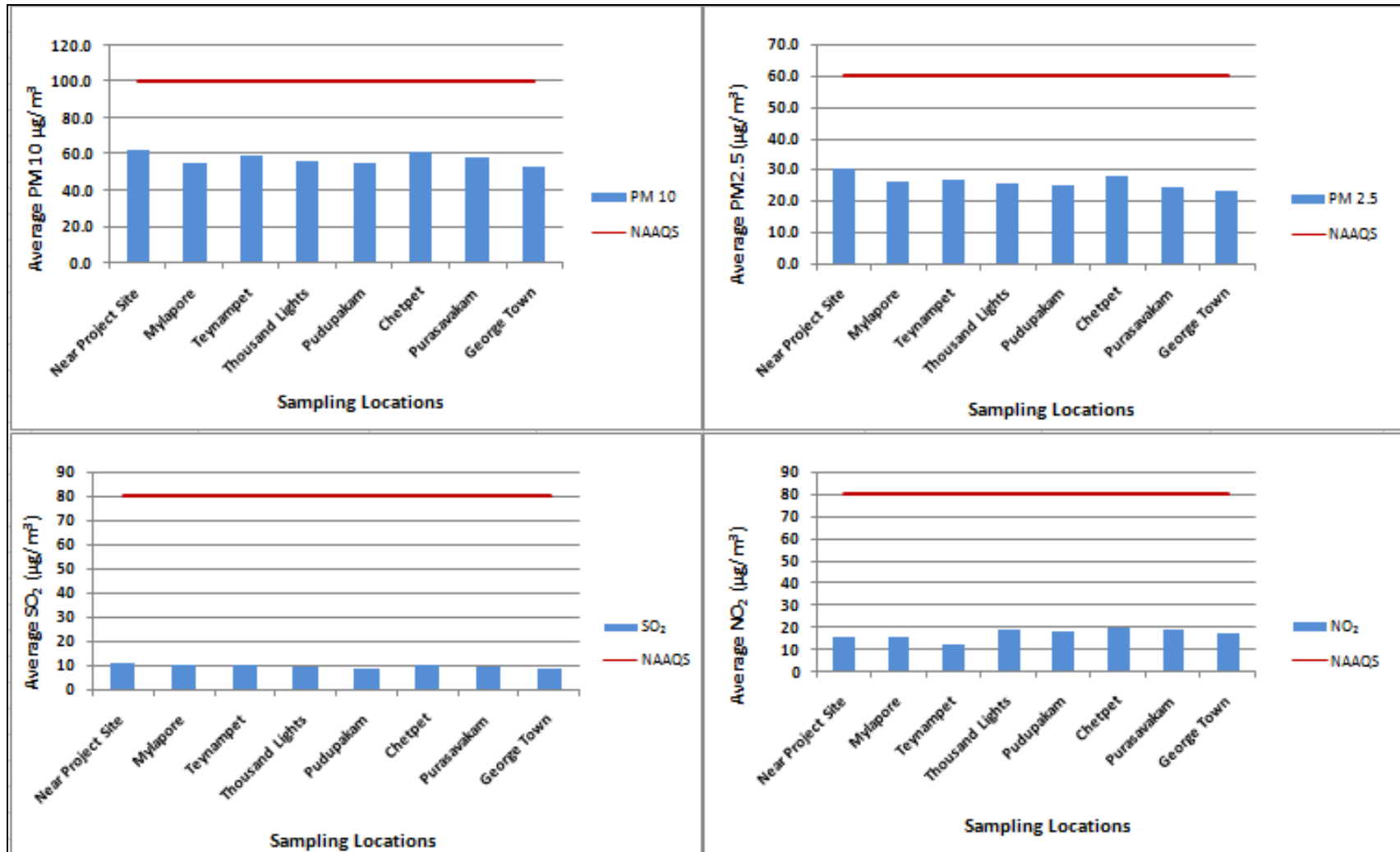


Figure 3-23 Trends of Measured Ambient Concentrations in the Study Area

3.6.4.4 Observations

The ambient air quality has been monitored at 8 locations for 12 parameters as per NAAQS, 2009 within the study area. The average baseline levels of PM₁₀ is 41.9 to 67.6 µg/m³, PM_{2.5} is 16.3 to 30.7 µg/m³, SO₂ is 6.6 to 12.3 µg/m³, NO₂ is 13.2 to 24.8 µg/m³ and all the parameters are well within the National Ambient Air Quality Standards at all monitoring locations during the study period.

3.7 Noise Environment

The prevailing ambient noise level at a particular location is nothing but the resultant (total) of all kinds of noise sources existing at various distances around that location. The ambient noise level at a location varies continuously depending on the type of surrounding activities.

Ambient noise levels have been established by monitoring noise levels at Eight (08) locations in and around 10 Km distance from project area during the study period using precision noise level meter. The noise monitoring locations in the study area were selected after giving due consideration to the various land use categories. The land use categories include commercial, residential, rural and sensitive areas. Noise levels were recorded on an hourly basis for one complete day at each location using pre- calibrated noise levels. Sampling map of noise monitoring locations are given in **Figure 3-24**.

3.7.1 Results and Discussion

Based on the recorded hourly noise levels at each monitoring location, the day equivalent (L_d) and night equivalent (L_n) were calculated;

- L_d: Average noise levels between 6:00 hours to 22.00 hours.
- L_n: Average noise levels between 22:00 hours to 6.00 hours.

The comparison of day equivalent noise levels (L_d) and night equivalent noise levels (L_n) with the respective CPCB stipulated noise standards for various land use categories are shown in the **Table 3-11**.

Table 3-11 Day And Night Equivalent Noise Levels

S. No	Location	Location Code	Distance (~km) from Project boundary	Direction	Noise level in dB(A) Leq		CPCB Standard		Environmental Setting
					Day	Night	Lday (Ld)	LNight (Ln)	
1.	Project Site	N1	Within the Site		50.5	43.4	55	45	Project site
2.	Mylapore	N2	3.36	SSW	52.3	44.7	55	45	Residential
3.	Teynampet	N3	4.12	SW	51.7	43.3	55	45	Residential
4.	Thousand Lights	N4	3.31	W	52.3	42.8	55	45	Residential
5.	Pudupakam	N5	1.85	W	54.8	44.3	55	45	Residential
6.	Chetpet	N6	4.67	W	53.2	42.2	55	45	Residential
7.	Purasavakam	N7	4.25	NW	54.6	41.5	55	45	Residential
8.	George Town	N8	2.67	N	53.6	40.2	55	45	Residential

3.7.2 Observations

It is observed that the day equivalent and night equivalent noise levels at all locations are within prescribed CPCB standards.

- In residential area, day time max noise levels were in range of 50.5 to 54.8 dB (A) and 40.2 to 44.7 dB(A) during night time across the sampling stations. The field observations during the study period indicate that the ambient noise levels in Residential area noise exceeded the limit prescribed by CPCB (55 dB (A) Day time & 45 dB (A) Night time).

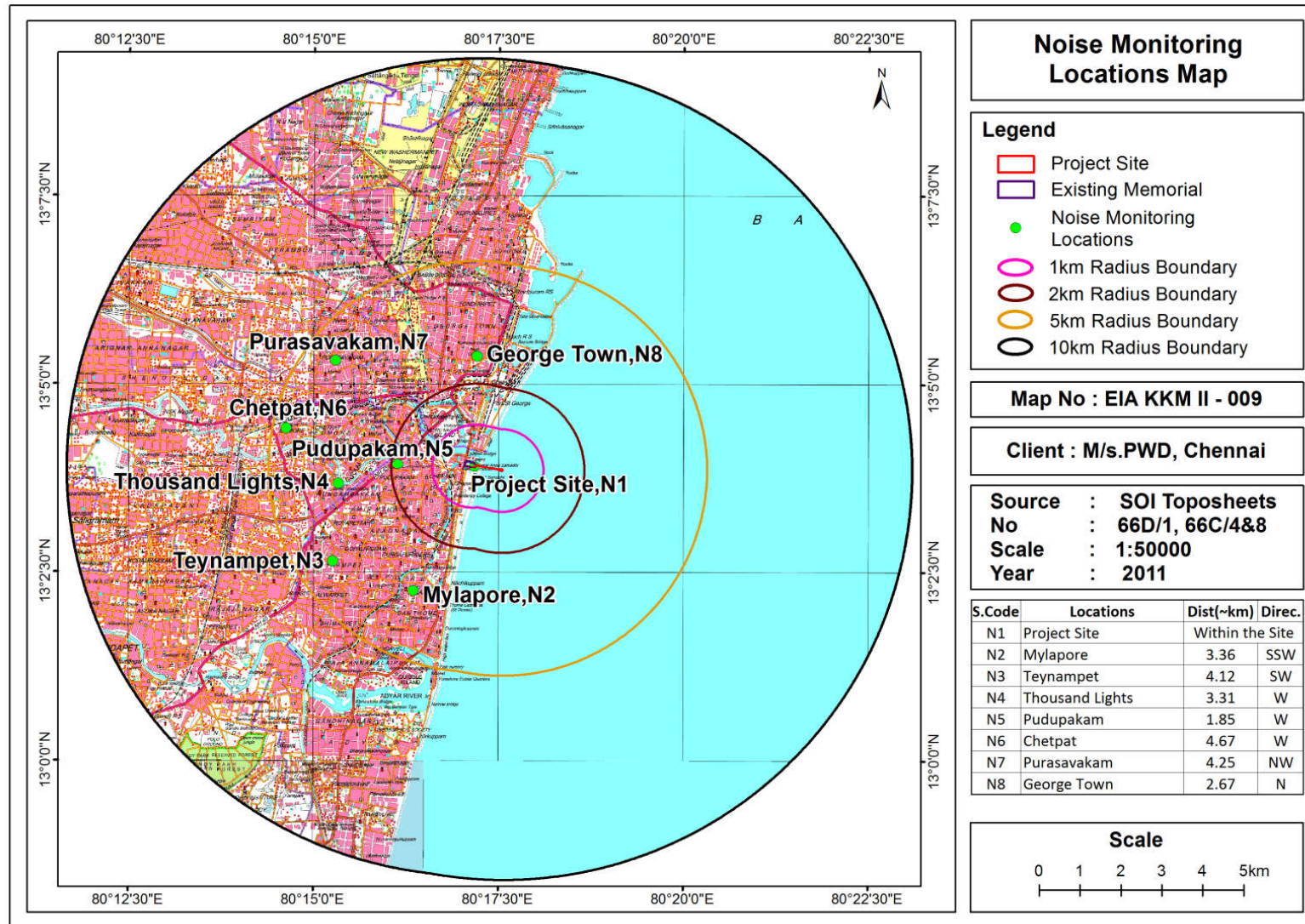


Figure 3-24 Map showing the noise monitoring locations

3.8 Water Environment

3.8.1 Surface Water Resources

Chennai city lacks a perennial water source, and therefore, catering the water requirements of the population remains a huge challenge for several decades. According to Chennai Metro Water, Chennai receives about 985 million liters per day from various sources against the required amount of 1,200 MLD. This demand is expected to rise to 2,100 MLD by 2031. This situation reminds us the fact that Chennai is bound to face water supply shortages in the forth coming years as well. As no big river flows through Chennai, the city has solely relied on annual monsoon rains to replenish water reservoirs. Ground water resources in Chennai are replenished by rain water and the city's average rainfall is 1,276 mm. Chennai, after having grown into a metropolis, is now the Chennai Metropolitan Area for planning purposes.

The CMA has 22 water courses, including three rivers, a canal, and four reservoir tanks. This also includes 16 minor waterways. The city has three rivers flowing into the Bay of Bengal, namely, the Cooum, the Adyar, and the Kosasthalaiyar, which divide the city into north-south sections. The Buckingham canal connects all the three rivers. There are four reservoirs in the city, namely, Red Hills, Cholavaram, Poondi and Chembarambakkam, with a combined capacity of 11,057 mcft. The Red Hills reservoir has a capacity of 3,300 mcft. The Cholavaram reservoir has a capacity of 881 mcft. The Poondi reservoir has a capacity of 3,231 mcft. The Chembarambakkam reservoir has a capacity of 3,645 mcft. Water to the city's residents is being supplied also from desalination plants at Nemelli and Minjur; aquifers in Neyveli, Minjur and Panchetty; Cauvery water from Veeranam Lake; Krishna River from Andhra Pradesh; Poondi reservoir; and lakes at Red Hills, Chembarambakkam and Cholavaram. Given the increasing demand of water requirements in Chennai city, it remains an important challenge for city authorities to source water from multiple sources to distribute water to all walks of life. A recent report from Central Water Commission that monitors water levels confirm that water situation in major reservoirs spread across Tamil Nadu and other Southern States continue to decline to about 11% of their collective storage. This statistics is definitely not encouraging to water planners and general public.

Source: http://shodhganga.inflibnet.ac.in/bitstream/10603/203913/13/13_chapter%205.pdf

3.8.2 Surface Water Quality Assessment

Water quality monitoring and assessment can be used to determine ambient water quality, the extent and causes of a water quality problem, or to measure the effectiveness of best management practices being implemented in water system. Monitoring helps to determine the trends in the quality of the aquatic environment and the impact due to the release of contaminants, other anthropogenic activities, and/or by waste treatment operations (impact monitoring). To establish the baseline status of water

environment, the representative sampling locations for surface water within a radial distance of 10Km from project site have been selected as per CPCB guidelines of Water Quality Monitoring through an adequate survey of the project area. Test methods used for the analysis of water quality parameters is given in **Table 3-12**. Water sampling and map of sampling location are given in **Figure 3-25**.

Table 3-12 Test Methods Used For the Analysis of Water Quality Parameters

S. No	Parameter Measured	Test Method
1.	Colour	IS:3025 (Part- 4) 1983 (Reaff 2006)
2.	Turbidity	IS 3025(Part - 10):1984
3.	pH	IS:3025 (Part - 11): 1983 (Reaff: 2006)
4.	Conductivity	IS:3025 (Part - 14): 1983 (Reaff: 2006)
5.	Total Dissolve Solids	IS: 3025:1(Part - 16) 1984 (Reaff 2006)
6.	Total Suspended Solids	IS 3025 (Part - 17) 1984 (Reaff 1996)
7.	Alkalinity as CaCO ₃	IS:3025,1 (Part - 23) 1986 (Reaff 2009)
8.	Total Hardness as CaCO ₃	IS:3025 (Part - 21) 1983 (Reaff 2006)
9.	Sodium	IS:3025,5(Part - 45) 1993 (Reaff 2006)
10.	Potassium	IS:3025,5(Part - 45) 1993 (Reaff 2006)
11.	Calcium as Ca	IS 3025 (Part - 40):1991
12.	Magnesium as Mg	IS 3025 (Part - 46) 1994
13.	Chloride	IS 3025 (Part - 32):1988
14.	Sulphate SO ₄	IS 3025(Part - 24):1986
15.	Nitrate as NO ₃	ASTM (Part - 31)1978
16.	Phosphate	IS 3025 (Pt 45) 1993 (R 2006)
17.	Fluorides as F	IS 3025 (Part - 60):2008
18.	Cyanide	IS 3025 (Part-27):1986
19.	Arsenic	IS 3025:(Part-37):1988(Reaff 2009)
20.	Boron	IS:3025 (Part - 57):2003
21.	Cadmium	IS 3025 (Part - 41)1991
22.	Chromium, Total	IS:3025 (Part - 52) 2003 (Reaff 2009)
23.	Copper	IS:3025 (Part - 42)1992 (Reaff: 2009)
24.	Iron	IS 3025 (Part - 53):2003
25.	Lead	IS:3025 (Part - 47) 1994 (Reaff 2009)
26.	Manganese	IS 3025:(Part - 59):2006
27.	Mercury	IS 3025 (Part48):1994 RA 1999
28.	Nickel	IS 3025:(Part-54):2003(Reaff 2009)
29.	Selenium	IS 3025 Part (56)2003
30.	Zinc	IS:3025 (Part - 49) 1994 (Reaff 2009)
31.	Dissolved Oxygen	IS:3025 (Part - 38)1989 (Reaff 2009)
32.	BOD	5210B APHA22nd Edn 2012
33.	COD	IS:3025 (Part-58)-2006

Table 3-13 Details of Surface Water Sampling Locations

S. No	Name of the Water body	Location Code	Distance from Project Boundary (~Km)	Direction
1.	Marine Sample near Project Site	SW1	Within the Site	
2.	Adyar R d/s	SW2	6.62	SSW
3.	Adyar R u/s	SW3	9.31	WSW
4.	Buckingham Canal d/s	SW4	0.46	W
5.	Cooum/Kuvam R u/s	SW5	1.14	WNW
6.	Buckingham Canal u/s	SW6	2.04	NW
7.	Otteri Nala	SW7	5.35	NNW
8.	Cooum/Kuvam R d/s (Near Sea Mouth)	SW8	0.18	N

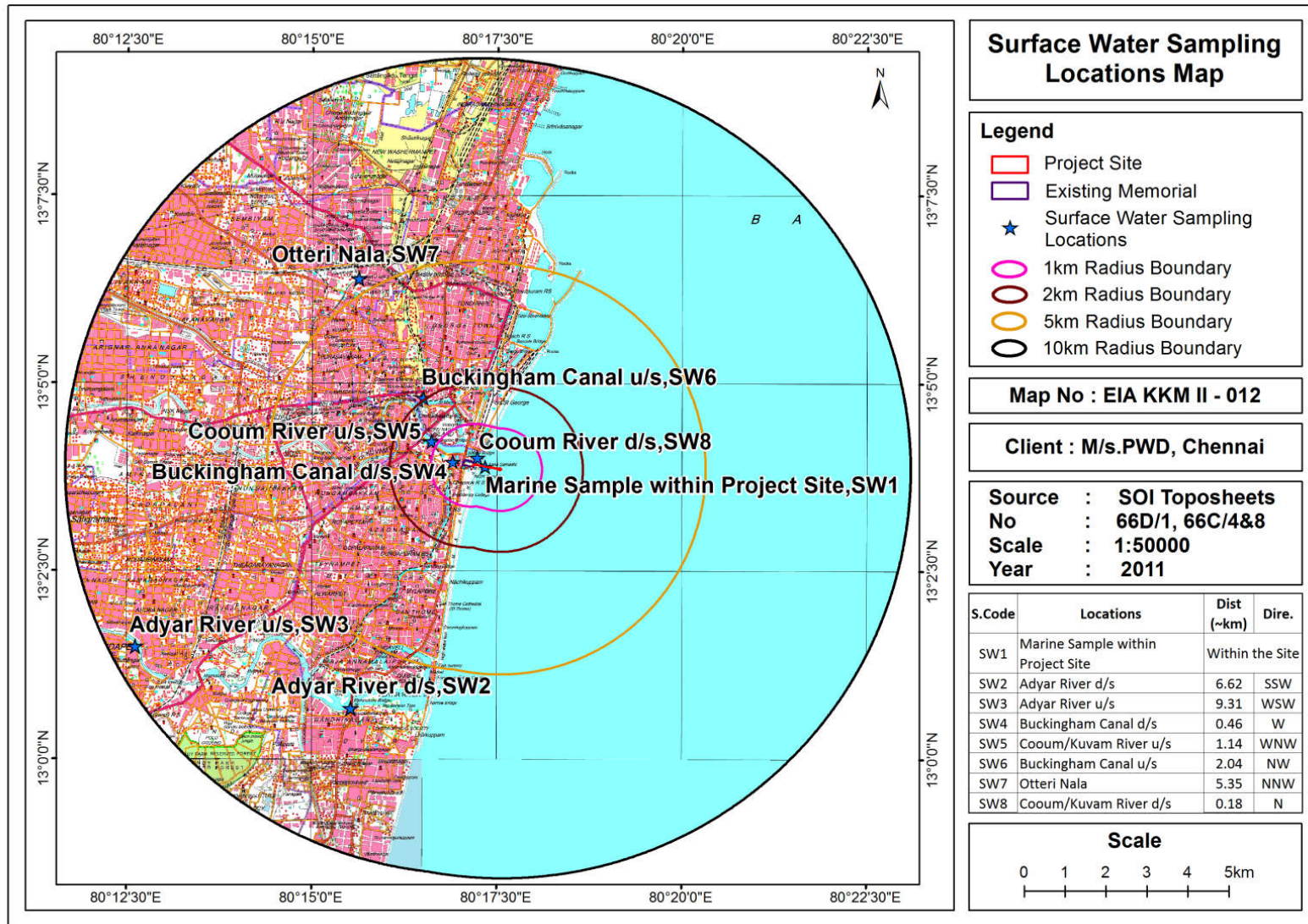


Figure 3-25 Map showing the surface water monitoring locations

Table 3-14 Physicochemical Parameters of Surface water samples from study area (27th May-28th July 2021)

S. No	Parameter	Unit	Surface water standards (IS 2296 Class-A)	Marine sample near project site	Adyar River d/s	Adyar River u/s	Buckingham Canal d/s	Cooum River u/s	Buckingham Canal u/s	Otteri Nala	Cooum River d/s
				SW1	SW 2	SW 3	SW 4	SW 5	SW 6	SW 7	SW 8
1	pH (at 25°C)	--	6.5-8.5	8.17	6.78	7.23	6.69	7.42	7.47	7.58	6.9
2	Electrical Conductivity	µS/cm	-	52008	14797	4305	40314	39369	33087	2817	43350
3	Total Dissolved Solids	mg/l	500	34565	10110	2819	27081	26441	22456	1932	30240
4	Total Suspended Solids	mg/l	-	19	48	41	38	46	29	25	52
5	Total Alkalinity as CaCO ₃	mg/l	-	436.9	327.4	278.9	367.5	334.5	307.8	231.9	389.5
6	Total Hardness as CaCO ₃	mg/l	300	5503.8	1563.8	574.7	4306.0	4209.3	3569.7	297.0	4813.0
7	Sodium as Na	mg/l	-	8924.2	2535.7	618.2	6982.1	6825.3	5788.2	481.6	7804.2
8	Potassium as K	mg/l	-	398.4	113.2	27.6	311.7	304.7	258.4	21.5	348.4
9	Calcium as Ca	mg/l	-	1249.4	355.0	130.5	977.5	955.5	810.3	67.4	1092.6
10	Magnesium as Mg	mg/l	-	578.4	164.3	60.4	452.5	442.4	375.2	31.2	505.8
11	Chloride as Cl	mg/l	250	13280.0	3773.3	920.0	10390.0	10156.7	8613.3	574.1	11613.3
12	Sulphate as SO ₄	mg/l	400	5511.2	1565.9	381.8	4311.9	4215.0	3574.5	238.2	4819.5
13	Nitrate as NO ₃	mg/l	20	2.8	5.1	4.0	3.8	6.0	3.7	3.4	4.4
14	Fluorides as F	mg/l	1.5	0.87	0.27	0.21	0.63	0.5	0.44	0.12	0.69
15	Cyanide	mg/l	0.05	BLQ(LOQ 0.01)	BLQ(LOQ 0.01)	BLQ(LOQ 0.01)	BLQ(LOQ 0.01)	BLQ(LOQ 0.01)	BLQ(LOQ 0.01)	BLQ(LOQ 0.01)	BLQ(LOQ 0.01)
16	Arsenic	mg/l	0.05	BLQ(LOQ 0.005)	BLQ(LOQ 0.005)	BLQ(LOQ 0.005)	BLQ(LOQ 0.005)	BLQ(LOQ 0.005)	BLQ(LOQ 0.005)	BLQ(LOQ 0.005)	BLQ(LOQ 0.005)
17	Boron as B	mg/l	-	BLQ(LOQ 0.1)	BLQ(LOQ 0.1)	BLQ(LOQ 0.1)	BLQ(LOQ 0.1)	BLQ(LOQ 0.1)	BLQ(LOQ 0.1)	BLQ(LOQ 0.1)	BLQ(LOQ 0.1)

18	Cadmium as Cd	mg/l	0.01	BLQ(LO Q 0.001)	BLQ(LOQ 0.001)	BLQ(LO Q 0.001)	BLQ(LOQ 0.001)	BLQ(LO Q 0.001)	BLQ(L OQ 0.001)	BLQ(LOQ 0.001)	BLQ(L OQ 0.001)
19	Chromium, Total	mg/l	0.05	BLQ(LO Q 0.01)	BLQ(LOQ 0.01)	BLQ(LO Q 0.01)	BLQ(LOQ 0.01)	BLQ(LO Q 0.01)	BLQ(L OQ 0.01)	BLQ(LOQ 0.01)	BLQ(L OQ 0.01)
20	Copper as Cu	mg/l	1.5	BLQ(LO Q 0.01)	BLQ(LOQ 0.01)	BLQ(LO Q 0.01)	BLQ(LOQ 0.01)	BLQ(LO Q 0.01)	BLQ(L OQ 0.01)	BLQ(LOQ 0.01)	BLQ(L OQ 0.01)
21	Lead as Pb	mg/l	0.1	BLQ(LO Q 0.005)	BLQ(LOQ 0.005)	BLQ(LO Q 0.005)	BLQ(LOQ 0.005)	BLQ(LO Q 0.005)	BLQ(L OQ 0.005)	BLQ(LOQ 0.005)	BLQ(L OQ 0.005)
22	Manganese as Mn	mg/l	0.5	BLQ(LO Q 0.05)	BLQ(LOQ 0.05)	BLQ(LO Q 0.05)	BLQ(LOQ 0.05)	BLQ(LO Q 0.05)	BLQ(L OQ 0.05)	BLQ(LOQ 0.05)	BLQ(L OQ 0.05)
23	Mercury	mg/l	0.001	BLQ(LO Q 0.0005)	BLQ(LOQ 0.0005)	BLQ(LO Q 0.0005)	BLQ(LOQ 0.0005)	BLQ(LO Q 0.0005)	BLQ(L OQ 0.0005)	BLQ(LOQ 0.0005)	BLQ(L OQ 0.0005)
24	Nickel as Ni	mg/l	-	BLQ(LO Q 0.01)	BLQ(LOQ 0.01)	BLQ(LO Q 0.01)	BLQ(LOQ 0.01)	BLQ(LO Q 0.01)	BLQ(L OQ 0.01)	BLQ(LOQ 0.01)	BLQ(L OQ 0.01)
25	Selenium as Se	mg/l	0.01	BLQ(LO Q 0.005)	BLQ(LOQ 0.005)	BLQ(LO Q 0.005)	BLQ(LOQ 0.005)	BLQ(LO Q 0.005)	BLQ(L OQ 0.005)	BLQ(LOQ 0.005)	BLQ(L OQ 0.005)
26	Dissolved Oxygen	mg/l	6	6.3	4.5	5.9	3.6	2.7	5.2	5.7	1.9
27	Chemical Oxygen Demand as O ₂	mg/l	-	28.7	68.1	50.2	81.8	98.9	62.6	54.1	111.7
28	BOD, 3 days @ 27°C as O ₂	mg/l	2	6.0	14.5	10.8	15.9	18.8	13.7	9.9	20.6

Note: **BLQ** – Below Limit of Quantification; **LOQ** – Limit of Quantification

3.8.3 Results and Discussion

Surface water sample results are discussed below:

1. Surface Water sample results were compared with IS 2296:1992 and Marine water samples were compared with MoEF Standards 1998.
2. The pH range in the collected surface water samples varies between 6.69 – 7.58 and for marine water sample was recorded 8.17.
3. The Total Dissolved Solids range from 1932 mg/l to 30240 mg/l and for marine water sample was recorded 34565 mg/l.
4. The chloride content in the surface water for study area ranges from 574.1 mg/l to 11613.3 mg/l and for sea water sample was recorded 13280.0 mg/l.
5. The sulphate content in the surface water of the study area varies between 238.2 mg/l – 4819.5 mg/l and for sea water sample was observed 5511.2 mg/l.
6. The Total hardness ranges between 297.0 mg/l – 4813.0 mg/l and for sea water sample was 5503.8 mg/l.
7. BOD value of the collected surface water sample ranges from 9.9 mg/l to 20.6 mg/l and for sea water sample was obtained 6.0 mg/l.
8. COD value of collected surface water varies from 50.2 to 111.7 mg/l and for sea water sample was 28.7 mg/l.
9. The concentration of heavy metals like As, Cd, Cr, Pb, Mn, Hg, Ni and Se were within the limits of IS 2296:1992.

3.8.4 Marine Water Quality Assessment

There are total 10 sampling locations and from each location total 3 samples were taken surface, mid and bottom region. The water sampling is done by equipping Niskin water sampler.

3.8.4.1 Marine Monitoring Survey Photographs at the Project Location (08.10.2022)



Collection of water sample by Niskin Sampler



Water sample Collection

Table 3-15 Physicochemical Parameters of marine water samples from study area (October 2022)

S.No.	Parameters	Units	Sea Water - ST1			Sea Water - ST2		
			Surface (Depth - 0 Meter)	Mid (Depth - 1.5 Meter)	Bottom (Depth - 3 Meter)	Surface (Depth - 0 Meter)	Mid (Depth - 1.5 Meter)	Bottom (Depth - 3 Meter)
1	pH (at 25 °C)	-	7.95	7.8	7.95	7.98	8.12	7.96
2	Total dissolved salts	mg/l	30752	26050	29040	29345	30085	30298
3	Alkalinity	mg/l	110	120	110	120	120	110
4	Electrical conductivity	µS/cm	44800	42800	41800	42700	43100	43300
5	Colour	Hazen Unit	BLQ(LOQ; 1.0)	BLQ(LOQ; 1)	BLQ(LOQ; 1.0)	BLQ(LOQ; 1.0)	BLQ(LOQ; 1.0)	BLQ(LOQ; 1.0)
6	Turbidity	NTU	BLQ(LOQ; 0.1)	BLQ(LOQ; 0.1)	BLQ(LOQ; 0.1)	BLQ(LOQ; 0.1)	BLQ(LOQ; 0.1)	BLQ(LOQ; 0.1)
7	Odour	-	Agreeable	Agreeable	Agreeable	Agreeable	Agreeable	Agreeable
8	Sodium as Na	mg/l	8602	7225	8127	8270	8505	8508
9	Total Hardness as CaCO ₃	mg/l	5178	5064	5134	5091	5392	5565
10	Calcium as Ca	mg/l	480	408.4	427	436	480.96	465.3
11	Chloride as Cl	mg/l	17914.72	15044.41	16924.96	17221.89	17716.78	17716.77
12	Magnesium as Mg	mg/l	966.4	982	987.8	972	1017.8	1069.2
13	Sulphate as SO ₄	mg/l	1699.34	1610.06	1649.81	1670.12	1576.4	1644.41
14	Nitrate as NO ₃	mg/l	2.67	2.41	1.24	2.59	2.54	1.42
15	Iron as Fe	mg/l	BLQ(LOQ; 0.01)	BLQ(LOQ; 0.02)	BLQ(LOQ; 0.01)	BLQ(LOQ; 0.01)	BLQ(LOQ; 0.01)	BLQ(LOQ; 0.01)
16	Copper as Cu	mg/l	BLQ(LOQ; 0.05)	BLQ(LOQ; 0.05)	BLQ(LOQ; 0.05)	BLQ(LOQ; 0.05)	BLQ(LOQ; 0.05)	BLQ(LOQ; 0.05)
17	Lead as Pb	mg/l	0.7256	0.4003	0.2943	0.4652	0.4060	0.2777
18	Potassium as K	mg/l	604	507	571	580	597	597
19	Phosphate as PO ₄	mg/l	0.07	BLQ(LOQ; 0.02)	0.11	0.06	0.1	BLQ(LOQ; 0.02)
20	Total suspended solid	mg/l	BLQ(LOQ; 1.0)	BLQ(LOQ; 1)	BLQ(LOQ; 1.0)	BLQ(LOQ; 1.0)	BLQ(LOQ; 1.0)	BLQ(LOQ; 1.0)
21	Carbonate	mg/l	BLQ(LOQ; 1.0)	BLQ(LOQ; 1)	BLQ(LOQ; 1.0)	BLQ(LOQ; 1.0)	BLQ(LOQ; 1.0)	BLQ(LOQ; 1.0)
22	Bi Carbonate	mg/l	110	120	110	120	120	110

23	BOD,5 days @27°C as O2	mg/l	2	4	5	3	4	6
24	COD as O2	mg/l	36	48	66	44	52	72
25	Total Chromium	mg/l	BLQ(LOQ; 0.01)	BLQ(LOQ; 0.01)	BLQ(LOQ; 0.01)	BLQ(LOQ; 0.01)	BLQ(LOQ; 0.01)	BLQ(LOQ; 0.01)

S.No.	Parameters	Units	Sea Water - ST3			Sea Water - ST4		
			Surface (Depth - 0 Meter)	Mid (Depth - 1.5 Meter)	Bottom (Depth - 3 Meter)	Surface (Depth - 0 Meter)	Mid (Depth - 3 Meter)	Bottom (Depth - 6 Meter)
1	pH (at 25 °C)	-	7.25	7.1	7.19	7.05	7.08	7.15
2	Total dissolved salts	mg/l	26470	24688	25300	24202	23015	22395
3	Alkalinity	mg/l	140	190	160	170	170	150
4	Electrical conductivity	µS/cm	38800	35300	36200	35300	35000	38000
5	Colour	Hazen Unit	BLQ(LOQ; 1.0)	BLQ(LOQ; 1.0)	BLQ(LOQ; 1.0)	BLQ(LOQ; 1.0)	BLQ(LOQ; 1.0)	BLQ(LOQ; 1.0)
6	Turbidity	NTU	3.2	BLQ(LOQ; 0.1)	BLQ(LOQ; 0.1)	3	BLQ(LOQ; 0.1)	BLQ(LOQ; 0.1)
7	Odour	-	Agreeable	Agreeable	Agreeable	Agreeable	Agreeable	Agreeable
8	Sodium as Na	mg/l	7412	6890	7082	6748	6415	6083
9	Total Hardness as CaCO3	mg/l	4840	4689	4827	4671	4814	4856
10	Calcium as Ca	mg/l	400.8	397.4	410.36	380.64	403.9	410.2
11	Chloride as Cl	mg/l	15440.3	14351.58	14747.48	14054.65	13361.81	12668.9
12	Magnesium as Mg	mg/l	932.4	897.6	923.4	903.6	924	930.6
13	Sulphate as SO4	mg/l	1662.4	1650.72	1615.78	1540.2	1533	1683
14	Nitrate as NO3	mg/l	4.84	3.98	1.42	3.94	4.37	3.07
15	Iron as Fe	mg/l	0.08	BLQ(LOQ; 0.01)	BLQ(LOQ; 0.01)	0.07	BLQ(LOQ; 0.01)	BLQ(LOQ; 0.01)
16	Copper as Cu	mg/l	BLQ(LOQ; 0.05)	BLQ(LOQ; 0.05)	BLQ(LOQ; 0.05)	BLQ(LOQ; 0.05)	BLQ(LOQ; 0.05)	BLQ(LOQ; 0.05)
17	Lead as Pb	mg/l	0.5986	0.3584	0.4715	1.0911	0.4926	0.4081
18	Potassium as K	mg/l	520	483	498	475	451	428
19	Phosphate as PO4	mg/l	0.25	0.31	0.94	1.81	0.06	0.07
20	Total suspended solid	mg/l	7	BLQ(LOQ; 1.0)	BLQ(LOQ; 1.0)	6	BLQ(LOQ; 1.0)	BLQ(LOQ; 1.0)
21	Carbonate	mg/l	BLQ(LOQ; 1.0)	BLQ(LOQ; 1.0)	BLQ(LOQ; 1.0)	BLQ(LOQ; 1.0)	BLQ(LOQ; 1.0)	BLQ(LOQ; 1.0)
22	Bi Carbonate	mg/l	140	190	160	170	170	150
23	BOD,5 days @27°C as O2	mg/l	2	5	6	3	4	5
24	COD as O2	mg/l	44	56	64	48	56	68
25	Total Chromium	mg/l	BLQ(LOQ; 0.01)	BLQ(LOQ; 0.01)	BLQ(LOQ; 0.01)	BLQ(LOQ; 0.01)	BLQ(LOQ; 0.01)	BLQ(LOQ; 0.01)

S.No.	Parameters	Units	Sea Water - ST5			Sea Water - ST6		
			Surface (Depth - 0 Meter)	Mid (Depth - 3 Meter)	Bottom (Depth - 6 Meter)	Surface (Depth - 0 Meter)	Mid (Depth - 3 Meter)	Bottom (Depth - 6 Meter)
1	pH (at 25 °C)	-	7.15	7.71	7.03	7.07	7.25	7.61
2	Total dissolved salts	mg/l	26012	27370	24610	23898	26690	25840
3	Alkalinity	mg/l	130	140	160	170	140	140
4	Electrical conductivity	µS/cm	37300	40200	36700	36200	38500	38100
5	Colour	Hazen Unit	BLQ(LOQ; 1.0)	BLQ(LOQ; 1.0)	BLQ(LOQ; 1.0)	BLQ(LOQ; 1.0)	BLQ(LOQ; 1.0)	BLQ(LOQ; 1.0)
6	Turbidity	NTU	2.1	BLQ(LOQ; 0.1)	BLQ(LOQ; 0.1)	BLQ(LOQ; 0.1)	2.5	BLQ(LOQ; 0.1)
7	Odour	-	Agreeable	Agreeable	Agreeable	Agreeable	Agreeable	Agreeable
8	Sodium as Na	mg/l	7176	7698	6844	6605	7460	7223
9	Total Hardness as CaCO ₃	mg/l	5155	5120	5168	4865	4748	4916
10	Calcium as Ca	mg/l	430.7	450.16	441	420.9	409.4	415.18
11	Chloride as Cl	mg/l	14954.43	16034.17	14252	13757.19	15539.29	15044.41
12	Magnesium as Mg	mg/l	990.6	970.4	987.6	926.2	904.8	942
13	Sulphate as SO ₄	mg/l	1620.4	1491.8	1558.8	1642.3	1688.8	1590.6
14	Nitrate as NO ₃	mg/l	5.21	4.47	2.71	4.22	5.15	4.04
15	Iron as Fe	mg/l	0.09	BLQ(LOQ; 0.01)	BLQ(LOQ; 0.01)	BLQ(LOQ; 0.01)	0.09	BLQ(LOQ; 0.01)
16	Copper as Cu	mg/l	BLQ(LOQ; 0.05)	BLQ(LOQ; 0.05)	BLQ(LOQ; 0.05)	BLQ(LOQ; 0.05)	BLQ(LOQ; 0.05)	BLQ(LOQ; 0.05)
17	Lead as Pb	mg/l	0.7055	0.4205	0.3248	0.7331	0.3709	0.2938
18	Potassium as K	mg/l	505	540	481	463	523	507
19	Phosphate as PO ₄	mg/l	0.17	BLQ(LOQ; 0.02)	BLQ(LOQ; 0.02)	0.25	0.16	BLQ(LOQ; 0.02)
20	Total suspended solid	mg/l	4	BLQ(LOQ; 1.0)	BLQ(LOQ; 1.0)	BLQ(LOQ; 1.0)	6	BLQ(LOQ; 1.0)
21	Carbonate	mg/l	BLQ(LOQ; 1.0)	BLQ(LOQ; 1.0)	BLQ(LOQ; 1.0)	BLQ(LOQ; 1.0)	BLQ(LOQ; 1.0)	BLQ(LOQ; 1.0)
22	Bi Carbonate	mg/l	130	140	160	170	140	140
23	BOD,5 days @27°C as O ₂	mg/l	2	3	6	3	4	5
24	COD as O ₂	mg/l	40	52	68	36	48	60
25	Total Chromium	mg/l	BLQ(LOQ; 0.01)	BLQ(LOQ; 0.01)	BLQ(LOQ; 0.01)	BLQ(LOQ; 0.01)	BLQ(LOQ; 0.01)	BLQ(LOQ; 0.01)

S.No.	Parameters	Units	Sea Water - ST7			Sea Water - ST8		
			Surface (Depth - 0 Meter)	Mid (Depth - 4.5 Meter)	Bottom (Depth - 9 Meter)	Surface (Depth - 0 Meter)	Mid (Depth - 4.5 Meter)	Bottom (Depth - 9 Meter)
1	pH (at 25 °C)	-	7.09	7.25	7.07	7.15	7.23	7.09
2	Total dissolved salts	mg/l	27595	26550	22905	26142	23455	22555
3	Alkalinity	mg/l	160	130	160	160	150	160
4	Electrical conductivity	µS/cm	39800	38200	35400	37600	36000	37100
5	Colour	Hazen Unit	BLQ(LOQ; 1.0)	BLQ(LOQ; 1.0)	BLQ(LOQ; 1.0)	BLQ(LOQ; 1.0)	BLQ(LOQ; 1.0)	BLQ(LOQ; 1.0)

6	Turbidity	NTU	BLQ(LOQ; 0.1)	2	BLQ(LOQ; 0.1)	3.1	BLQ(LOQ; 0.1)	BLQ(LOQ; 0.1)
7	Odour	-	Agreeable	Agreeable	Agreeable	Agreeable	Agreeable	Agreeable
8	Sodium as Na	mg/l	7745	7413	6368	7318	6415	6178
9	Total Hardness as CaCO ₃	mg/l	4838	4817	4770	4749	4654	4880
10	Calcium as Ca	mg/l	424.04	406.38	420.78	430.9	421.16	450.42
11	Chloride as Cl	mg/l	16133.15	15440.3	13262.83	15242.36	13361.81	12866.93
12	Magnesium as Mg	mg/l	917.8	923.4	903.1	892	874.8	912
13	Sulphate as SO ₄	mg/l	1619.6	1673.98	1469.4	1581.02	1627.8	1510.2
14	Nitrate as NO ₃	mg/l	4.63	4.08	2.3	4.71	2.83	2.36
15	Iron as Fe	mg/l	BLQ(LOQ; 0.01)	0.06	BLQ(LOQ; 0.01)	0.07	BLQ(LOQ; 0.01)	BLQ(LOQ; 0.01)
16	Copper as Cu	mg/l	BLQ(LOQ; 0.05)	BLQ(LOQ; 0.05)	BLQ(LOQ; 0.05)	BLQ(LOQ; 0.05)	BLQ(LOQ; 0.05)	BLQ(LOQ; 0.05)
17	Lead as Pb	mg/l	0.4996	0.4564	0.3942	0.3048	0.3808	0.3287
18	Potassium as K	mg/l	543	520	447	513	450	434
19	Phosphate as PO ₄	mg/l	0.2	0.3	0.1	4.7	0.37	0.34
20	Total suspended solid	mg/l	BLQ(LOQ; 1.0)	5	BLQ(LOQ; 1.0)	7	BLQ(LOQ; 1.0)	BLQ(LOQ; 1.0)
21	Carbonate	mg/l	BLQ(LOQ; 1.0)	BLQ(LOQ; 1.0)	BLQ(LOQ; 1.0)	BLQ(LOQ; 1.0)	BLQ(LOQ; 1.0)	BLQ(LOQ; 1.0)
22	Bi Carbonate	mg/l	160	130	160	160	150	160
23	BOD,5 days @27°C as O ₂	mg/l	2	5	5	4	5	6
24	COD as O ₂	mg/l	40	60	60	48	52	68
25	Total Chromium	mg/l	BLQ(LOQ; 0.01)	BLQ(LOQ; 0.01)	BLQ(LOQ; 0.01)	BLQ(LOQ; 0.01)	BLQ(LOQ; 0.01)	BLQ(LOQ; 0.01)

S.No.	Parameters	Units	Sea Water - ST9			Sea Water - ST10		
			Surface (Depth - 0 Meter)	Mid (Depth - 4.5 Meter)	Bottom (Depth - 9 Meter)	Surface (Depth - 0 Meter)	Mid (Depth - 6 Meter)	Bottom (Depth - 12 Meter)
1	pH (at 25 °C)	-	7.31	7.09	7.13	7.05	7.25	7.09
2	Total dissolved salts	mg/l	23695	25630	25460	24995	24570	25240
3	Alkalinity	mg/l	150	140	150	150	130	170
4	Electrical conductivity	µS/cm	36400	36800	37900	35800	37400	36500
5	Colour	Hazen Unit	BLQ(LOQ; 1.0)	BLQ(LOQ; 1.0)	BLQ(LOQ; 1.0)	BLQ(LOQ; 1.0)	BLQ(LOQ; 1.0)	BLQ(LOQ; 1.0)
6	Turbidity	NTU	BLQ(LOQ; 0.1)	BLQ(LOQ; 0.1)	BLQ(LOQ; 0.1)	BLQ(LOQ; 0.1)	BLQ(LOQ; 0.1)	BLQ(LOQ; 0.1)
7	Odour	-	Agreeable	Agreeable	Agreeable	Agreeable	Agreeable	Agreeable
8	Sodium as Na	mg/l	6557	7175	7130	6985	6748	7082
9	Total Hardness as CaCO ₃	mg/l	4716	4634	4746	4771	4794	4857
10	Calcium as Ca	mg/l	405.62	413.2	410.9	440.74	420.49	436.18
11	Chloride as Cl	mg/l	13658.74	14945.43	14846.46	14549.53	14054.6	14747.48
12	Magnesium as Mg	mg/l	899.2	874.8	903.4	891.3	909.2	914.9
13	Sulphate as SO ₄	mg/l	1518	1625.8	1549.8	1506.32	1690.4	1405
14	Nitrate as NO ₃	mg/l	4.29	3.44	3.3	4.05	3.67	2.15

15	Iron as Fe	mg/l	BLQ(LOQ; 0.01)	BLQ(LOQ; 0.01)	BLQ(LOQ; 0.01)	BLQ(LOQ; 0.01)	BLQ(LOQ; 0.01)	BLQ(LOQ; 0.01)
16	Copper as Cu	mg/l	BLQ(LOQ; 0.05)	BLQ(LOQ; 0.05)	BLQ(LOQ; 0.05)	BLQ(LOQ; 0.05)	BLQ(LOQ; 0.05)	BLQ(LOQ; 0.05)
17	Lead as Pb	mg/l	0.2395	0.2850	0.2482	0.1982	0.3346	0.3094
18	Potassium as K	mg/l	459	505	502	489	474	497
19	Phosphate as PO ₄	mg/l	0.25	0.17	BLQ(LOQ; 0.02)	0.42	0.27	BLQ(LOQ; 0.02)
20	Total suspended solid	mg/l	BLQ(LOQ; 1.0)	BLQ(LOQ; 1.0)	BLQ(LOQ; 1.0)	BLQ(LOQ; 1.0)	BLQ(LOQ; 1.0)	BLQ(LOQ; 1.0)
21	Carbonate	mg/l	BLQ(LOQ; 1.0)	BLQ(LOQ; 1.0)	BLQ(LOQ; 1.0)	BLQ(LOQ; 1.0)	BLQ(LOQ; 1.0)	BLQ(LOQ; 1.0)
22	Bi Carbonate	mg/l	160	140	150	150	130	170
23	BOD,5 days @27°C as O ₂	mg/l	3	3	6	2	4	4
24	COD as O ₂	mg/l	44	56	72	36	52	64
25	Total Chromium	mg/l	BLQ(LOQ; 0.01)	BLQ(LOQ; 0.01)	BLQ(LOQ; 0.01)	BLQ(LOQ; 0.01)	BLQ(LOQ; 0.01)	BLQ(LOQ; 0.01)

Results and Discussion

Surface water sample results are discussed below:

1. Marine water samples were compared with MoEF Standards 1998.
2. The pH range in the collected surface water samples varies between 7.03 – 8.12
3. The Total Dissolved Solids range from 22395 mg/l to 30752 mg/l.
4. The chloride content in the surface water for study area ranges from 12668.9 mg/l to 17914.7 mg/l.
5. The sulphate content in the surface water of the study area varies between 1469.4 mg/l – 1699.34.
6. The Total hardness ranges between 4634 mg/l – 5565 mg/.
7. BOD value of the collected surface water sample ranges from 2 mg/l to 6 mg/l .
8. COD value of collected surface water varies from 36 to 72 mg/l.

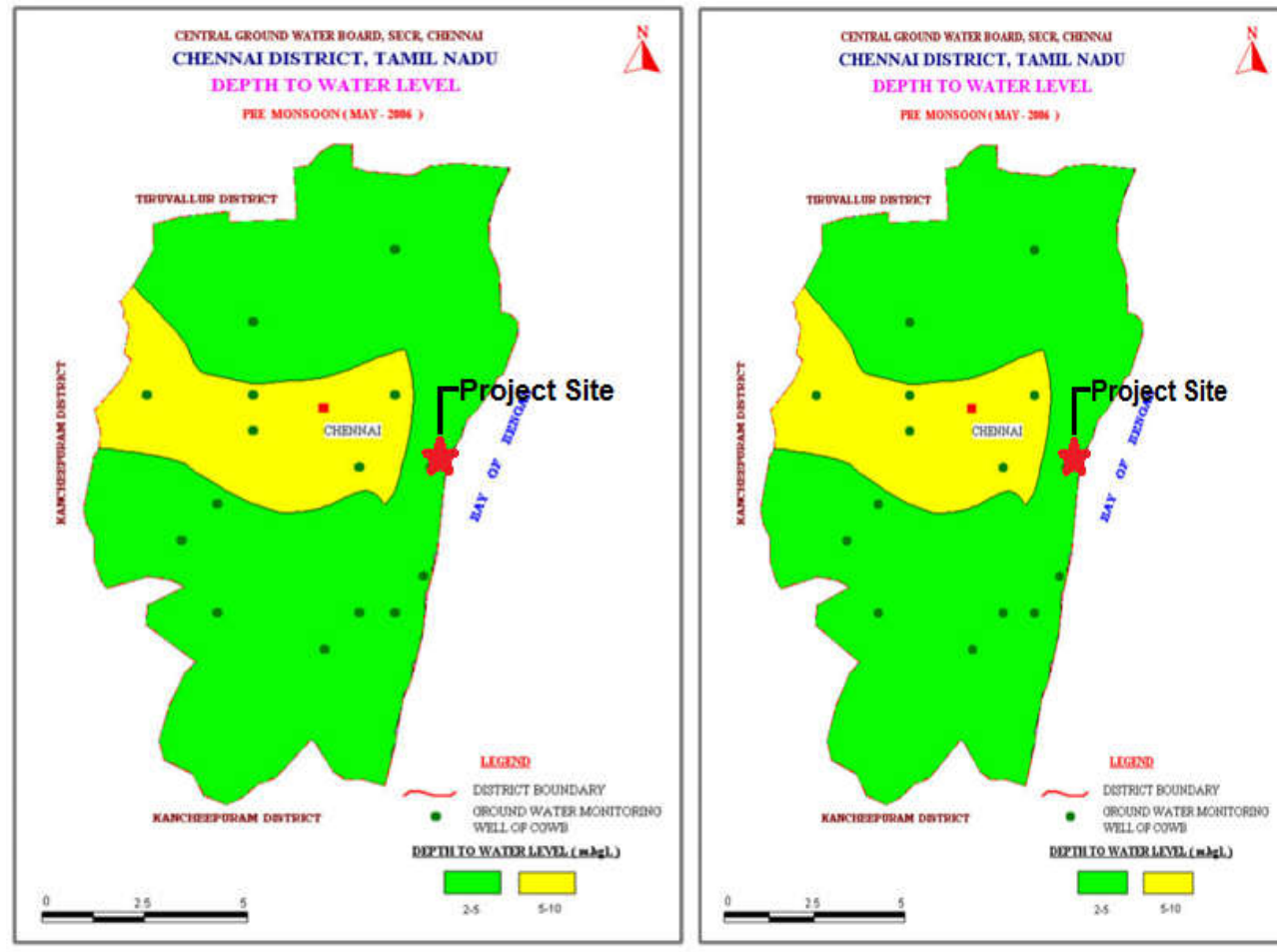
3.9 Ground water resources

The groundwater potential of the gross geographical area of the basin is estimated on pro-rata basis from the district-wise groundwater resources-2009 published by the Central Groundwater Board (CGWB) as given in **Table 3-16**. Depth to water level during Pre Monsoon & Post Monsoon for Chennai District, Tamil Nadu, is given in **Figure 3-26**.

Table 3-16 The yield and depth of aquifers

Formation	Type of well	Depth range (m BGL)	Yield (lps)
Alluvium	Tube well	10 - 30	1 - 12
	Dug well	6 - 11	0.058 - 1.16
Sand stone	Tube well	20 - 28	2 - 3
Gondwana	Tube well	20 - 60	1 - 3
Crystalline	Bore well	10 - 15	Up to 4

Source: http://cgwb.gov.in/District_Profile/TamilNadu/chennai.pdf



Source: http://cgwb.gov.in/District_Profile/TamilNadu/chennai.pdf

Figure 3-26 Depth to water level during Pre-Monsoon & Post Monsoon of Chennai District

3.9.1 Ground water Quality

Groundwater is the principal source for domestic and drinking purposes in almost all towns/wards near the study area. The quality of the groundwater received is influenced by pollution of soil and air, industrial and domestic waste disposal, organic components, pathogenic microorganisms, application of fertilizers and pesticides in agriculture, etc. Total Eight (08) ground water monitoring locations were identified for assessment in different locations/villages/towns around the project site based on the usage of sub surface water by the settlements/ villages/towns in the study area. The groundwater results are compared with the desirable and permissible water quality standards as per IS: 10500 (2012) for drinking water. Groundwater quality monitoring locations and results are given in **Table 3-17** and **Table 3-18**. Map showing the groundwater monitoring locations are given in **Figure 3-27**.

Table 3-17 Details of Groundwater Quality Monitoring Locations

Station Code	Location	Distance (~km) from Project boundary	Directions
GW1	Near Project Site	0.05	W
GW2	Mylapore	3.36	SSW
GW3	Teynampet	4.12	SW
GW4	Thousand Lights	3.31	W
GW5	Pudupakam	1.85	W
GW6	Chetpet	4.67	W
GW7	Purasavakam	4.25	NW
GW8	George Town	2.67	N

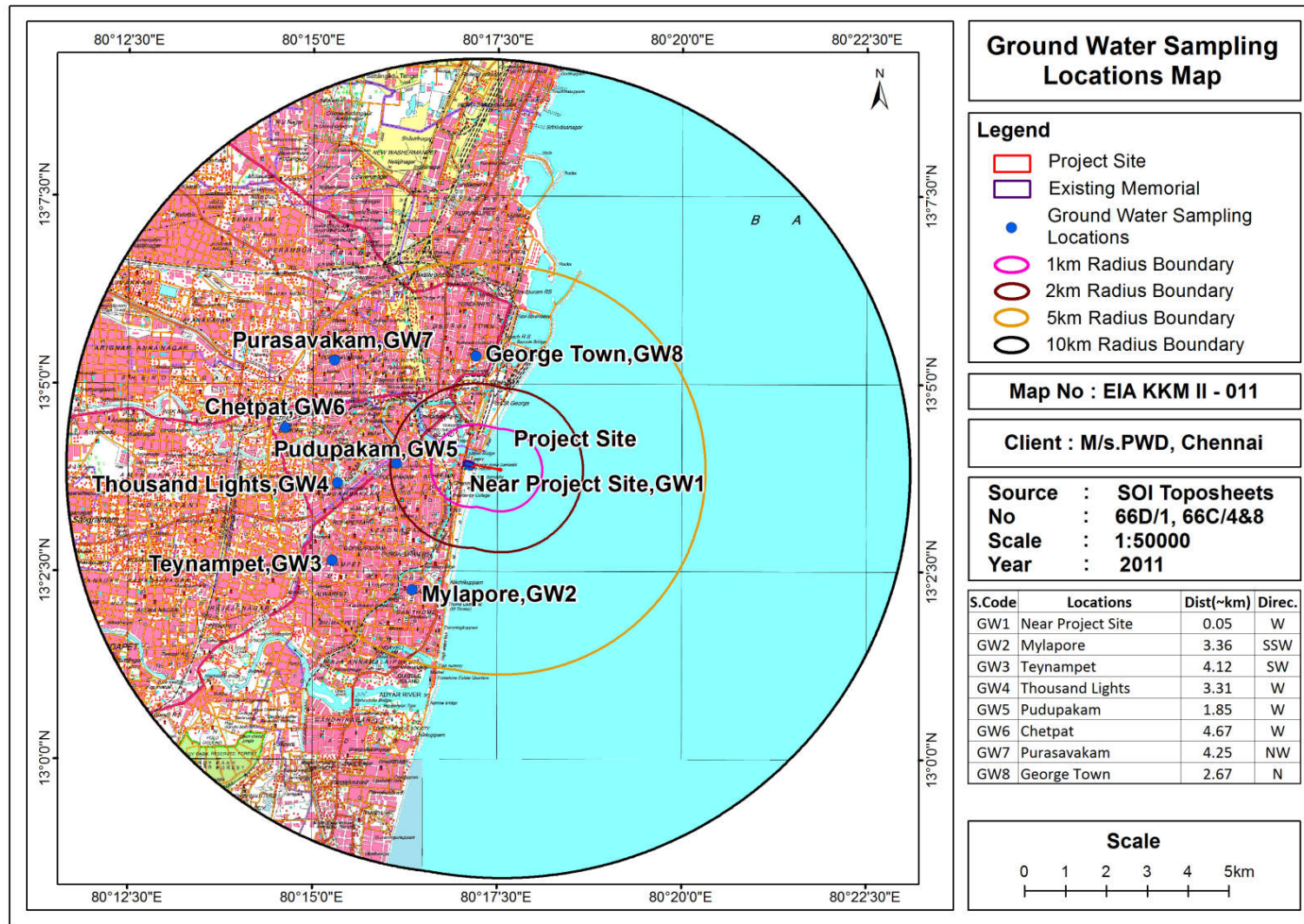


Figure 3-27 Map showing the groundwater monitoring locations

Table 3-18 Physico-chemical analysis of Ground water samples from study area (27th May-28th July 2021-July 2021)

Sl. No	Parameters	Unit	Drinking water Standard (IS 10500: 2012) Permissible Limit	Drinking water Standard (IS 10500: 2012) Acceptable Limit	Project Site	Mylapore	Teynampet	Thousand Lights	Pudupakam	Chetpet	Purasavakam	George Town
					GW1	GW2	GW3	GW4	GW5	GW6	GW7	GW8
1.	Colour	Hazen	15	5	BLQ(LO Q 1)	BLQ(LO Q 1)	BLQ(LO Q 1)	BLQ(LOQ 1)	BLQ(LO Q 1)	BLQ(LO Q 1)	BLQ(LO Q 1)	BLQ(LOQ 1)
2.	Turbidity	NTU	5	1	BLQ(LO Q 0.1)	BLQ(LO Q 0.1)	BLQ(LO Q 0.1)	BLQ(LOQ 0.1)	BLQ(LO Q 0.1)	BLQ(LO Q 0.1)	BLQ(LO Q 0.1)	BLQ(LOQ 0.1)
3.	pH	--	NR	6.5-8.5	7.98	7.6	7.37	7.96	7.8	7.75	7.41	7.83
4.	Conductivity	µS/cm	-	-	2098	1887	1675	1732	1427	1526	1843	1478
5.	Total Dissolve Solids	mg/l	2000	500	1450	1298	1136	1164	993	1041	1263	1010
6.	Total Suspended Solids		-	-	BLQ(LO Q 1)	BLQ(LO Q 1)	BLQ(LO Q 1)	BLQ(LOQ 1)	BLQ(LO Q 1)	BLQ(LO Q 1)	BLQ(LO Q 1)	BLQ(LOQ 1)
7.	Alkalinity as CaCO ₃	mg/l	600	200	301	269	234	241	198	215	261	209
8.	Total Hardness as CaCO ₃	mg/l	600	200	478	427	372	390	315	348	415	338
9.	Sodium as Na	mg/l	-	-	221.2	197.4	172.2	177.0	178.7	157.9	191.8	153.4
10.	Potassium as K	mg/l	-	-	15.8	14.1	12.3	10.4	7.1	8.5	13.7	7.6
11.	Calcium as Ca	mg/l	200	75	108.6	96.9	84.5	88.5	71.5	79.0	94.1	76.7
12.	Magnesium as Mg	mg/l	100	30	50.3	44.9	39.1	41.0	33.1	36.6	43.6	35.5
13.	Chloride as Cl	mg/l	1000	250	395.0	352.5	307.5	316.0	260.0	282.0	342.5	274.0
14.	Sulphate SO ₄	mg/l	400	200	163.9	146.3	127.6	131.1	107.9	117.0	142.1	113.7
15.	Nitrate as NO ₃	mg/l	NR	45	4.3	6.5	7.8	4.8	5.5	6.2	7.1	5.4

Sl. No	Parameters	Unit	Drinking water Standard (IS 10500: 2012) Permissible Limit	Drinking water Standard (IS 10500: 2012) Acceptable Limit	Project Site	Mylapore	Teynampet	Thousand Lights	Pudupakam	Chetpet	Purasavakam	George Town
					GW1	GW2	GW3	GW4	GW5	GW6	GW7	GW8
16.	Fluorides as F		1.5	1	0.67	0.26	0.44	0.79	0.59	0.48	0.62	0.52
17.	Cyanide	mg/l	NR	0.05	BLQ(LO Q 0.01)	BLQ(LO Q 0.01)	BLQ(LO Q 0.01)	BLQ(LOQ 0.01)	BLQ(LO Q 0.01)	BLQ(LO Q 0.01)	BLQ(LO Q 0.01)	BLQ(LOQ 0.01)
18.	Arsenic as As	mg/l	0.05	0.01	BLQ(LO Q 0.005)	BLQ(LO Q 0.005)	BLQ(LO Q 0.005)	BLQ(LOQ 0.005)	BLQ(LO Q 0.005)	BLQ(LO Q 0.005)	BLQ(LO Q 0.005)	BLQ(LOQ 0.005)
19.	Boron as B	mg/l	1.0	0.5	BQL(LO Q 0.1)	BQL(LO Q 0.1)	BQL(LO Q 0.1)	BQL(LOQ 0.1)	BQL(LO Q 0.1)	BQL(LO Q 0.1)	BQL(LO Q 0.1)	BQL(LOQ 0.1)
20.	Cadmium as Cd	mg/l	NR	0.003	BQL(LO Q 0.001)	BQL(LO Q 0.001)	BQL(LO Q 0.001)	BQL(LOQ 0.001)	BQL(LO Q 0.001)	BQL(LO Q 0.001)	BQL(LO Q 0.001)	BQL(LOQ 0.001)
21.	Chromium as Cr	mg/l	NR	0.05	BQL(LO Q 0.01)	BQL(LO Q 0.01)	BQL(LO Q 0.01)	BQL(LOQ 0.01)	BQL(LO Q 0.01)	BQL(LO Q 0.01)	BQL(LO Q 0.01)	BQL(LOQ 0.01)
22.	Copper as Cu	mg/l	1.5	0.05	BLQ(LO Q 0.01)	BLQ(LO Q 0.01)	BLQ(LO Q 0.01)	BLQ(LOQ 0.01)	BLQ(LO Q 0.01)	BLQ(LO Q 0.01)	BLQ(LO Q 0.01)	BLQ(LOQ 0.01)
23.	Lead as Pb	mg/l	NR	0.01	BLQ(LO Q 0.005)	BLQ(LO Q 0.005)	BLQ(LO Q 0.005)	BLQ(LOQ 0.005)	BLQ(LO Q 0.005)	BLQ(LO Q 0.005)	BLQ(LO Q 0.005)	BLQ(LOQ 0.005)
24.	Manganese as Mn	mg/l	0.3	0.1	BLQ(LO Q 0.05)	BLQ(LO Q 0.05)	BLQ(LO Q 0.05)	BLQ(LOQ 0.05)	BLQ(LO Q 0.05)	BLQ(LO Q 0.05)	BLQ(LO Q 0.05)	BLQ(LOQ 0.05)
25.	Mercury	mg/l	NR	0.001	BLQ(LO Q 0.0005)	BLQ(LO Q 0.0005)	BLQ(LO Q 0.0005)	BLQ(LOQ 0.0005)	BLQ(LO Q 0.0005)	BLQ(LO Q 0.0005)	BLQ(LO Q 0.0005)	BLQ(LOQ 0.0005)
26.	Nickel as Ni	mg/l	NR	0.02	BLQ(LO Q 0.01)	BLQ(LO Q 0.01)	BLQ(LO Q 0.01)	BLQ(LOQ 0.01)	BLQ(LO Q 0.01)	BLQ(LO Q 0.01)	BLQ(LO Q 0.01)	BLQ(LOQ 0.01)
27.	Selenium as Se	mg/l	NR	0.01	BLQ(LO Q 0.005)	BLQ(LO Q 0.005)	BLQ(LO Q 0.005)	BLQ(LOQ 0.005)	BLQ(LO Q 0.005)	BLQ(LO Q 0.005)	BLQ(LO Q 0.005)	BLQ(LOQ 0.005)

Sl. No	Parameters	Unit	Drinking water Standard (IS 10500: 2012) Permissible Limit	Drinking water Standard (IS 10500: 2012) Acceptable Limit	Project Site	Mylapore	Teynampet	Thousand Lights	Pudupakam	Chetpet	Purasavakam	George Town
					GW1	GW2	GW3	GW4	GW5	GW6	GW7	GW8
28.	Zinc as Zn	mg/l	15	5	BLQ(LOQ 0.1)	BLQ(LOQ 0.1)	BLQ(LOQ 0.1)	BLQ(LOQ 0.1)	BLQ(LOQ 0.1)	BLQ(LOQ 0.1)	BLQ(LOQ 0.1)	BLQ(LOQ 0.1)

(Note: BLQ – Below Limit of Quantification; LOQ – Limit of Quantification; NR – No Relaxation)

3.9.2 Results and Discussion

A summary of analytical results of the major parameters are presented below:

1. The ground water results of the study area indicate that the pH range varies between 7.37 and 7.98. It is observed that the pH range is within the permissible limit of IS 10500:2012.
2. The Total Dissolved Solids range of the collected ground water sample is varied between 993 mg/l – 1450 mg/l. All the samples are within the permissible limit of IS 10500: 2012.
3. The acceptable limit of the chloride content is 250mg/l and permissible limit is 1000 mg/l. The chloride content in the collected ground water samples in the study area ranges between 260 mg/l – 395 mg/l. It is observed that all the samples are within the permissible limit of IS 10500:2012.
4. The acceptable limit of the sulphate content is 200mg/l and permissible limit is 400mg/l. The sulphate content in the collected ground water samples in the study area is varied between 107.9 mg/l – 163.9 mg/l. It is observed that all the samples are meeting the acceptable limit of the IS 10500: 2012.
5. The Total hardness ranges is between 315 mg/l – 478 mg/l for ground water samples. It is observed that all the samples are within the permissible limit of the IS 10500: 2012.

3.10 Soil as a resource and its Quality

Chennai's major soil types are beach sands, clay and alluvial soils. In order to assess the quality of soil at different locations in the study area; various land use categories were taken into the account. Soil samples were carried out at Eight (08) locations in the study area. Soil analysis was carried as per IS: 2720 methods. Soil quality monitoring locations, results and Soil ICAR classification are given in **Table 3-19**. Physico-Chemical parameter of the soil sample from the study area are tabulated in **Table 3-20**. Map showing the soil monitoring locations and soil texture classification are given in **Figure 3-28** and **Table 3-21** respectively.

Table 3-19 Soil Quality Monitoring Locations

Location Code	Location	Distance (~km) from Project boundary	Directions
S1	Project Site	Within the Site	
S2	Mylapore	3.36	SSW
S3	Teynampet	4.12	SW
S4	Thousand Lights	3.31	W
S5	Pudupakam	1.85	W
S6	Chetpet	4.67	W
S7	Purasavakam	4.25	NW
S8	George Town	2.67	N

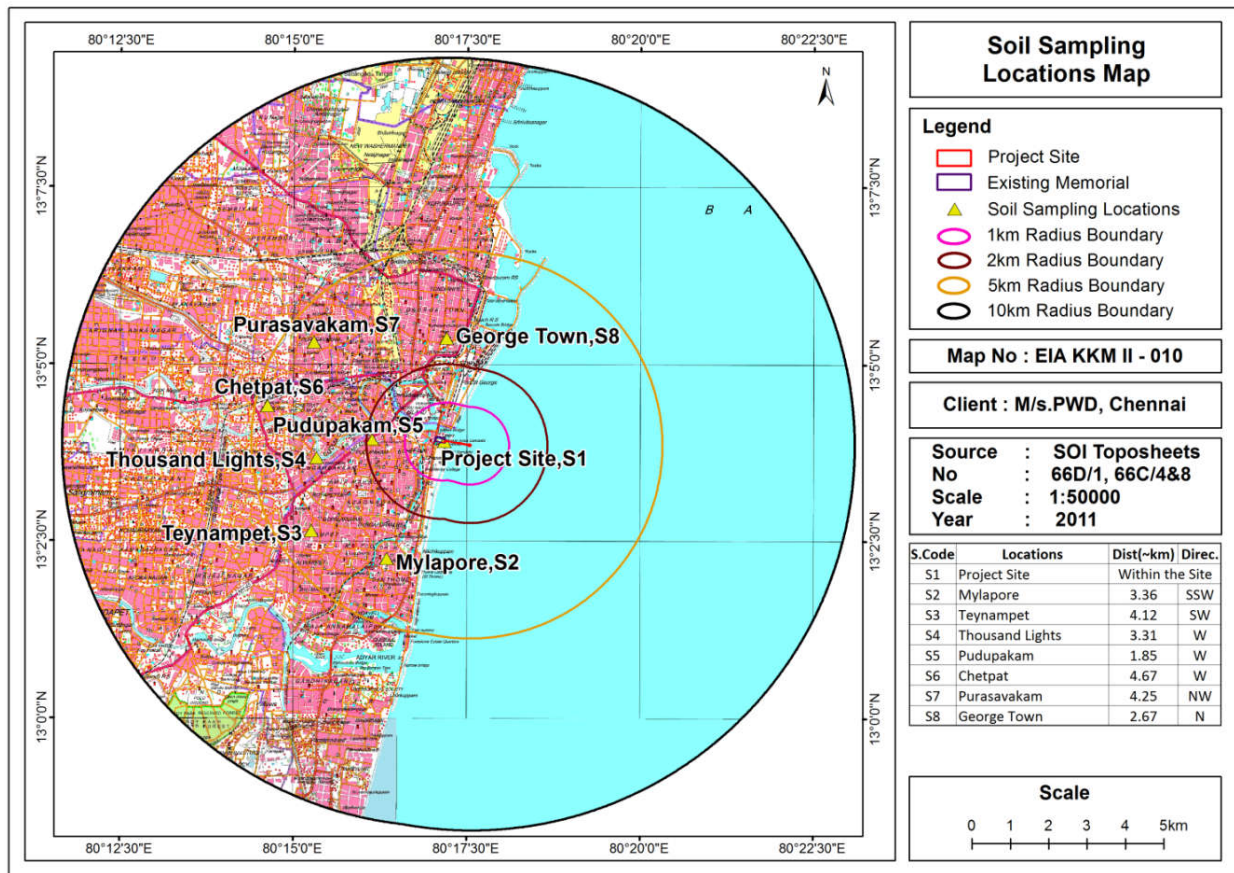


Figure 3-28 Map showing the soil monitoring locations

Table 3-20 Physico-Chemical parameters of soil samples from the study area (27th May-28th July 2021-July 2021)

S. No	Parameters	Units	Project Site	Mylapore	Teynampet	Thousand Lights	Pudupakam	Chetpat	Purasavakam	George Town
			S1	S2	S3	S4	S5	S6	S7	S8
1.	Soil Texture	-	Sand	Loamy Sand	Loamy Sand	Loamy Sand	Loamy Sand	Loamy Sand	Loamy Sand	Loamy Sand
2.	Sand	%	93.20	86.2	85.3	79.12	84.3	83.12	79.8	87
3.	Silt	%	3	10.5	11.7	11.8	10.7	11.88	16.2	3
4.	Clay	%	3	3.3	3.0	9.0	5.0	5.0	4.0	10
5.	pH	-	8.1	7.3	7.54	7.10	7.1	7.12	7.43	6.06
6.	Electrical conductivity	$\mu\text{S/cm}$	175	157	143	168	136	129	186	182
7.	Nitrogen as N	mg/kg	278	208	235	297	230	241	247	267
8.	Phosphorus	mg/kg	79.3	44.8	39.8	70.4	69.1	55.7	60.3	83
9.	Potassium	mg/kg	108	89	96	78	113	103	120	97

		g								
10.	Boron	mg/kg	BLQ(L OQ 1)	BLQ(L OQ 1)	BLQ(L OQ 1)	BLQ(L OQ 1)	BLQ(L OQ 1)	BLQ(L OQ 1)	BLQ(L OQ 1)	BLQ(L OQ 1)
11.	Cadmium	mg/kg	BLQ(L OQ 0.1)	BLQ(L OQ 0.1)	BLQ(L OQ 0.1)	BLQ(L OQ 0.1)	BLQ(L OQ 0.1)	BLQ(L OQ 0.1)	BLQ(L OQ 0.1)	BLQ(L OQ 0.1)
12.	Chromium	mg/kg	BLQ(L OQ 0.1)	BLQ(L OQ 0.1)	BLQ(L OQ 0.1)	BLQ(L OQ 0.1)	BLQ(L OQ 0.1)	BLQ(L OQ 0.1)	BLQ(L OQ 0.1)	BLQ(L OQ 0.1)

Note: BLQ – Below Limit of Quantification; LOQ – Limit Of Quantification

Table 3-21 Soil Classification as per ICAR

S.No	Project Site	Mylapore	Teynampet	Thousand Lights	Pudupakam	Chetpet	Purasavakam	George Town
	S1	S2	S3	S4	S5	S6	S7	S8
pH	Moderately Alkaline	Neutral	Slightly Alkaline	Slightly Alkaline	Neutral	Slightly Alkaline	Slightly Alkaline	Neutral
Salinity Electrical Conductivity	Average	Average	Average	Average	Average	Average	Average	Average
Nitrogen (Kg/ha)	Good	Good	Good	Better More	Good	Good	Good	Good
Phosphorous (Kg/ha)	Medium	Less	Less	Medium	Medium	Medium	Medium	Medium
Potassium (Kg/ha)	Very Less	Very Less	Very Less	Very Less	Very Less	Very Less	Very Less	Very Less

3.10.1 Results and Discussions

Summary of analytical results for major parameters are given below:

- The pH of the soil samples ranged from 6.06 to 8.1
- Conductivity of the soil samples ranged from 129 to 186 μ mhos/cm.
- Nitrogen content in the collected soil samples ranged from 208 mg/kg to 297 mg/kg.
- Phosphorous content ranged from 39.8 mg/kg to 83 mg/kg.
- Potassium content ranges from 78 mg/kg to 120 mg/kg.

3.10.2 Analysis of Physico-Chemical parameters of Sediment samples from the study area

The samples were collected in and around the project location within 1 km radius. Soil samples were carried out at Eight (08) locations in the study area. Soil analysis was carried as per IS: 2720 methods. Soil quality monitoring locations, results and Soil ICAR classification are given in **Table 3-22**.



Table 3-22 Physico-Chemical parameters of Sediment samples from the study area (October 2022)

Sr.No.	Parameters	Units	Sediment		
			S1	S2	S3
1	pH	-	7.19	7.22	7.59
2	Magnesium	mg/kg	363.2	599.4	445.84
3	Electrical Conductivity	μS/cm	1019	1080	1014
4	Potassium(Available)	mg/kg	127	179	166
5	Phosphorus(Available)	mg/kg	16.49	32.93	29.85
6	Arsenic	mg/kg	6.80	6.84	6.55
7	Iron	mg/kg	13.24	5.64	6.58
8	Lead	mg/kg	9.74	8.31	8.01
9	Zinc	mg/kg	38.25	36.07	36.36
10	Copper	mg/kg	12.98	12.65	13.36
11	Cadmium	mg/kg	0.54	0.62	0.49
12	Chromium	mg/kg	29.53	28.30	28.23
13	Manganese	mg/kg	206.22	197.24	194.93
14	Mercury	mg/kg	0.63	1.57	0.16
15	Calcium	mg/kg	757	1243	743
16	Bulk Density	gm/cc	1.23	1.28	1.22
17	Total Polycyclic Aromatic Hydrocarbons	mg/kg	BLQ(LOQ: 0.1)	BLQ(LOQ: 0.1)	BLQ(LOQ: 0.1)
18	Total Petroleum Hydrocarbons	mg/kg	BLQ(LOQ: 0.1)	BLQ(LOQ: 0.1)	BLQ(LOQ: 0.1)
19	NIitrogen N(Available)	mg/kg	1536	1344	1235
20	Sediment Texture	-	Loam	Clay loam	Clay loam

	Soil Texture - i)Sand	%	36.8	35.3	33.3
	Soil Texture ii)Silt	%	38.7	34.3	36.2
	Soil Texture iii)Clay	%	24.5	30.4	30.5
21	Odour	-	Disagreeable	Disagreeable	Disagreeable
22	H ₂ S	mg/kg	BLQ(LOQ0.1)	BLQ(LOQ0.1)	BLQ(LOQ0.1)
23	Boron	mg/kg	BLQ(LOQ0.1)	BLQ(LOQ0.1)	BLQ(LOQ0.1)
24	BTEX	mg/kg	BLQ(LOQ: 0.1)	BLQ(LOQ: 0.1)	BLQ(LOQ: 0.1)
25	Phenols	mg/kg	BLQ(LOQ0.001)	BLQ(LOQ0.001)	BLQ(LOQ0.001)
26	Total Solids	%	97.58	97.44	97.36
27	Particle size distribution				
i	Coarse Sand	%	11.2	11	10.4
ii	Medium Sand	%	12.1	11.6	11.3
iii	Fine Sand	%	13.5	12.7	11.6
iv	Coarse Silt	%	12.4	11.2	11.6
v	Medium Silt	%	13.1	10.6	13.1
vi	Fine Silt	%	13.2	12.5	11.5
vii	Caly	%	24.5	30.4	30.5
28	Poly chlorinated Bi-phenol	mg/kg	BLQ(LOQ: 0.1)	BLQ(LOQ: 0.1)	BLQ(LOQ: 0.1)
29	Loss on Ignition (Water content)	%	23.93	30.42	31.56
30	Organic substances	%	23.93	30.42	31.56
31	Inorganic substances	%	76.07	69.58	68.44
32	Coliform		<2	<2	<2

S.No.	Parameters	Units	Sediment		
			S4	S5	S6
1	pH	-	7.55	7.59	7.35
2	Magnesium	mg/kg	360.61	423.96	357.84
3	Electrical Conductivity	μS/cm	1106	785	937
4	Potassium(Available)	mg/kg	216	153	151
5	Phosphorus(Available)	mg/kg	18.99	18.97	20.12
6	Arsenic	mg/kg	3.01	3.55	3.37
7	Iron	mg/kg	4.25	3.98	5.67
8	Lead	mg/kg	5.08	5.20	5.41
9	Zinc	mg/kg	24.33	25.27	25.28
10	Copper	mg/kg	13.84	13.22	14.77
11	Cadmium	mg/kg	1.60	1.27	1.68
12	Chromium	mg/kg	15.58	14.77	16.63

13	Manganese	mg/kg	102.94	99.85	107.83
14	Mercury	mg/kg	0.31	BLQ(LOQ0.05)	BLQ(LOQ0.05)
15	Calcium	mg/kg	902	848	895
16	Bulk Density	gm/cc	1.26	1.25	1.24
17	Total Polycyclic Aromatic Hydrocarbons	mg/kg	BLQ(LOQ: 0.1)	BLQ(LOQ: 0.1)	BLQ(LOQ: 0.1)
18	Total Petroleum Hydrocarbons	mg/kg	BLQ(LOQ: 0.1)	BLQ(LOQ: 0.1)	BLQ(LOQ: 0.1)
19	NIitrogen N(Available)	mg/kg	1056	1456	1213
20	Sediment Texture	-	Clay loam	Loam	Loam
	Soil Texture i)Sand	%	34.3	38.7	40.4
	Soil Texture ii)Silt	%	35.3	35.8	38.5
	Soil Texture iii)Clay	%	30.4	25.5	21.1
21	Odour	-	Disagreeable	Disagreeable	Disagreeable
22	H2S	mg/kg	BLQ(LOQ0.1)	BLQ(LOQ0.1)	BLQ(LOQ0.1)
23	Boron	mg/kg	BLQ(LOQ0.1)	BLQ(LOQ0.1)	BLQ(LOQ0.1)
24	BTEX	mg/kg	BLQ(LOQ: 0.1)	BLQ(LOQ: 0.1)	BLQ(LOQ: 0.1)
25	Phenols	mg/kg	BLQ(LOQ0.001)	BLQ(LOQ0.001)	BLQ(LOQ0.001)
26	Total Solids	%	97.38	97.66	97.84
27	Particle size distribution				
i	Coarse Sand	%	11.2	12.3	13.5
ii	Medium Sand	%	12.2	13.6	12.8
iii	Fine Sand	%	10.9	12.8	14.1
iv	Coarse Silt	%	11.6	10.5	11.8
v	Medium Silt	%	13.1	13.1	12.8
vi	Fine Silt	%	10.6	12.2	13.9
vii	Caly	%	30.4	25.5	21.1
28	Poly chlorinated Bi-phenol	mg/kg	BLQ(LOQ: 0.1)	BLQ(LOQ: 0.1)	BLQ(LOQ: 0.1)
29	Loss on Ignition (Water content)	%	26.14	24.57	24.84
30	Organic substances	%	26.14	24.57	24.84
31	Inorganic substances	%	73.86	75.43	75.16
32	Coliform		<2	<2	<2

S.No.	Parameters	Units	Sediment	
			S7	S8
1	pH	-	6.53	6.57
2	Magnesium	mg/kg	339.1	371.97
3	Electrical Conductivity	μS/cm	1018	853
4	Potassium(Available)	mg/kg	148	151
5	Phosphorus(Available)	mg/kg	34.86	34.68

6	Arsenic	mg/kg	1.93	1.87
7	Iron	mg/kg	6.35	12.78
8	Lead	mg/kg	2.38	2.29
9	Zinc	mg/kg	6.72	6.84
10	Copper	mg/kg	1.87	1.82
11	Cadmium	mg/kg	BLQ(LOQ0.05)	BLQ(LOQ0.05)
12	Chromium	mg/kg	12.92	12.72
13	Manganese	mg/kg	64.17	62.80
14	Mercury	mg/kg	0.19	0.17
15	Calcium	mg/kg	706	930
16	Bulk Density	gm/cc	1.23	1.24
17	Total Polycyclic Aromatic Hydrocarbons	mg/kg	BLQ(LOQ: 0.1)	BLQ(LOQ: 0.1)
18	Total Petroleum Hydrocarbons	mg/kg	BLQ(LOQ: 0.1)	BLQ(LOQ: 0.1)
19	Nitrogen N(Available)	mg/kg	1684	1455
20	Sediment Texture	-	Loam	Loam
	Soil Texture i)Sand	%	41.7	40
	Soil Texture ii)Silt	%	39.8	38.1
	Soil Texture iii)Clay	%	18.5	21.9
21	Odour	-	Disagreeable	Disagreeable
22	H ₂ S	mg/kg	BLQ(LOQ0.1)	BLQ(LOQ0.1)
23	Boron	mg/kg	BLQ(LOQ0.1)	BLQ(LOQ0.1)
24	BTEX	mg/kg	BLQ(LOQ: 0.1)	BLQ(LOQ: 0.1)
25	Phenols	mg/kg	BLQ(LOQ0.001)	BLQ(LOQ0.001)
26	Total Solids	%	97.47	98.12
27	Particle size distribution			
i	Coarse Sand	%	14.1	13.2
ii	Medium Sand	%	13.1	12.5
iii	Fine Sand	%	14.5	14.3
iv	Coarse Silt	%	13.2	11.6
v	Medium Silt	%	11.8	13.8
vi	Fine Silt	%	14.8	12.7
vii	Clay	%	18.5	21.9
28	Poly chlorinated Bi-phenol	mg/kg	BLQ(LOQ: 0.1)	BLQ(LOQ: 0.1)
29	Loss on Ignition (Water content)	%	23.75	23.25
30	Organic substances	%	23.75	23.25
31	Inorganic substances	%	76.25	76.75
32	Coliform		<2	<2

3.10.3 Results and Discussions

Summary of analytical results for major parameters are given below:

- The pH of the sediment samples ranged from 6.53 to 7.59
- Conductivity of the sediment samples ranged from 785 to 1106 μ mhos/cm.
- Magnesium of the sediment samples ranged from 339.1 to 599.4 mg/kg.

- Nitrogen content in the collected sediment samples ranged from 208 mg/kg to 297 mg/kg.
- Phosphorous content ranged from 16.49 mg/kg to 34.86 mg/kg.
- Arsenic content ranges from 127 mg/kg to 216 mg/kg.
- Iron content ranges from 3.98 mg/kg to 13.24 mg/kg.
- Lead content ranges from 2.29 mg/kg to 9.74 mg/kg.
- Zinc content ranges from 6.72 mg/kg to 38.25 mg/kg.
- Copper content ranges from 1.82 mg/kg to 14.77 mg/kg.
- Chromium content ranges from 12.72 mg/kg to 29.53 mg/kg.
- Manganese content ranges from 62.80 mg/kg to 206.22 mg/kg.
- Mercury content ranges from 0.16 mg/kg to 1.57 mg/kg.
- Calcium content ranges from 706.00 mg/kg to 1243 mg/kg.

3.11 Biological Environment

An ecological study of the ecosystem is essential to understand the impact of urbanization on existing flora and fauna of the study area. Studies on various aspects of ecosystem play an important role in identifying sensitive issues for under taking appropriate action to mitigate the impact, if any. The biological study was under taken as a part of the EIA study report to understand the present status of ecosystem prevailing in the study area, to compare it with past condition with the help of available data, to predict changes in the biological environment as a result of present activities and to suggest measures for maintaining its health. Secondary source information was collected to study the flora & fauna in 15 km radius. Some of the information was gathered from the local habitants. All the collected data were classified to interpret the impact of pollution on the flora and fauna of that region. Documenting of the wild plants as well as cultivated crop plants was made and all the available information was recorded.

During data collection, the following aspects were considered for ecological studies:

- ❖ Assessment of present status of flora and fauna;
- ❖ Identification of rare and endangered species of plants and animals (if any);
- ❖ Identification of ecologically sensitive areas within the study area;
- ❖ Assessment of Aquatic Ecology with specific reference to flora and fauna.

3.11.1 Methodology

Terrestrial investigations for flora and fauna details were recorded. Discussions with Experts were carried-out to collect information related to local biodiversity in and around the area.

3.11.2 Flora Study

- The assessment of the flora of the study area is done by extensive secondary source information of the area of 10 km radius.
- Plants species were documented based on their habit characters of family, genus and species using available floral, other related literature.
- Besides the identification of plant species, information was collected on the vernacular names and uses of plants made by local inhabitants.

3.11.3 Fauna

Secondary source information for biodiversity of the study area was collected to identify the important animal groups such as birds, mammals and reptiles.

- ❖ Secondary information collected from local villagers, published government data etc.
- ❖ List of the endangered and endemic species as per the schedule of The Wildlife Protection Act, 1972.
- ❖ Emphasis is given to identify avifauna and mammals to determine the presence and absence of Schedule-1 species, listed in The Wildlife Protection Act 1972, as well as in Red List of IUCN.

3.11.4 Floristic Composition within the study area

The ecology and diversity assessed within the 10 km radius in the study area. It is observed that human settlements present in and around the project site and within the study area of 10 km radius and many of construction building area/ colonies have very low level of plantations.

There were a total of 53 species belonging to 25 genera under 25 families found in the study area. The study area does not have any forest land or permanent natural vegetation and the main land use feature of the study area is comprised habitation and cultivating lands. From the primary observation, the tree species recorded in the plantation area were *Cocos nucifera*, *Azadirachta indica*, *Ficus benghalensis*, *Mangifera indica*, *Musa paradisiaca*. The detailed list of plant species found in study area provided in **Table 3-23**. The Taxonomy of Flora is given below

Table 3-23 List of Plant species dound in the study area

Habit	Proposed project site
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Herbs	19
Grass	4
Climber	2
Shrub	1
Trees	1

3.11.5 Rare and endangered Floral species

During the vegetation documentation for the study area recorded any such species which are endangered or threatened under IUCN (International Union for Conservation of Nature and Natural resources) guidelines found in the Indian Biodiversity Portal.

Table 3-24 The detailed list of plant species

S.No	Scientific name	Family	Habitat	Vernacular Name	IUCN status
1	<i>Abutilon indicum</i>	Malvaceae	Shrub	Thuthi	NA
2	<i>Acalypha indica</i>	Euphorbiaceae	Herb	Kuppaimeni	NA
3	<i>Acanthospermum hispidum</i>	Asteraceae	Herb	Kombu mull	NA
4	<i>Aerva persica</i>	Amaranthaceae	Shrub	Perumpulai	NA
5	<i>Aristida setacea</i>	Poaceae	Herb	—	NA
6	<i>Atriplex repens</i>	Chenopodiaceae	Herb	—	NA
7	<i>Azadirachta indica</i>	Meliaceae	Tree	Veppamaram	NA
8	<i>Boerhavia diffusa</i>	Nyctaginaceae	Herb	Mukurattai	NA
10	<i>Bulbostylis barbata</i>	Cyperaceae	Herb	—	NA
11	<i>Calotropis gigantea</i>	Asclepiadaceae	Shrub	Erukku	NA
12	<i>Canavalia cathartica</i>	Fabaceae	Climber	—	NA
13	<i>Canavalia rosea</i>	Fabaceae	Climber	—	NA
14	<i>Cassia italica</i>	Caesalpiniaceae	Herb	Nilavahai	NA
15	<i>Casuarina litorea</i>	Casuarinaceae	Tree	Chavuku	NA
16	<i>Catharanthus roseus</i>	Apocynaceae	Herb	Nithyakalyani	NA
17	<i>Cenchrus ciliaris</i>	Poaceae	Herb	Kolukattai pul	NA
18	<i>Citrullus colocynthis</i>	Cucurbitaceae	Herb	Peykkumatti	NA
19	<i>Cocos nucifera</i>	Arecaceae	Tree	Thennaimaram	NA
20	<i>Croton bonplandianus</i>	Euphorbiaceae	Herb	Mannannaichedi	NA
21	<i>Datura metel</i>	Solanaceae	Herb	Oomathai	NA
22	<i>Euphorbia hirta</i>	Euphorbiaceae	Herb	Amampatchaiarisi	NA
23	<i>Euphorbia tortilis</i>	Euphorbiaceae	Shrub	Tirukukalli	NA
24	<i>Fimbristylis cymosa</i>	Cyperaceae	Herb	—	NA

25	<i>Gisekia pharnaceoides</i>	Aizoaceae	Herb	Manalkeerai	NA
26	<i>Gomphrena serrata</i>	Amaranthaceae	Herb	—	NA
27	<i>Hibiscus tiliaceus</i>	Malvaceae	Tree	Neerparuthi	LC
28	<i>Launaea intybea</i>	Asteraceae	Herb	—	NA
29	<i>Launaea sarmentosa</i>	Asteraceae	Herb	—	NA
30	<i>Leucas aspera</i>	Lamiaceae	Herb	Thumbai	NA
31	<i>Lopholepisoritho cephalo</i>	Poaceae	Herb	—	NA
34	<i>Passiflora foetida</i>	Passifloraceae	Climber	Sirupunaikali	NA
35	<i>Pedaliium murex</i>	Pedaliaceae	Herb	Perunerunji	NA
36	<i>Percularia daemia</i>	Asclepiadaceae	Climber	—	NA
37	<i>Phyla nodiflora</i>	Verbenaceae	Herb	Koduppai	LC
38	<i>Prosopis juliflora</i>	Mimosaceae	Tree	Veelikkaruvai	NA
39	<i>Pycreus polystachyos</i>	Poaceae	Herb	—	LC
40	<i>Sida cordifolia</i>	Malvaceae	Herb	Nilathuthi	NA
41	<i>Spinifex littoreus</i>	Poaceae	Herb	Ravananmeesai	NA
42	<i>Tephrosia purpurea</i>	Fabaceae	Under Shrub	Kolingi	NA
43	<i>Thespesia populnea</i>	Malvaceae	Tree	Poovarasu	LC
44	<i>Tribulus terrestris</i>	Zygophyllaceae	Herb	Nerinji	NA
45	<i>Vernonia cinerea</i>	Asteraceae	Herb	Mukuttipundu	NA
46	<i>Zoysia matrella</i>	Poaceae	Grass	—	NA
47	<i>Canavalia cathartica</i>	Fabaceae	Climber	Maunaloa	LC
48	<i>Ipomoea pes-caprae</i>	Convolvulaceae	Creeper	Bayhops	LC
49	<i>Pupalia lappacea</i> var. <i>orbiculata</i>	Amaranthaceae	Herb	—	LC
50	<i>Turnera subulata</i>	Passifloraceae	Herb	White buttercup	LC
Aquatic Plants					
51	<i>Avicennia marina</i>	Acanthaceae	Tree	Mangrove	LC
52	<i>Calophyllum inophyllum</i>	Calophyllaceae	Tree	Mangrove	LC
53	<i>Pontederia crassipes</i>	Pontederiaceae	hydrophyte	Water hyacinth	LC

LC-Least Concern; NA-Not Assessed

Source:

1. List of Plants : TN Plants of Tamil Nadu: http://tnenvi.s.nic.in/tnenvi_s_old/database_bio_flo.htm
2. AliyamurthyKarthigeyan, IlangovanKumaraswamy and Wilson Arisdason. 2013 An Assessment of Angiosperm Diversity of Adyar Estuary, Chennai – A Highly Degraded Estuarian Ecosystem, Tamil Nadu, India
3. Flora of Tamil Nadu. Botanical survey of India.1983
4. IUCN Status : <https://www.iucnredlist.org/>

3.11.6 Faunal Communities

The faunal diversity of the study area documented through secondary sources. Such as reference of relevant literatures (published/unpublished) and dialogues with local villagers were also carried out to consolidate the presence of faunal distribution in the area (*Smith 1933-43, Ali and Ripley 1983, Daniel 1983, Prater 1993, Murthy and Chandrasekhar 1988*).

3.11.7 Mammals

No wild mammalian species was directly sighted during the field survey. Dialogue with local villagers located around the study area also could not confirm presence of any wild animal in that area.

3.11.8 Avifauna

From the primary survey, a total of 24 species of avifauna were identified and recorded in the study area. The diversity of avifauna from this region was found to be quite high and encouraging. IUCN threatened species not observed at the study area. **Table 3-25** show the bird recorded from the Study area and its Conservation Status.

Table 3-25 Bird recorded from the Study area and Conservation Status

S.No	Species name	Common name	IUCN status
1	<i>Alauda gulgula</i>	Oriental Skylark	Least Concern
2	<i>Alcedo atthis</i>	Small Blue	Least Concern
3	<i>Ardeola grayii</i>	Pond Heron	Least Concern
4	<i>Bubulcus ibis</i>	Cattle Egret	Least Concern
5	<i>Centropus sinensis</i>	Greater coucal	Least Concern
8	<i>Corvus splendens</i>	House crow	Least Concern
9	<i>Cuculus canorus</i>	Common cuckoo	Least Concern
10	<i>Cypsiurus balasiensis</i>	Asian palm swift	Least Concern
11	<i>Dicrurus macrocercus</i>	Black drongo	Least Concern
12	<i>Egretta garzetta</i>	Little Egret	Least Concern
13	<i>Elanus caeruleus</i>	Black-winged Kite	Least Concern
15	<i>Haliastur indus</i>	Brahminy kite	Least Concern
16	<i>Merops orientalis</i>	Green bee eater	Least Concern
17	<i>Milvus migrans</i>	Black kite	Least Concern
19	<i>Perdicula asiatica</i>	Bush Quail	Least Concern
20	<i>Phalacrocorax niger</i>	Little cormorant	Least Concern
21	<i>Pseudibis papillosa</i>	Black Ibis	Least Concern
23	<i>Streptopelia chinensis</i>	Spotted dove	Not assessed
24	<i>Vanellus indicus</i>	Red-wattled lapwing	Least Concern

LC-Least Concern; NA-Not Assessed

3.11.9 Reptiles and Amphibians

As per the secondary information, six species of reptiles and amphibians were observed in the study area and mentioned in the **Table 3-26**.

Table 3-26 Reptiles & Amphibians recorded from the Study area

S.No	Reptiles & Amphibians	Common name	IUCN Status
1	<i>Hemidactylus sp.</i>	House lizard	Not Assessed
2	<i>Eutropis macularia</i>	Common skink	Not Assessed
3	<i>Bungarus caeruleus</i>	Common Krait	Not Assessed
4	<i>Ophisops leschenault</i>	Snake-eyed lizard	Not Assessed
5	<i>Rana tigrina</i>	Common yellow frog	Least Concern
6	<i>Lepidochelys olivacea</i>	Olive Ridley Turtle	Vulnerable

3.11.10 Butterfly

Butterfly can also serve as useful indicators of forest biodiversity. They are responsible for a large part of the complex interconnections that characterize natural forest ecosystems. The butterfly communities that are present in forests help to maintain crucial ecological processes and preserve biodiversity as a whole. They participate in most of the ecological processes that sustain ecosystems. The present study 20 species were recorded and mentioned in the **Table 3-27**.

Table 3-27 Butterfly recorded from the Study area

S.No	Zoological Name	Family	Common Name	IUCN status
1	<i>Ariadne merione</i>	Nymphalidae	Common Caster	Least Concern
2	<i>Atrophaneura aristolochiae</i>	Papilionidae	Common Rose	Least Concern
3	<i>Catopsilia pomona</i>	Pieridae	Common Emigrant	Least Concern
4	<i>Catopsilia pyranthe</i>	Pieridae	Mottled Emigrant	Least Concern
5	<i>Colotis etrida</i>	Pieridae	Small Orange Tip	Least Concern
6	<i>Danaus chrysippus</i>	Nymphalidae	Plain Tiger	Least Concern
7	<i>Danaus genutia</i>	Nymphalidae	Striped Tiger	Least Concern
8	<i>Delias eucharis</i>	Pieridae	Common Jezebel	Least Concern
9	<i>Euchrysops cnejus</i>	Lycaenidae	Gram Blue	Least Concern
10	<i>Eurema hecabe</i>	Pieridae	Common Grass Yellow	Least Concern
11	<i>Hypolimnias bolina</i>	Nymphalidae	Great Egg Fly	Least Concern
12	<i>Hypolimnias misippus</i>	Nymphalidae	Danaid Egg Fly	Not Assessed
13	<i>Junonia almana</i>	Nymphalidae	Peacock Pansy	Least Concern
14	<i>Junonia hierta</i>	Nymphalidae	Yellow Pansy	Least Concern
15	<i>Junonia iphita</i>	Nymphalidae	Chocolate Pansy	Least Concern
16	<i>Junonia lemonias</i>	Nymphalidae	Lemon Pansy	Least Concern
17	<i>Junonia orithya</i>	Nymphalidae	Blue Pansy	Least Concern
18	<i>Leptosia nina</i>	Pieridae	Psyche	Least Concern
19	<i>Mycalesis perseus</i>	Nymphalidae	Common Bush Brown	Least Concern
20	<i>Phalanta phalantha</i>	Nymphalidae	Common Leopard	Least Concern

3.11.11 Aquatic Ecology**Significance of Plankton:**

Planktons can be broadly grouped into two categories those with plant origin are called ‘Phytoplankton’ and those with animal origin are called ‘Zooplankton’. **Table 3-28** and **Table 3-29** shows the list of most common Phytoplankton and Zooplankton from Adyar River.

Table 3-28 List of most common Phytoplankton from Adyar River

S.No	Phytoplankton
1	<i>Oscillatoria subbrevis</i>
2	<i>Pediastrum duplex</i>
3	<i>Spirogyra sp.</i>
4	<i>Navicula rhynchocephala</i>
5	<i>Microcystis aeruginosa</i>

Table 3-29 List of most common Zooplankton from Adyar River

S.No	Species
Rotifera	
1	<i>Assulina muscorum</i>
2	<i>Brachionus falcatus</i>
3	<i>Brachionus calyciflorus</i>
4	<i>Brachionu sanguularis</i>
5	<i>Lecane cervicornis</i>
6	<i>Polyarthra vulgaris</i>
7	<i>Filinia longiseta</i>
Copepoda	
8	<i>Mesocyclops hyalinus</i>
9	<i>Cyclopoid copepodite</i>
10	<i>Cyclopoid nauplii</i>
Cladocera	
11	<i>Chydorus sphaericus</i>
Ostracoda	
12	<i>Cypris subglobosa</i>
Miscellaneous - Aquatic insects	
13	<i>Mosquito larvae</i>



Plankton Samples collection

Source:**a) Birds:**

Ali, S. (2002). The Book of Indian Birds (13th Revised Edition). Oxford University Press, New Delhi, 326pp.

b) Butterflies:

Kehimkar I. The Book of Indian Butterflies. Bombay Natural History Society, 2008, 497.

Evans WH. Identification of Indian butterflies. The Bombay Natural History Society, Bombay, 1927, 32.

Kunte K (2000a). Butterflies of Peninsular India. Indian Academy of Science, University of Press (India) Limited, Hyderabad, India, 354.

c) Mammals:

Kamalakaran, M. & P.O. Nameer (2019). A checklist of mammals of Tamil Nadu, India. Journal of Threatened Taxa 11(8): 13992–14009; <https://doi.org/10.11609/jott.4705.11.8.13992-14009>.

d) Reptiles:

Aengals, R., Sathish Kumar, V.M., Palot, M.J. & Ganesh, S.R. (2018). A Checklist of Reptiles of India. 35 pp. Version 3.0. Online publication is available at www.zsi.gov.in (Last update: May 2018)

3.11.12 Impact on Biological Environment and Wildlife

As the proposed project is a construction of monument and there will be no emission and generation of waste during the operational phase. Thus, there will be no impact on the biological environment and wildlife. During the construction phase, no adverse impacts are envisaged and all the impacts would be fully mitigated.

3.11.13 Impact on Flora

Plantation will be developed in the undeveloped area as per plantation programme. These activities will help to improve the floral cover of the area. The greenery and plantation development will eventually attract micro fauna, birds etc in the area. Assistance will be taken from local forest department in selection of species of plants so that green coverage may improve fast. The varieties would include those plants, which are suitable to the area.

3.11.14 Impact on Fauna

The study area is in non-forest land where presence of fauna is very rare. As such, there will be no adverse impact of the plant unit activity on fauna around the plant unit area.

3.11.15 Green Belt Development

The proposed green belt in the plant unit area will to be designed taking into consideration the availability of area as the efficacy of green belt in pollution control mainly depends on width of green belt, distance from pollution sources, site of the habitat from working place and tree height & density.

While considering the above aspects due care will be taken for selecting suitable characteristics plant species as those fast growing and evergreen trees, trees with large leaf area, locally suitable plant species, those resistant to specific pollutant and those which would maintain the regional ecological balance, soil and hydrological conditions. The plantation work for green belt development will be carried in consultation with a local forest department which will help minimizing adverse impact on the flora found in the area.

The following plant species will be planted according to CPCB guidelines: *Cassia fistula*, *Delbergia sisso*, *Mangifera indica*, *Acacia nilotica*, *Tectona grandis*, *Azadirachta indica*, *Albizia lebbek*, *Prosopis cineraria*, *Delonix regia*, *Ficus benghalensis*, *Butea monosperma*, *Phoenix sylvestris* etc.

3.12 Socio Economic profile

Chennai district was ranked 1st in terms of the highest population in Tamil Nadu State. The population of the district is 4,646,732 which comprise of 2,335,844 male and 2,310,888 female populations.

Source: http://censusindia.gov.in/2011census/dchb/DCHB_A/33/3302_PART_A_DCHB_CHENNAI.pdf

3.12.1 Socio Economic Aspects

A socio-economic study was undertaken in assessing aspects which are dealing with social and cultural conditions, and economic status in the study area. The study provides information such as demographic structure, population dynamics, infrastructure resources, and agriculture, trade, and industrial development in the study area. The study of these characteristic helps in identification, prediction and evaluation of impacts on socio-economic and parameters of human interest due to proposed project developments. The parameters are:

- Demographic structure
- Infrastructure Facility
- Economic Status
- Health status
- Cultural attributes

Awareness and opinion of people about the project and Industries in the area. **Table 3-30**, **Table 3-31** and **Table 3-32** shows some important Social Indicators of Chennai, Kancheepuram and Thiruvallur district of Tamil nadu respectively.

Table 3-30 Social Indicators of Chennai District

S.No	Social Indicators	Chennai District
1	Decadal variation %	7
2	Sex ratio	989
3	Population density (Persons per square Km)	26553
4	Scheduled caste population %	16.78
5	Scheduled tribe population %	0.22
6	Literacy rate %	90.2
7	Work Participation rate %	39.1
8	Main Workers %	89.12
9	Marginal Workers %	10.88
10	Cultivators %	0.8
11	Agricultural labourers %	0.75
12	Workers in household industries %	2.05
13	Other workers %	96.4

Table 3-31 Social Indicators of Kancheepuram District

S.No	Social Indicators	Kancheepuram District
1	Decadal variation %	39
2	Sex ratio	986
3	Population density (Persons per square Km)	892
4	Scheduled caste population %	23.7
5	Scheduled tribe population %	1
6	Literacy rate %	84.5
7	Work Participation rate %	41.9
8	Main Workers %	81.7
9	Marginal Workers %	18.3
10	Cultivators %	5.34
11	Agricultural labourers %	16.28
12	Workers in household industries %	3.27
13	Other workers %	75.11

Table 3-32 Social Indicators of Thiruvallur District

S.No	Social Indicators	Thiruvallur District
------	-------------------	----------------------

1	Decadal variation %	35.3
2	Sex ratio	987
3	Population density (Persons per square Km)	1098
4	Scheduled caste population %	22
5	Scheduled tribe population %	1.3
6	Literacy rate %	84
7	Work Participation rate %	23.5
8	Main Workers %	81.14
9	Marginal Workers %	18.86
10	Cultivators %	4.78
11	Agricultural labourers %	17.59
12	Workers in household industries %	3.79
13	Other workers %	73.84

Source:https://censusindia.gov.in/nada/index.php/catalog/1103/download/3426/DH_2011_3303_PART_B_DCHB_KANCHEEPURAM.pdf

https://censusindia.gov.in/nada/index.php/catalog/1094/download/3390/DH_2011_3301_PART_A_DCHB_THIRUVALLUR.pdf

index.php/catalog/1090/download/3374/DH_2011_3302_PART_A_DCHB_CHENNAI.pdf

3.12.2 Population

Chennai district ranked 1st in terms of the highest population in the State. The district population density was 26553 persons/sq. km. Chennai district is a Metropolitan City. A minimum population of 5,000; ii) At least 75 per cent of male working population engaged in non-agricultural pursuits; and iii) A density of population of at least 400 per sq. km. (1,000 per sq. mile) For identification of places which would qualify to be classified as 'urban' all villages, which, as per the 2001 Census had a population of 4,000 and above, a population density of 400 persons per sq. km. and having at least 75 per cent of male working population engaged in non-agricultural activity were considered.

Kancheepuram district ranked 2nd in terms of the highest population in Tamil Nadu. Kancheepuram district has recorded population density of 892 persons/sq km. The percentage of decadal population variation during 2001-2011 was 39%. The urban population was 63.5% in the district. Maduranthakam taluk has the highest number of the inhabited villages (188) while Sholinganallur taluk has the lowest number (6) of such villages. Semmanjeri village (L.C.No. 629379) in Sholinganallur taluk had the highest

population of 29751 persons and Murukkanthankal village (L.C.No. 629659) in Kancheepuram taluk recorded the lowest population of 4 persons in the district. Cheyyur village (L.C.No. 630208) in Cheyyur taluk is the largest village with an area of 3385.24 hectares and Mahanyam Reserve Forest (L.C.No. 629339) in Sriperumbudur taluk is the smallest village with an area of 10.58 hectares in the district.

Thiruvallur district ranked 4th in terms of the highest population in Tamil Nadu. Thiruvallur district has the urban population share of 65.1%. The density of population in the district was 1098 persons/ sq km. The district Sex Ratio was 987, lower when compared to the State Sex Ratio of 996. Pulicut village (L. C. No. 628672) in Ponneri taluk had the highest population of 17925 and Sennavaram village (L.C. No. 629088) in Thiruvallur taluk returned the lowest population of 18 in the district. Karimanal village (L.C.No. 628636) in Ponneri taluk is the largest village with an area of 3894.76 hectares and Nayapakkam Reserve Forest Village (L.C.No. 628872) in Uthukottai taluk is the smallest village with an area of 0.31 hectares in the district. Thiruvallur taluk has the highest number of the inhabited villages (133) while Ambattur taluk has the lowest number of 12 such villages.

Source:https://censusindia.gov.in/nada/index.php/catalog/1103/download/3426/DH_2011_3303_PART_B_DCHB_KANCHEEPURAM.pdf

https://censusindia.gov.in/nada/index.php/catalog/1094/download/3390/DH_2011_3301_PART_A_DCHB_THIRUVALLUR.pdf

[index.php/catalog/1090/download/3374/DH_2011_3302_PART_A_DCHB_CHENNAI.pdf](https://censusindia.gov.in/nada/index.php/catalog/1090/download/3374/DH_2011_3302_PART_A_DCHB_CHENNAI.pdf)

3.12.3 Population Density and Sex Ratio

A minimum population of 5,000. At least 75 per cent of male working population engaged in non-agricultural pursuits. A density of population of at least 400 per sq. km. (1,000 per sq. mile). For identification of places which would qualify to be classified as 'urban' all villages, which, as per the 2001 Census had a population of 4,000 and above, a population density of 400 persons per sq. km. and having at least 75 per cent of male working population engaged in non-agricultural activity were considered.

Source:https://censusindia.gov.in/nada/index.php/catalog/1103/download/3426/DH_2011_3303_PART_B_DCHB_KANCHEEPURAM.pdf

https://censusindia.gov.in/nada/index.php/catalog/1094/download/3390/DH_2011_3301_PART_A_DCHB_THIRUVALLUR.pdf

[index.php/catalog/1090/download/3374/DH_2011_3302_PART_A_DCHB_CHENNAI.pdf](https://censusindia.gov.in/nada/index.php/catalog/1090/download/3374/DH_2011_3302_PART_A_DCHB_CHENNAI.pdf)

3.12.4 Scheduled Castes and Scheduled Tribes

The district Scheduled Castes decadal population growth during 2001- 2011 was 30.4%, the highest among the districts. The Scheduled Castes (SCs) and the Scheduled Tribes (STs) in Chennai may have migrated from other parts of the State. According to 2011 census, the SCs population was 779667 accounting to 16.78% to the total population of Chennai. Similarly, the STs population was 10061 accounting to 0.22% to the total population of Chennai.

Scheduled Caste population in Kancheepuram district was 23.7% and Scheduled Tribes population was 1% in 2011. The Scheduled Castes and Scheduled Tribes population in rural and urban areas of the district As per the constitutional obligation, for discharging the basic requirements of the schedule caste / schedule tribe population, the availability of population details for each notified castes and tribes, the office of the Register General and Census commissioner, India has been providing such details since 1951 census.

Scheduled Castes population and Scheduled Tribe population in Thiruvallur district is very less in thiruvallur. Thiruvallur has a population of 821646 persons belonging to Scheduled Castes which represents 22% of the total population of the district. Of these, 451999 reside in rural areas and that 34.8% of the Scheduled Caste population. The percentage of Scheduled Tribes is very low in the district as 1.3% which is even lesser than 1.4% of 2001 census.

Source:https://censusindia.gov.in/nada/index.php/catalog/1103/download/3426/DH_2011_3303_PART_B_DCHB_KANCHEEPURAM.pdf

https://censusindia.gov.in/nada/index.php/catalog/1094/download/3390/DH_2011_3301_PART_A_DCHB_THIRUVALLUR.pdf

index.php/catalog/1090/download/3374/DH_2011_3302_PART_A_DCHB_CHENNAI.pdf

3.12.5 Education & Literacy

Literacy rate of the population is defined as the percentage of literates in the age-group seven years and above. For different age-groups the percentage of literates in that age-group gives the literacy rate. The Chennai district has recorded the 2nd highest literacy rate of 90.2% among the districts.

The kancheepuram district has recorded the highest literacy rate of 84.5% as compared with the State literacy rate of 80.1%. The rural literacy was 76% in 2011. Males with 83.6% and females with 68.2%. While the urban literacy in the district was 89.4% in 2011. Males with 93.5% and females with 85.2%. The literacy in the district has seen significant increase in 2011 census compared to 2001 census.

The district has recorded higher literacy rate (84%) as compared with the State literacy rate of 80.1%. Thiruvallur stands at the sixth place in the case of percentage of literacy. The Literacy rate of the district is 84% in 2011 which is increased from 76.9% in 2001, against to the literacy rate of the state as 80.1%.

The literacy of females stood at 78.3% as compared to 89.7% for males. The female literacy rate is considerably increased in the district from 68.4% in 2001 to 78.3% in 2011.

Source: https://censusindia.gov.in/nada/index.php/catalog/1103/download/3426/DH_2011_3303_PART_B_DCHB_KANCHEEPURAM.pdf

https://censusindia.gov.in/nada/index.php/catalog/1094/download/3390/DH_2011_3301_PART_A_DCHB_THIRUVALLUR.pdf

[index.php/catalog/1090/download/3374/DH_2011_3302_PART_A_DCHB_CHENNAI.pdf](https://censusindia.gov.in/nada/index.php/catalog/1090/download/3374/DH_2011_3302_PART_A_DCHB_CHENNAI.pdf)

Type of school (Chennai)	Total schools		Rural Schools	
	Government	Private	Government	Private
Primary	130	503	0	0
Primary + Upper Primary	97	89	0	0
Primary + Upper Primary + Secondary + Higher Secondary	59	239	0	0
Upper Primary only	0	1	0	0
Upper Primary + Secondary + Higher Secondary	52	109	0	0
Primary + Upper Primary + Secondary	18	91	0	0
Upper Primary + Secondary	47	36	1	0

(Source: District Information Systems on Education (DISE report card 2016-17))

Type of school (Kancheepuram)	Total schools		Rural Schools	
	Government	Private	Government	Private
Primary	868	503	809	373
Primary + Upper Primary	346	105	308	68
Primary + Upper Primary + Secondary + Higher Secondary	49	186	39	113
Upper Primary only	1	2	1	0
Upper Primary + Secondary + Higher Secondary	126	41	100	16
Primary + Upper Primary + Secondary	35	118	28	82
Upper Primary + Secondary	120	41	110	26

(Source: District Information Systems on Education (DISE report card 2016-17))

Type of school (Thiruvallur)	Total schools	Rural Schools
------------------------------	---------------	---------------

	Government	Private	Government	Private
Primary	941	487	815	252
Primary + Upper Primary	487	60	225	35
Primary + Upper Primary + Secondary + Higher Secondary	33	192	12	55
Upper Primary only	1	1	2	0
Upper Primary + Secondary + Higher Secondary	36	0	69	13
Primary + Upper Primary + Secondary	126	2	11	53
Upper Primary + Secondary	18	0	117	7

(Source: District Information Systems on Education (DISE report card 2016-17))

3.12.6 Employment and Livelihood

In 2010-11, according to MSME-Chennai, the registered industrial units in Chennai include -11185 micro manufacturing units, 16967 micro service units, 2288 small manufacturing units, 5730 small service units, 139 medium manufacturing units and 796 medium service units. These units had generated employment for about 229467 persons.

It is a vocational training institute imparting trainings in specific fields acquiring necessary skill, which will make the trainees employable or create them opportunities of selfemployment. Trainings offered by Industrial Training Institutes (ITI) fall under this category

Indian Census in 1991 treated the population size of 5 million and above as the cutoff point to identify a place as the mega city. Whereas, for the purpose of inclusion in Centrally Sponsored Scheme for Infrastructure Development in Mega cities the Ministry of Urban Affairs and employment,

Department of Urban Development adopted the criteria of 4 million and above population as per 1991 Census for Mega Cities. In 2001 Census, cities with 10 million and above population have been treated as Mega cities and the same criteria of population have been adopted in 2011 census.

Source: https://censusindia.gov.in/nada/index.php/catalog/1103/download/3426/DH_2011_3303_PART_B_DCHB_KANCHEEPURAM.pdf

https://censusindia.gov.in/nada/index.php/catalog/1094/download/3390/DH_2011_3301_PART_A_DCHB_THIRUVALLUR.pdf

[index.php/catalog/1090/download/3374/DH_2011_3302_PART_A_DCHB_CHENNAI.pdf](https://censusindia.gov.in/nada/index.php/catalog/1090/download/3374/DH_2011_3302_PART_A_DCHB_CHENNAI.pdf)

3.12.7 Social Economic Profile of the study area

The project area comes under the Chennai, Kanchipuram and Thiruvallur District of Tamil nadu. **Table 3-33** provides the details on population profile within study area.

Table 3-33 Population profile within study area

Sl. No	Name	No of Households	Total Population Person	Total Population Male	Total Population Female	Population in the age group 0-6 Person	Scheduled Castes population Person	Scheduled Tribes population Person
0-5 Km								
Chennai								
1.	Chennai (M Corp.) WARD NO.-0018	3925	16424	8197	8227	1508	433	2
2.	Chennai (M Corp.) WARD NO.-0019	3772	15457	7761	7696	1628	415	4
3.	Chennai (M Corp.) WARD NO.-0022	5714	26177	12962	13215	2589	12673	60
4.	Chennai (M Corp.) WARD NO.-0023	4254	18434	9503	8931	1798	367	23
5.	Chennai (M Corp.) WARD NO.-0024	4476	21002	10531	10471	2097	2511	8
6.	Chennai (M Corp.) WARD NO.-0025	4329	19261	9609	9652	1957	3802	98
7.	Chennai (M Corp.) WARD NO.-	4656	20239	10416	9823	2061	2717	3

	0026							
8.	Chennai (M Corp.) WARD NO.- 0027	5202	24426	12806	11620	2667	5536	107
9.	Chennai (M Corp.) WARD NO.- 0028	5840	26156	13826	12330	2777	4404	75
10.	Chennai (M Corp.) WARD NO.- 0029	3967	19415	10172	9243	1705	1172	4
11.	Chennai (M Corp.) WARD NO.- 0030	4838	25286	13610	11676	2133	1072	3
12.	Chennai (M Corp.) WARD NO.- 0031	7226	32152	16030	16122	3316	16598	44
13.	Chennai (M Corp.) WARD NO.- 0041	4826	21550	10871	10679	2294	7823	7
14.	Chennai (M Corp.) WARD NO.- 0042	6137	27857	13821	14036	3015	15041	62
15.	Chennai (M Corp.) WARD NO.- 0043	3422	15835	8124	7711	1730	1256	26
16.	Chennai (M Corp.) WARD NO.-	3162	14291	7343	6948	1704	3652	4

	0044							
17.	Chennai (M Corp.) WARD NO.- 0045	3916	17871	8839	9032	1936	9879	10
18.	Chennai (M Corp.) WARD NO.- 0046	3049	12747	6423	6324	1243	1092	14
19.	Chennai (M Corp.) WARD NO.- 0047	2999	14379	7370	7009	1330	2627	10
20.	Chennai (M Corp.) WARD NO.- 0048	3978	18269	9385	8884	1955	6886	30
21.	Chennai (M Corp.) WARD NO.- 0049	3228	16889	8677	8212	1638	1790	1
22.	Chennai (M Corp.) WARD NO.- 0070	6214	26313	12906	13407	1931	1932	21
23.	Chennai (M Corp.) WARD NO.- 0071	2948	12091	5988	6103	897	692	7
24.	Chennai (M Corp.) WARD NO.- 0072	7870	32446	16367	16079	3120	12705	26
25.	Chennai (M Corp.) WARD NO.-	5624	23476	12319	11157	1856	3097	27

	0078							
26.	Chennai (M Corp.) WARD NO.- 0079	4628	19748	9870	9878	2065	7575	66
27.	Chennai (M Corp.) WARD NO.- 0080	4297	20318	10593	9725	2324	10438	30
28.	Chennai (M Corp.) WARD NO.- 0081	4037	17123	8533	8590	1617	2356	11
29.	Chennai (M Corp.) WARD NO.- 0082	3639	16338	8219	8119	1592	3819	28
30.	Chennai (M Corp.) WARD NO.- 0083	3999	19140	10113	9027	1865	3790	16
31.	Chennai (M Corp.) WARD NO.- 0084	4793	17825	9527	8298	1759	1397	42
32.	Chennai (M Corp.) WARD NO.- 0085	2720	11304	5933	5371	827	392	35
33.	Chennai (M Corp.) WARD NO.- 0086	4001	16185	9537	6648	1262	1858	7
34.	Chennai (M Corp.) WARD NO.-	3452	14375	7331	7044	1419	385	302

	0087							
35.	Chennai (M Corp.) WARD NO.- 0088	5401	23618	11897	11721	2552	591	21
36.	Chennai (M Corp.) WARD NO.- 0089	4030	16014	8048	7966	1229	181	7
37.	Chennai (M Corp.) WARD NO.- 0090	4114	17329	8637	8692	1764	1243	14
38.	Chennai (M Corp.) WARD NO.- 0091	5094	22285	10912	11373	2249	7836	161
39.	Chennai (M Corp.) WARD NO.- 0092	3981	16511	8233	8278	1697	2748	71
40.	Chennai (M Corp.) WARD NO.- 0093	3861	17368	8670	8698	1814	1083	3
41.	Chennai (M Corp.) WARD NO.- 0094	5328	22407	11285	11122	2343	6399	9
42.	Chennai (M Corp.) WARD NO.- 0095	2901	11664	5630	6034	902	831	69
43.	Chennai (M Corp.) WARD NO.-	3134	12954	6701	6253	1027	1708	3

	0096							
44.	Chennai (M Corp.) WARD NO.- 0100	2343	9545	4852	4693	893	505	0
45.	Chennai (M Corp.) WARD NO.- 0101	3149	12703	6477	6226	1027	441	35
46.	Chennai (M Corp.) WARD NO.- 0102	2208	9377	4739	4638	809	245	0
47.	Chennai (M Corp.) WARD NO.- 0103	3467	16595	8111	8484	1538	3334	9
48.	Chennai (M Corp.) WARD NO.- 0104	5167	20897	10400	10497	1972	11195	6
49.	Chennai (M Corp.) WARD NO.- 0105	3940	17965	9086	8879	1749	4783	26
50.	Chennai (M Corp.) WARD NO.- 0106	4519	20023	9674	10349	1996	3803	18
51.	Chennai (M Corp.) WARD NO.- 0107	5529	22902	11329	11573	1986	3297	9
52.	Chennai (M Corp.) WARD NO.-	4907	20042	9832	10210	1695	2261	40

	0108							
53.	Chennai (M Corp.) WARD NO.- 0109	4140	18546	9308	9238	1670	5458	2
54.	Chennai (M Corp.) WARD NO.- 0110	3439	13867	7016	6851	1297	5849	7
55.	Chennai (M Corp.) WARD NO.- 0111	4136	18480	9239	9241	1848	1834	17
56.	Chennai (M Corp.) WARD NO.- 0112	3657	14912	7444	7468	1228	1525	89
57.	Chennai (M Corp.) WARD NO.- 0113	4926	19701	9480	10221	1610	2079	121
58.	Chennai (M Corp.) WARD NO.- 0114	7965	32913	16198	16715	3030	8855	46
59.	Chennai (M Corp.) WARD NO.- 0115	6453	24775	12394	12381	2455	1057	10
60.	Chennai (M Corp.) WARD NO.- 0142	7224	26525	12952	13573	2046	3548	19
61.	Chennai (M Corp.) WARD NO.-	5020	20124	9920	10204	1700	4688	17

	0143							
62.	Chennai (M Corp.) WARD NO.-0144	5498	21231	10447	10784	1822	2685	25
63.	Chennai (M Corp.) WARD NO.-0145	5863	24508	12133	12375	2487	7795	30
64.	Chennai (M Corp.) WARD NO.-0146	4389	17539	8639	8900	1420	1104	31
65.	Chennai (M Corp.) WARD NO.-0147	4724	17881	8952	8929	1266	545	16
66.	Chennai (M Corp.) WARD NO.-0148	4732	17914	8869	9045	1361	1414	7
67.	Chennai (M Corp.) WARD NO.-0150	7853	31270	15373	15897	3123	2583	23
	Total	304230	1301184	656389	644795	123220	255685	2174

5-10 km**Chennai**

1.	Chennai (M Corp.) WARD NO.-0001	18900	76760	38805	37955	8209	7010	108
2.	Chennai (M Corp.) WARD NO.-0002	16713	66897	33781	33116	7196	11315	160
3.	Chennai (M Corp.) WARD NO.-0003	13248	52995	26804	26191	6326	2568	21
4.	Chennai (M Corp.) WARD NO.-0004	3634	15186	7506	7680	1564	4499	11
5.	Chennai (M Corp.) WARD NO.-0005	11147	45204	22583	22621	4707	5644	92

6.	Chennai (M Corp.) WARD NO.-0006	4775	19523	9739	9784	1983	2681	5
7.	Chennai (M Corp.) WARD NO.-0007	5592	22161	11063	11098	2138	1242	15
8.	Chennai (M Corp.) WARD NO.-0008	8462	33039	16401	16638	3449	4078	12
9.	Chennai (M Corp.) WARD NO.-0009	5059	20306	10184	10122	1948	422	0
10.	Chennai (M Corp.) WARD NO.-0010	11223	44747	22331	22416	5210	5945	65
11.	Chennai (M Corp.) WARD NO.-0011	7838	33287	16596	16691	4054	15993	19
12.	Chennai (M Corp.) WARD NO.-0012	3880	16254	7999	8255	1761	547	12
13.	Chennai (M Corp.) WARD NO.-0013	5103	21829	10813	11016	2653	4738	55
14.	Chennai (M Corp.) WARD NO.-0014	8295	35130	17440	17690	3927	5080	12
15.	Chennai (M Corp.) WARD NO.-0015	4847	19952	10114	9838	1862	202	7
16.	Chennai (M Corp.) WARD NO.-0016	5377	22947	11578	11369	2108	566	3
17.	Chennai (M Corp.) WARD NO.-0017	5722	24670	12537	12133	2399	2466	14
18.	Chennai (M Corp.) WARD NO.-0020	3340	13276	6625	6651	1283	211	11
19.	Chennai (M Corp.) WARD NO.-0021	3769	16044	7969	8075	1642	1911	8
20.	Chennai (M Corp.) WARD NO.-0032	7897	32269	16124	16145	3703	22247	13
21.	Chennai (M Corp.) WARD NO.-0033	9935	41617	20930	20687	4398	12890	123
22.	Chennai (M Corp.) WARD NO.-0034	12845	49559	24710	24849	5025	6470	68
23.	Chennai (M Corp.) WARD NO.-0035	10027	40075	20183	19892	4233	4749	14
24.	Chennai (M Corp.) WARD NO.-0036	13056	52262	26082	26180	5453	18235	74
25.	Chennai (M Corp.) WARD NO.-0037	7064	26491	13110	13381	2104	2130	44
26.	Chennai (M Corp.) WARD NO.-0038	8936	35187	17533	17654	3494	16173	159
27.	Chennai (M Corp.) WARD NO.-0039	7080	30573	15390	15183	3182	9611	82
28.	Chennai (M Corp.) WARD NO.-0040	12004	51479	25710	25769	5959	28903	163
29.	Chennai (M Corp.) WARD NO.-0048	3978	18269	9385	8884	1955	6886	30

30.	Chennai (M Corp.) WARD NO.-0050	13280	51527	25678	25849	4739	3629	155
31.	Chennai (M Corp.) WARD NO.-0051	11324	46250	22896	23354	4779	5471	139
32.	Chennai (M Corp.) WARD NO.-0052	5916	23233	11610	11623	2144	6167	163
33.	Chennai (M Corp.) WARD NO.-0053	6235	23831	11720	12111	2142	4949	87
34.	Chennai (M Corp.) WARD NO.-0054	10083	39058	19355	19703	3827	5527	162
35.	Chennai (M Corp.) WARD NO.-0055	5741	23220	11378	11842	2138	6150	142
36.	Chennai (M Corp.) WARD NO.-0056	9854	38123	18860	19263	3699	6288	76
37.	Chennai (M Corp.) WARD NO.-0057	5711	21805	10779	11026	2013	2440	64
38.	Chennai (M Corp.) WARD NO.-0058	7542	30577	15172	15405	2951	5685	108
39.	Chennai (M Corp.) WARD NO.-0059	6178	23595	11688	11907	2284	3436	27
40.	Chennai (M Corp.) WARD NO.-0060	7418	29821	14753	15068	3041	8174	42
41.	Chennai (M Corp.) WARD NO.-0061	4116	17321	8818	8503	1556	4062	214
42.	Chennai (M Corp.) WARD NO.-0062	28300	110474	55689	54785	11760	15214	552
43.	Chennai (M Corp.) WARD NO.-0063	21119	81648	40932	40716	8290	14630	1191
44.	Chennai (M Corp.) WARD NO.-0064	18420	72144	36618	35526	6003	8025	288
45.	Chennai (M Corp.) WARD NO.-0065	24471	95564	48064	47500	10081	9471	237
46.	Chennai (M Corp.) WARD NO.-0066	12896	50926	25217	25709	4687	7752	185
47.	Chennai (M Corp.) WARD NO.-0067	9710	37331	18563	18768	3432	4117	127
48.	Chennai (M Corp.) WARD NO.-0068	8456	32999	16333	16666	3157	5436	51
49.	Chennai (M Corp.) WARD NO.-0069	6509	27133	13348	13785	2627	11187	37
50.	Chennai (M Corp.) WARD NO.-0073	5841	22662	11199	11463	2175	3135	8
51.	Chennai (M Corp.) WARD NO.-0074	14580	56960	28799	28161	6350	4208	136
52.	Chennai (M Corp.) WARD NO.-0075	15314	60126	30426	29700	6595	5917	108
53.	Chennai (M Corp.) WARD NO.-0076	6123	24524	12355	12169	2419	5115	22

54.	Chennai (M Corp.) WARD NO.-0077	6211	23619	11767	11852	2256	1564	31
55.	Chennai (M Corp.) WARD NO.-0097	5311	20860	10416	10444	2019	2670	20
56.	Chennai (M Corp.) WARD NO.-0098	4316	17466	8615	8851	1746	2215	11
57.	Chennai (M Corp.) WARD NO.-0099	3679	15460	7665	7795	1532	5320	20
58.	Chennai (M Corp.) WARD NO.-0116	6053	23624	11569	12055	2087	5055	60
59.	Chennai (M Corp.) WARD NO.-0117	9497	36192	18284	17908	3509	2801	37
60.	Chennai (M Corp.) WARD NO.-0118	8947	34310	17078	17232	3354	6554	51
61.	Chennai (M Corp.) WARD NO.-0119	5871	23472	11436	12036	2143	4468	24
62.	Chennai (M Corp.) WARD NO.-0120	7598	28874	14244	14630	2489	4938	37
63.	Chennai (M Corp.) WARD NO.-0121	6643	25912	12896	13016	2397	4195	26
64.	Chennai (M Corp.) WARD NO.-0122	7748	30204	14921	15283	2678	9000	63
65.	Chennai (M Corp.) WARD NO.-0123	6867	25733	12838	12895	2116	3724	12
66.	Chennai (M Corp.) WARD NO.-0124	6119	22907	11394	11513	1879	937	52
67.	Chennai (M Corp.) WARD NO.-0125	5622	20416	10079	10337	1258	247	23
68.	Chennai (M Corp.) WARD NO.-0126	4426	17718	9381	8337	1042	245	53
69.	Chennai (M Corp.) WARD NO.-0127	5987	24606	13097	11509	1892	637	31
70.	Chennai (M Corp.) WARD NO.-0128	15290	58003	28987	29016	5797	2137	90
71.	Chennai (M Corp.) WARD NO.-0129	15647	59322	29937	29385	5923	3928	115
72.	Chennai (M Corp.) WARD NO.-0130	14578	55784	28182	27602	6276	8327	150
73.	Chennai (M Corp.) WARD NO.-0131	15384	58468	29409	29059	6651	7644	75
74.	Chennai (M Corp.) WARD NO.-0132	11257	41733	21026	20707	4490	4222	21
75.	Chennai (M Corp.) WARD NO.-0133	6893	25793	12985	12808	2370	1918	5
76.	Chennai (M Corp.) WARD NO.-0134	6256	23054	11599	11455	2362	945	31
77.	Chennai (M Corp.) WARD NO.-0135	13202	49869	25168	24701	5044	9980	27

78.	Chennai (M Corp.) WARD NO.-0136	8548	33270	16871	16399	3324	7804	22
79.	Chennai (M Corp.) WARD NO.-0137	5662	22019	11270	10749	1988	1261	18
80.	Chennai (M Corp.) WARD NO.-0138	9952	37720	18892	18828	3731	8096	55
81.	Chennai (M Corp.) WARD NO.-0139	8366	35299	18014	17285	3186	9603	109
82.	Chennai (M Corp.) WARD NO.-0140	8238	33089	17750	15339	3602	5023	136
83.	Chennai (M Corp.) WARD NO.-0141	12627	54598	29874	24724	5216	5619	104
84.	Chennai (M Corp.) WARD NO.-0149	8398	32138	15893	16245	2927	3429	32
85.	Chennai (M Corp.) WARD NO.-0151	9362	34509	17113	17396	2873	4852	197
86.	Chennai (M Corp.) WARD NO.-0152	6961	25707	12692	13015	2121	3042	57
87.	Chennai (M Corp.) WARD NO.-0154	13928	53855	27071	26784	5883	7685	127
88.	Chennai (M Corp.) WARD NO.-0155	20827	75748	37737	38011	6810	5371	85
Kancheepuram								
89.	Nandambakkam	3174	12560	6284	6276	1583	3187	9
90.	Manapakkam (CT)	3458	13344	6715	6629	1602	2999	56
91.	Manapakkam (CT) WARD NO.-0001	3458	13344	6715	6629	1602	2999	56
92.	Nandambakkam (TP)	2930	11239	5561	5678	1207	1780	41
93.	Nandambakkam (TP) WARD NO.-0001	243	962	487	475	105	100	26
94.	Nandambakkam (TP) WARD NO.-0002	146	515	257	258	44	35	0
95.	Nandambakkam (TP) WARD NO.-0003	225	855	422	433	104	86	0
96.	Nandambakkam (TP) WARD NO.-0004	214	774	373	401	87	110	0
97.	Nandambakkam (TP) WARD NO.-0005	196	737	361	376	78	71	0
98.	Nandambakkam (TP) WARD NO.-0006	84	356	140	216	24	24	0
99.	Nandambakkam (TP) WARD NO.-0008	211	779	385	394	44	12	0

100.	Nandambakkam (TP) WARD NO.-0009	197	725	356	369	80	59	0
101.	Nandambakkam (TP) WARD NO.-0010	275	1111	549	562	126	823	5
102.	Nandambakkam (TP) WARD NO.-0011	216	871	430	441	110	49	0
103.	Nandambakkam (TP) WARD NO.-0012	234	897	445	452	93	73	0
104.	Nandambakkam (TP) WARD NO.-0013	145	589	306	283	70	49	4
105.	Nandambakkam (TP) WARD NO.-0014	131	495	264	231	33	86	3
106.	Nandambakkam (TP) WARD NO.-0015	121	448	230	218	57	28	0
107.	Manapakkam	439	1687	839	848	178	804	13
Thiruvallur								
108.	Tiruvottiyur (M)	63862	249446	125300	124146	26903	35332	502
109.	Tiruvottiyur (M) WARD NO.-0001	507	2038	1015	1023	168	456	4
110.	Tiruvottiyur (M) WARD NO.-0002	823	3268	1645	1623	356	405	5
111.	Tiruvottiyur (M) WARD NO.-0003	1489	5793	2931	2862	649	2231	0
112.	Tiruvottiyur (M) WARD NO.-0004	2806	10783	5343	5440	1309	2176	3
113.	Tiruvottiyur (M) WARD NO.-0005	1149	4466	2232	2234	497	363	0
114.	Tiruvottiyur (M) WARD NO.-0006	829	3486	1806	1680	380	1508	0
115.	Tiruvottiyur (M) WARD NO.-0007	1310	5194	2620	2574	584	552	0
116.	Tiruvottiyur (M) WARD NO.-0008	718	2777	1349	1428	277	1098	1
117.	Tiruvottiyur (M) WARD NO.-0009	1394	5302	2719	2583	542	433	0
118.	Tiruvottiyur (M) WARD NO.-0010	2477	9587	4811	4776	943	2858	25
119.	Tiruvottiyur (M) WARD NO.-0011	1409	5606	2829	2777	555	286	4
120.	Tiruvottiyur (M) WARD NO.-0012	1078	4149	2037	2112	435	529	0
121.	Tiruvottiyur (M) WARD NO.-0013	961	3791	1866	1925	464	206	73
122.	Tiruvottiyur (M) WARD NO.-0014	1534	5964	2991	2973	656	359	36

123.	Tiruvottiyur (M) WARD NO.-0015	1000	3856	1936	1920	415	118	0
124.	Tiruvottiyur (M) WARD NO.-0016	1313	5039	2514	2525	536	855	16
125.	Tiruvottiyur (M) WARD NO.-0017	1525	5786	2883	2903	554	970	5
126.	Tiruvottiyur (M) WARD NO.-0018	1163	4384	2209	2175	454	272	8
127.	Tiruvottiyur (M) WARD NO.-0019	1232	4663	2388	2275	463	109	0
128.	Tiruvottiyur (M) WARD NO.-0020	1346	5428	2748	2680	537	455	6
129.	Tiruvottiyur (M) WARD NO.-0021	1486	5826	2884	2942	574	175	8
130.	Tiruvottiyur (M) WARD NO.-0022	959	3699	1875	1824	392	151	2
131.	Tiruvottiyur (M) WARD NO.-0023	902	3420	1691	1729	341	246	0
132.	Tiruvottiyur (M) WARD NO.-0024	729	3038	1515	1523	329	1169	0
133.	Tiruvottiyur (M) WARD NO.-0025	1161	4859	2432	2427	545	1281	0
134.	Tiruvottiyur (M) WARD NO.-0026	797	3070	1548	1522	376	1071	0
135.	Tiruvottiyur (M) WARD NO.-0027	1179	4519	2223	2296	568	453	0
136.	Tiruvottiyur (M) WARD NO.-0028	807	3239	1615	1624	336	572	0
137.	Tiruvottiyur (M) WARD NO.-0029	1172	4885	2454	2431	575	715	0
138.	Tiruvottiyur (M) WARD NO.-0030	1037	4219	2028	2191	453	1649	0
139.	Tiruvottiyur (M) WARD NO.-0031	1084	4256	2157	2099	415	291	0
140.	Tiruvottiyur (M) WARD NO.-0032	1326	5184	2574	2610	510	214	3
141.	Tiruvottiyur (M) WARD NO.-0033	988	3794	1922	1872	328	71	0
142.	Tiruvottiyur (M) WARD NO.-0034	2081	8133	4114	4019	795	392	17
143.	Tiruvottiyur (M) WARD NO.-0035	865	3250	1615	1635	357	234	13
144.	Tiruvottiyur (M) WARD NO.-0036	1409	5528	2787	2741	559	380	0
145.	Tiruvottiyur (M) WARD NO.-0037	1226	4792	2404	2388	493	720	20
146.	Tiruvottiyur (M) WARD NO.-0038	907	3688	1833	1855	382	857	0

147.	Tiruvottiyur (M) WARD NO.-0039	1144	4514	2281	2233	495	1019	2
148.	Tiruvottiyur (M) WARD NO.-0040	589	2348	1168	1180	275	275	212
149.	Tiruvottiyur (M) WARD NO.-0041	2884	11357	5798	5559	1335	881	12
150.	Tiruvottiyur (M) WARD NO.-0042	1811	7091	3594	3497	741	342	0
151.	Tiruvottiyur (M) WARD NO.-0043	3606	14047	7100	6947	1625	1207	4
152.	Tiruvottiyur (M) WARD NO.-0044	1481	5862	2929	2933	768	497	4
153.	Tiruvottiyur (M) WARD NO.-0045	1309	4901	2450	2451	549	459	2
154.	Tiruvottiyur (M) WARD NO.-0046	1023	3856	1941	1915	423	487	0
155.	Tiruvottiyur (M) WARD NO.-0047	2016	7691	3895	3796	821	2295	3
156.	Tiruvottiyur (M) WARD NO.-0048	1821	7020	3601	3419	769	990	14
157.	Madavaram (M)	29792	119105	59887	59218	13030	14764	333
158.	Madavaram (M) WARD NO.-0001	1081	4369	2257	2112	467	345	11
159.	Madavaram (M) WARD NO.-0002	1156	4787	2473	2314	558	361	0
160.	Madavaram (M) WARD NO.-0003	862	3501	1764	1737	309	266	16
161.	Madavaram (M) WARD NO.-0004	304	1287	648	639	108	186	0
162.	Madavaram (M) WARD NO.-0005	650	2603	1302	1301	269	1283	0
163.	Madavaram (M) WARD NO.-0006	428	1748	863	885	182	376	0
164.	Madavaram (M) WARD NO.-0007	1066	4337	2183	2154	595	1134	0
165.	Madavaram (M) WARD NO.-0008	1070	4193	2110	2083	447	244	9
166.	Madavaram (M) WARD NO.-0009	710	2789	1361	1428	285	54	12
167.	Madavaram (M) WARD NO.-0010	1019	4015	2042	1973	422	128	4
168.	Madavaram (M) WARD NO.-0011	1128	4425	2251	2174	464	291	9
169.	Madavaram (M) WARD NO.-0012	405	1631	776	855	193	932	0
170.	Madavaram (M) WARD NO.-0013	698	2831	1374	1457	309	976	1

171.	Madavaram (M) WARD NO.-0014	933	3598	1849	1749	321	211	0
172.	Madavaram (M) WARD NO.-0015	626	2500	1223	1277	270	31	0
173.	Madavaram (M) WARD NO.-0016	638	2593	1294	1299	276	240	1
174.	Madavaram (M) WARD NO.-0017	407	1715	852	863	181	1409	0
175.	Madavaram (M) WARD NO.-0018	1000	4018	1931	2087	370	346	0
176.	Madavaram (M) WARD NO.-0019	475	2012	1014	998	232	1120	0
177.	Madavaram (M) WARD NO.-0020	480	1975	992	983	222	487	3
178.	Madavaram (M) WARD NO.-0021	1376	5526	2751	2775	588	631	13
179.	Madavaram (M) WARD NO.-0022	891	3547	1804	1743	427	193	4
180.	Madavaram (M) WARD NO.-0023	2968	11948	6058	5890	1340	496	67
181.	Madavaram (M) WARD NO.-0024	2316	9318	4746	4572	1052	382	39
182.	Madavaram (M) WARD NO.-0025	1134	4353	2153	2200	490	352	9
183.	Madavaram (M) WARD NO.-0026	1556	5995	3035	2960	634	287	71
184.	Madavaram (M) WARD NO.-0027	981	3855	1940	1915	467	910	5
185.	Madavaram (M) WARD NO.-0028	635	2455	1247	1208	296	64	4
186.	Madavaram (M) WARD NO.-0029	2045	8097	4070	4027	921	259	45
187.	Madavaram (M) WARD NO.-0030	754	3084	1524	1560	335	770	10
188.	Chinnasekkadu (TP)	3238	12396	6365	6031	1472	3665	13
189.	Chinnasekkadu (TP) WARD NO.-0001	189	769	400	369	88	197	0
190.	Chinnasekkadu (TP) WARD NO.-0002	116	437	219	218	58	214	0
191.	Chinnasekkadu (TP) WARD NO.-0003	190	722	361	361	75	221	4
192.	Chinnasekkadu (TP) WARD NO.-0004	127	479	242	237	54	85	0
193.	Chinnasekkadu (TP) WARD NO.-0005	354	1266	693	573	135	569	0
194.	Chinnasekkadu (TP) WARD NO.-0006	245	934	483	451	101	532	1

195.	Chinnasekkadu (TP) WARD NO.-0007	302	1158	575	583	146	374	4
196.	Chinnasekkadu (TP) WARD NO.-0008	160	619	321	298	75	117	0
197.	Chinnasekkadu (TP) WARD NO.-0009	435	1738	904	834	208	441	4
198.	Chinnasekkadu (TP) WARD NO.-0010	240	951	493	458	118	103	0
199.	Chinnasekkadu (TP) WARD NO.-0011	208	783	400	383	81	76	0
200.	Chinnasekkadu (TP) WARD NO.-0012	132	458	218	240	55	73	0
201.	Chinnasekkadu (TP) WARD NO.-0013	221	836	424	412	129	65	0
202.	Chinnasekkadu (TP) WARD NO.-0014	203	792	410	382	93	333	0
203.	Chinnasekkadu (TP) WARD NO.-0015	116	454	222	232	56	265	0
Total		1027035	4044373	2030648	2013725	411822	637949	9637

3.12.8 Employment and livelihood

Economic vibrancy in area is shown by the type and nature of the occupation available in the area. Of the total working population, the majority is the main workers i.e they have steady job more than six months per annum. It is due to the industrialization in the area. The job opportunity is due to the development of Industrial and Service sectors. **Table 3-34** shows the classification of workers within the study area.

Table 3-34 Classification of workers within study area

Sl. No	Name	Total Workers	Main Workers	Marginal Workers	Agriculture Workers				Household Industry Workers		Other Workers	
					Cultivators		Agri. Labourers		Main	Marginal	Main	Marginal
					Main	Marginal	Main	Marginal				
0-5 Km												
Chennai												
1.	Chennai (M Corp.) WARD NO.-0018	5828	5599	229	6	6	15	2	79	13	5499	208
2.	Chennai (M Corp.) WARD NO.-0019	5878	5403	475	21	6	27	6	82	17	5273	446
3.	Chennai (M Corp.) WARD NO.-0022	9881	7803	2078	54	35	32	20	184	123	7533	1900
4.	Chennai (M Corp.) WARD NO.-0023	6862	6148	714	61	29	15	4	129	24	5943	657
5.	Chennai (M Corp.) WARD NO.-0024	7185	6566	619	21	19	58	16	575	28	5912	556
6.	Chennai (M Corp.) WARD NO.-0025	6965	6118	847	31	11	42	21	174	51	5871	764
7.	Chennai (M Corp.)	7574	6761	813	35	15	27	7	84	18	6615	773

	WARD NO.-0026											
8.	Chennai (M Corp.) WARD NO.-0027	9677	8140	1537	40	3	43	6	104	45	7953	1483
9.	Chennai (M Corp.) WARD NO.-0028	10746	9626	1120	41	15	39	5	105	25	9441	1075
10.	Chennai (M Corp.) WARD NO.-0029	6854	5864	990	29	23	44	39	134	98	5657	830
11.	Chennai (M Corp.) WARD NO.-0030	8652	7982	670	70	20	41	7	114	10	7757	633
12.	Chennai (M Corp.) WARD NO.-0031	11755	10052	1703	204	35	64	25	136	152	9648	1491
13.	Chennai (M Corp.) WARD NO.-0041	7821	6731	1090	11	11	32	3	156	45	6532	1031
14.	Chennai (M Corp.) WARD NO.-0042	11262	10024	1238	26	18	361	241	1144	129	8493	850
15.	Chennai (M Corp.) WARD NO.-0043	6233	4782	1451	14	7	33	14	121	61	4614	1369
16.	Chennai (M Corp.) WARD NO.-0044	5086	4356	730	3	4	10	7	68	16	4275	703
17.	Chennai (M Corp.) WARD NO.-0045	6819	6126	693	28	6	41	6	89	15	5968	666
18.	Chennai (M Corp.) WARD NO.-0046	4603	4036	567	13	3	25	3	61	32	3937	529
19.	Chennai (M Corp.) WARD NO.-0047	4813	4439	374	12	4	18	5	123	32	4286	333

20.	Chennai (M Corp.) WARD NO.-0048	6418	6042	376	23	7	35	4	206	79	5778	286
21.	Chennai (M Corp.) WARD NO.-0049	5487	4899	588	12	4	21	3	96	33	4770	548
22.	Chennai (M Corp.) WARD NO.-0070	10447	9510	937	31	17	41	11	131	22	9307	887
23.	Chennai (M Corp.) WARD NO.-0071	4646	4231	415	13	7	10	0	68	9	4140	399
24.	Chennai (M Corp.) WARD NO.-0072	12493	10888	1605	47	9	86	10	236	73	10519	1513
25.	Chennai (M Corp.) WARD NO.-0078	8919	8139	780	35	18	56	7	126	7	7922	748
26.	Chennai (M Corp.) WARD NO.-0079	7466	6364	1102	61	13	83	17	122	24	6098	1048
27.	Chennai (M Corp.) WARD NO.-0080	8589	7210	1379	28	10	69	24	92	14	7021	1331
28.	Chennai (M Corp.) WARD NO.-0081	6375	5898	477	35	17	64	8	96	7	5703	445
29.	Chennai (M Corp.) WARD NO.-0082	6622	6202	420	38	12	145	6	53	8	5966	394
30.	Chennai (M Corp.) WARD NO.-0083	7140	6384	756	47	6	55	6	132	22	6150	722
31.	Chennai (M Corp.) WARD NO.-0084	7116	6713	403	103	11	124	11	146	8	6340	373
32.	Chennai (M Corp.)	5117	4274	843	44	7	18	29	94	58	4118	749

	WARD NO.-0085											
33.	Chennai (M Corp.) WARD NO.-0086	7533	5818	1715	71	263	53	15	40	26	5654	1411
34.	Chennai (M Corp.) WARD NO.-0087	5488	4753	735	42	6	61	18	123	46	4527	665
35.	Chennai (M Corp.) WARD NO.-0088	8232	7808	424	33	11	89	10	175	8	7511	395
36.	Chennai (M Corp.) WARD NO.-0089	6331	5642	689	30	6	29	7	89	16	5494	660
37.	Chennai (M Corp.) WARD NO.-0090	6475	5975	500	17	16	149	7	123	38	5686	439
38.	Chennai (M Corp.) WARD NO.-0091	8655	6777	1878	23	11	57	17	123	91	6574	1759
39.	Chennai (M Corp.) WARD NO.-0092	7046	5983	1063	66	10	31	9	123	53	5763	991
40.	Chennai (M Corp.) WARD NO.-0093	6205	5739	466	57	7	39	20	81	12	5562	427
41.	Chennai (M Corp.) WARD NO.-0094	8551	7585	966	39	7	31	10	106	34	7409	915
42.	Chennai (M Corp.) WARD NO.-0095	4833	4303	530	33	3	36	7	56	20	4178	500
43.	Chennai (M Corp.) WARD NO.-0096	5198	4842	356	21	7	42	7	67	7	4712	335
44.	Chennai (M Corp.) WARD NO.-0100	3621	3351	270	12	11	21	11	43	11	3275	237

45.	Chennai (M Corp.) WARD NO.-0101	4902	4604	298	6	5	32	4	60	7	4506	282
46.	Chennai (M Corp.) WARD NO.-0102	3707	3252	455	14	16	22	7	46	3	3170	429
47.	Chennai (M Corp.) WARD NO.-0103	6356	5779	577	21	10	25	14	76	9	5657	544
48.	Chennai (M Corp.) WARD NO.-0104	8874	7488	1386	56	9	34	4	103	24	7295	1349
49.	Chennai (M Corp.) WARD NO.-0105	7790	5778	2012	43	19	104	91	152	45	5479	1857
50.	Chennai (M Corp.) WARD NO.-0106	8085	6492	1593	14	11	44	12	131	44	6303	1526
51.	Chennai (M Corp.) WARD NO.-0107	9876	8785	1091	66	25	57	7	175	36	8487	1023
52.	Chennai (M Corp.) WARD NO.-0108	8764	7708	1056	31	6	29	14	72	26	7576	1010
53.	Chennai (M Corp.) WARD NO.-0109	8166	6426	1740	54	23	38	27	120	54	6214	1636
54.	Chennai (M Corp.) WARD NO.-0110	6065	5630	435	17	13	27	4	56	7	5530	411
55.	Chennai (M Corp.) WARD NO.-0111	7429	6026	1403	28	37	63	16	191	111	5744	1239
56.	Chennai (M Corp.) WARD NO.-0112	6440	5423	1017	58	111	49	18	113	26	5203	862
57.	Chennai (M Corp.)	7548	6897	651	78	9	119	10	140	24	6560	608

	WARD NO.-0113											
58.	Chennai (M Corp.) WARD NO.-0114	13648	11207	2441	512	130	86	33	147	87	10462	2191
59.	Chennai (M Corp.) WARD NO.-0115	10263	9097	1166	31	3	40	10	175	39	8851	1114
60.	Chennai (M Corp.) WARD NO.-0142	10571	9660	911	38	8	16	8	150	15	9456	880
61.	Chennai (M Corp.) WARD NO.-0143	8340	7438	902	59	11	31	19	81	49	7267	823
62.	Chennai (M Corp.) WARD NO.-0144	8516	7715	801	27	5	58	5	109	14	7521	777
63.	Chennai (M Corp.) WARD NO.-0145	9459	8249	1210	23	8	35	13	89	65	8102	1124
64.	Chennai (M Corp.) WARD NO.-0146	7179	6143	1036	16	19	32	5	79	203	6016	809
65.	Chennai (M Corp.) WARD NO.-0147	7153	6496	657	22	17	41	8	136	18	6297	614
66.	Chennai (M Corp.) WARD NO.-0148	6916	6297	619	21	21	37	25	51	8	6188	565
67.	Chennai (M Corp.) WARD NO.-0150	12810	11626	1184	42	25	45	16	115	49	11424	1094
5-10 km												
Chennai												
1.	Chennai (M Corp.) WARD NO.-0001	29282	25031	4251	94	53	167	63	402	280	24368	3855

2.	Chennai (M Corp.) WARD NO.-0002	25368	22226	3142	102	33	115	25	412	163	21597	2921
3.	Chennai (M Corp.) WARD NO.-0003	19429	18213	1216	117	34	60	15	309	39	17727	1128
4.	Chennai (M Corp.) WARD NO.-0004	5176	4851	325	7	11	11	3	69	13	4764	298
5.	Chennai (M Corp.) WARD NO.-0005	17155	14679	2476	45	23	76	17	382	29	14176	2407
6.	Chennai (M Corp.) WARD NO.-0006	7801	7053	748	29	6	48	8	52	28	6924	706
7.	Chennai (M Corp.) WARD NO.-0007	8876	7335	1541	39	11	73	13	177	111	7046	1406
8.	Chennai (M Corp.) WARD NO.-0008	13409	11645	1764	131	28	55	165	254	38	11205	1533
9.	Chennai (M Corp.) WARD NO.-0009	8347	7239	1108	22	3	24	3	279	52	6914	1050
10.	Chennai (M Corp.) WARD NO.-0010	16579	15135	1444	77	11 8	52	10	288	55	14718	1261
11.	Chennai (M Corp.) WARD NO.-0011	11716	10605	1111	153	24	49	6	150	21	10253	1060
12.	Chennai (M Corp.) WARD NO.-0012	6064	5551	513	7	3	14	2	82	20	5448	488
13.	Chennai (M Corp.) WARD NO.-0013	7722	6938	784	8	14	10	6	58	24	6862	740
14.	Chennai (M Corp.)	12802	11398	1404	23	10	56	9	171	76	11148	1309

	WARD NO.-0014											
15.	Chennai (M Corp.) WARD NO.-0015	7285	6855	430	27	4	40	7	134	23	6654	396
16.	Chennai (M Corp.) WARD NO.-0016	8508	7619	889	54	21	39	8	111	29	7415	831
17.	Chennai (M Corp.) WARD NO.-0017	9034	8036	998	77	13	39	6	131	24	7789	955
18.	Chennai (M Corp.) WARD NO.-0020	4935	4543	392	10	10	14	2	61	9	4458	371
19.	Chennai (M Corp.) WARD NO.-0021	6083	5484	599	12	3	29	2	124	17	5319	577
20.	Chennai (M Corp.) WARD NO.-0032	11915	10016	1899	217	12	47	17	114	56	9638	1814
21.	Chennai (M Corp.) WARD NO.-0033	15293	13736	1557	128	21	80	37	219	65	13309	1434
22.	Chennai (M Corp.) WARD NO.-0034	18785	17181	1604	52	23	213	69	614	69	16302	1443
23.	Chennai (M Corp.) WARD NO.-0035	14393	13048	1345	50	27	98	7	277	40	12623	1271
24.	Chennai (M Corp.) WARD NO.-0036	20053	16850	3203	338	60	143	35	272	91	16097	3017
25.	Chennai (M Corp.) WARD NO.-0037	10571	9187	1384	118	50	37	14	130	50	8902	1270
26.	Chennai (M Corp.) WARD NO.-0038	13282	10661	2621	32	19	67	54	163	92	10399	2456

27.	Chennai (M Corp.) WARD NO.-0039	11962	10466	1496	48	14 2	62	22	343	78	10013	1254
28.	Chennai (M Corp.) WARD NO.-0040	18250	15947	2303	194	37	111	137	576	106	15066	2023
29.	Chennai (M Corp.) WARD NO.-0048	6418	6042	376	23	7	35	4	206	79	5778	286
30.	Chennai (M Corp.) WARD NO.-0050	20039	17943	2096	230	41	116	112	274	87	17323	1856
31.	Chennai (M Corp.) WARD NO.-0051	16604	14967	1637	66	33	123	20	220	55	14558	1529
32.	Chennai (M Corp.) WARD NO.-0052	8748	7632	1116	68	9	52	4	122	54	7390	1049
33.	Chennai (M Corp.) WARD NO.-0053	9125	8327	798	38	23	69	7	104	21	8116	747
34.	Chennai (M Corp.) WARD NO.-0054	14949	13591	1358	27	16	49	9	299	25	13216	1308
35.	Chennai (M Corp.) WARD NO.-0055	8849	7760	1089	23	25	29	6	64	8	7644	1050
36.	Chennai (M Corp.) WARD NO.-0056	14455	13217	1238	102	23	80	15	197	34	12838	1166
37.	Chennai (M Corp.) WARD NO.-0057	8103	7430	673	76	13	40	12	97	15	7217	633
38.	Chennai (M Corp.) WARD NO.-0058	11336	10133	1203	63	11	82	17	139	19	9849	1156
39.	Chennai (M Corp.)	8830	8415	415	25	7	33	2	121	7	8236	399

	WARD NO.-0059											
40.	Chennai (M Corp.) WARD NO.-0060	11793	10641	1152	26	14	42	8	238	65	10335	1065
41.	Chennai (M Corp.) WARD NO.-0061	6540	5658	882	24	16	38	36	51	47	5545	783
42.	Chennai (M Corp.) WARD NO.-0062	42020	37535	4485	158	72	192	68	650	223	36535	4122
43.	Chennai (M Corp.) WARD NO.-0063	31840	28463	3377	70	37	136	194	363	92	27894	3054
44.	Chennai (M Corp.) WARD NO.-0064	29198	26704	2494	87	42	125	29	295	82	26197	2341
45.	Chennai (M Corp.) WARD NO.-0065	37187	33975	3212	116	43	218	56	490	106	33151	3007
46.	Chennai (M Corp.) WARD NO.-0066	20559	17995	2564	157	27	85	26	226	59	17527	2452
47.	Chennai (M Corp.) WARD NO.-0067	15333	13532	1801	48	12	74	33	249	99	13161	1657
48.	Chennai (M Corp.) WARD NO.-0068	12782	11561	1221	105	13	94	14	150	56	11212	1138
49.	Chennai (M Corp.) WARD NO.-0069	10950	9660	1290	141	21	53	35	102	94	9364	1140
50.	Chennai (M Corp.) WARD NO.-0073	9245	8514	731	25	7	57	8	86	13	8346	703
51.	Chennai (M Corp.) WARD NO.-0074	22156	19714	2442	180	40	119	31	237	58	19178	2313

52.	Chennai (M Corp.) WARD NO.-0075	23633	20230	3403	101	55	276	128	322	221	19531	2999
53.	Chennai (M Corp.) WARD NO.-0076	9775	9009	766	61	7	47	7	72	29	8829	723
54.	Chennai (M Corp.) WARD NO.-0077	9479	8669	810	37	22	49	10	122	31	8461	747
55.	Chennai (M Corp.) WARD NO.-0097	8365	7730	635	77	14	47	14	226	31	7380	576
56.	Chennai (M Corp.) WARD NO.-0098	6578	5645	933	7	13	9	30	124	83	5505	807
57.	Chennai (M Corp.) WARD NO.-0099	6016	5375	641	6	11	21	4	72	161	5276	465
58.	Chennai (M Corp.) WARD NO.-0116	10185	8067	2118	45	44	197	14	155	38	7670	2022
59.	Chennai (M Corp.) WARD NO.-0117	14946	13056	1890	178	77	130	35	367	106	12381	1672
60.	Chennai (M Corp.) WARD NO.-0118	13315	12006	1309	37	12	57	14	126	23	11786	1260
61.	Chennai (M Corp.) WARD NO.-0119	9455	8680	775	22	10	21	11	98	25	8539	729
62.	Chennai (M Corp.) WARD NO.-0120	11945	10554	1391	85	26	77	16	165	71	10227	1278
63.	Chennai (M Corp.) WARD NO.-0121	10550	9371	1179	51	15	55	19	196	56	9069	1089
64.	Chennai (M Corp.)	12481	11148	1333	62	99	56	15	114	27	10916	1192

	WARD NO.-0122											
65.	Chennai (M Corp.) WARD NO.-0123	9508	8971	537	44	17	70	16	128	26	8729	478
66.	Chennai (M Corp.) WARD NO.-0124	9570	7855	1715	56	15	63	12	130	56	7606	1632
67.	Chennai (M Corp.) WARD NO.-0125	8419	7604	815	31	9	67	9	79	22	7427	775
68.	Chennai (M Corp.) WARD NO.-0126	7555	6369	1186	92	37	35	21	109	36	6133	1092
69.	Chennai (M Corp.) WARD NO.-0127	11224	10283	941	58	26	46	9	286	129	9893	777
70.	Chennai (M Corp.) WARD NO.-0128	23711	20757	2954	201	17 7	101	35	336	133	20119	2609
71.	Chennai (M Corp.) WARD NO.-0129	24813	22269	2544	236	10 3	126	58	330	95	21577	2288
72.	Chennai (M Corp.) WARD NO.-0130	22407	20248	2159	33	17	70	12	247	34	19898	2096
73.	Chennai (M Corp.) WARD NO.-0131	22531	21101	1430	48	36	112	11	321	49	20620	1334
74.	Chennai (M Corp.) WARD NO.-0132	17162	16351	811	28	38	36	6	283	47	16004	720
75.	Chennai (M Corp.) WARD NO.-0133	10082	9689	393	11	9	19	0	128	44	9531	340
76.	Chennai (M Corp.) WARD NO.-0134	9216	8782	434	14	19	17	2	73	9	8678	404

77.	Chennai (M Corp.) WARD NO.-0135	19741	19126	615	33	23	63	4	321	20	18709	568
78.	Chennai (M Corp.) WARD NO.-0136	13162	12624	538	30	17	63	1	142	27	12389	493
79.	Chennai (M Corp.) WARD NO.-0137	8668	8323	345	15	8	14	3	124	17	8170	317
80.	Chennai (M Corp.) WARD NO.-0138	15142	14428	714	27	18	27	1	177	35	14197	660
81.	Chennai (M Corp.) WARD NO.-0139	12841	11978	863	27	15	29	6	120	11	11802	831
82.	Chennai (M Corp.) WARD NO.-0140	14061	13184	877	11	9	55	27	170	26	12948	815
83.	Chennai (M Corp.) WARD NO.-0141	19027	18243	784	65	11	46	8	168	24	17964	741
84.	Chennai (M Corp.) WARD NO.-0149	13277	11535	1742	106	39	83	16	317	271	11029	1416
85.	Chennai (M Corp.) WARD NO.-0151	14494	12818	1676	78	27	94	15	274	65	12372	1569
86.	Chennai (M Corp.) WARD NO.-0152	11003	9819	1184	27	22	52	9	206	30	9534	1123
87.	Chennai (M Corp.) WARD NO.-0154	23232	19504	3728	101	48	155	134	832	212	18416	3334
88.	Chennai (M Corp.) WARD NO.-0155	31531	28444	3087	230	10 8	230	43	665	72	27319	2864

Kancheepuram

89.	Nandambakkam	5105	4187	918	101	57	102	55	166	47	3818	759
90.	Manapakkam (CT)	5492	5148	344	23	3	30	16	98	17	4997	308
91.	Manapakkam (CT) WARD NO.-0001	5492	5148	344	23	3	30	16	98	17	4997	308
92.	Nandambakkam (TP)	4646	4109	537	8	2	41	8	49	11	4011	516
93.	Nandambakkam (TP) WARD NO.- 0001	414	332	82	0	0	2	2	18	1	312	79
94.	Nandambakkam (TP) WARD NO.- 0002	195	118	77	0	0	0	1	2	2	116	74
95.	Nandambakkam (TP) WARD NO.- 0003	333	296	37	2	0	9	1	3	0	282	36
96.	Nandambakkam (TP) WARD NO.- 0004	339	320	19	0	1	0	1	0	0	320	17
97.	Nandambakkam (TP) WARD NO.- 0005	286	266	20	0	0	7	0	0	0	259	20
98.	Nandambakkam (TP) WARD NO.- 0006	167	143	24	0	0	0	1	3	0	140	23
99.	Nandambakkam	316	280	36	1	1	16	0	2	0	261	35

	(TP) WARD NO.- 0008											
100.	Nandambakkam (TP) WARD NO.- 0009	253	247	6	0	0	0	0	9	0	238	6
101.	Nandambakkam (TP) WARD NO.- 0010	403	395	8	0	0	4	0	2	0	389	8
102.	Nandambakkam (TP) WARD NO.- 0011	440	304	136	4	0	0	0	1	0	299	136
103.	Nandambakkam (TP) WARD NO.- 0012	345	338	7	0	0	0	0	9	0	329	7
104.	Nandambakkam (TP) WARD NO.- 0013	260	252	8	1	0	1	1	0	1	250	6
105.	Nandambakkam (TP) WARD NO.- 0014	212	187	25	0	0	0	1	0	3	187	21
106.	Nandambakkam (TP) WARD NO.- 0015	183	166	17	0	0	0	0	0	0	166	17
107.	Manapakkam	772	359	413	58	13	137	319	19	8	145	73

Thiruvallur

108.	Tiruvottiyur (M)	94000	81050	12950	451	163	509	136	1568	612	78522	12039
109.	Tiruvottiyur (M) WARD NO.-0001	801	586	215	2	1	2	1	3	1	579	212
110.	Tiruvottiyur (M) WARD NO.-0002	1103	935	168	0	2	10	0	14	4	911	162
111.	Tiruvottiyur (M) WARD NO.-0003	2209	1828	381	6	14	3	3	33	11	1786	353
112.	Tiruvottiyur (M) WARD NO.-0004	4137	3110	1027	2	2	3	3	53	47	3052	975
113.	Tiruvottiyur (M) WARD NO.-0005	1718	1406	312	8	9	8	2	21	14	1369	287
114.	Tiruvottiyur (M) WARD NO.-0006	1227	1077	150	8	7	10	4	19	2	1040	137
115.	Tiruvottiyur (M) WARD NO.-0007	2008	1888	120	5	0	6	0	29	0	1848	120
116.	Tiruvottiyur (M) WARD NO.-0008	1014	789	225	4	3	4	0	5	0	776	222
117.	Tiruvottiyur (M) WARD NO.-0009	1931	1714	217	1	2	8	1	15	11	1690	203
118.	Tiruvottiyur (M) WARD NO.-0010	3674	3094	580	12	9	41	9	31	15	3010	547
119.	Tiruvottiyur (M) WARD NO.-0011	1949	1802	147	6	2	8	0	17	4	1771	141
120.	Tiruvottiyur (M) WARD NO.-0012	1486	1172	314	3	2	2	0	15	3	1152	309

121.	Tiruvottiyur (M) WARD NO.-0013	1507	1332	175	9	5	6	1	15	10	1302	159
122.	Tiruvottiyur (M) WARD NO.-0014	2223	2035	188	9	3	5	0	34	8	1987	177
123.	Tiruvottiyur (M) WARD NO.-0015	1443	1349	94	4	0	8	2	22	0	1315	92
124.	Tiruvottiyur (M) WARD NO.-0016	1891	1694	197	1	0	11	0	6	2	1676	195
125.	Tiruvottiyur (M) WARD NO.-0017	2022	1728	294	0	1	4	2	41	16	1683	275
126.	Tiruvottiyur (M) WARD NO.-0018	1696	1282	414	5	10	19	8	11	22	1247	374
127.	Tiruvottiyur (M) WARD NO.-0019	1887	1836	51	3	2	9	0	42	3	1782	46
128.	Tiruvottiyur (M) WARD NO.-0020	2127	1635	492	8	2	53	9	28	13	1546	468
129.	Tiruvottiyur (M) WARD NO.-0021	2066	1956	110	16	0	5	4	14	2	1921	104
130.	Tiruvottiyur (M) WARD NO.-0022	1436	1271	165	0	1	6	1	14	1	1251	162
131.	Tiruvottiyur (M) WARD NO.-0023	1234	1106	128	2	0	5	1	31	13	1068	114
132.	Tiruvottiyur (M) WARD NO.-0024	1173	1130	43	0	0	3	0	5	0	1122	43
133.	Tiruvottiyur (M)	1624	1495	129	4	5	16	6	28	12	1447	106

	WARD NO.-0025											
134.	Tiruvottiyur (M) WARD NO.-0026	1101	1071	30	0	0	1	0	117	2	953	28
135.	Tiruvottiyur (M) WARD NO.-0027	1962	1575	387	24	2	0	0	11	3	1540	382
136.	Tiruvottiyur (M) WARD NO.-0028	1214	1077	137	0	0	1	0	9	6	1067	131
137.	Tiruvottiyur (M) WARD NO.-0029	1994	1778	216	2	2	7	2	43	104	1726	108
138.	Tiruvottiyur (M) WARD NO.-0030	1550	1156	394	3	1	8	2	31	22	1114	369
139.	Tiruvottiyur (M) WARD NO.-0031	1558	1486	72	6	3	40	2	29	6	1411	61
140.	Tiruvottiyur (M) WARD NO.-0032	1993	1713	280	8	1	15	1	51	12	1639	266
141.	Tiruvottiyur (M) WARD NO.-0033	1384	1219	165	5	1	4	0	17	5	1193	159
142.	Tiruvottiyur (M) WARD NO.-0034	3058	2649	409	8	4	4	0	32	6	2605	399
143.	Tiruvottiyur (M) WARD NO.-0035	1160	1106	54	1	2	8	1	6	0	1091	51
144.	Tiruvottiyur (M) WARD NO.-0036	1998	1930	68	2	2	11	3	63	3	1854	60
145.	Tiruvottiyur (M) WARD NO.-0037	1711	1613	98	3	1	6	0	35	4	1569	93

146.	Tiruvottiyur (M) WARD NO.-0038	1276	1130	146	3	0	4	2	16	0	1107	144
147.	Tiruvottiyur (M) WARD NO.-0039	2109	1350	759	163	4	12	14	19	16	1156	725
148.	Tiruvottiyur (M) WARD NO.-0040	943	698	245	1	0	8	2	29	2	660	241
149.	Tiruvottiyur (M) WARD NO.-0041	4331	3841	490	20	8	28	15	135	21	3658	446
150.	Tiruvottiyur (M) WARD NO.-0042	2661	2301	360	43	15	29	5	69	3	2160	337
151.	Tiruvottiyur (M) WARD NO.-0043	5637	4332	1305	14	13	22	22	113	140	4183	1130
152.	Tiruvottiyur (M) WARD NO.-0044	2009	1820	189	7	10	2	0	14	6	1797	173
153.	Tiruvottiyur (M) WARD NO.-0045	1885	1750	135	3	1	8	1	8	14	1731	119
154.	Tiruvottiyur (M) WARD NO.-0046	1458	1311	147	6	2	9	2	17	8	1279	135
155.	Tiruvottiyur (M) WARD NO.-0047	2784	2416	368	1	6	11	1	22	8	2382	353
156.	Tiruvottiyur (M) WARD NO.-0048	2638	2478	160	10	3	16	4	136	7	2316	146
157.	Madavaram (M)	43385	38017	5368	148	89	233	65	765	283	36871	4931
158.	Madavaram (M) WARD NO.-0001	1700	1318	382	31	5	31	4	56	63	1200	310

159.	Madavaram (M) WARD NO.-0002	1553	1488	65	4	1	3	0	8	1	1473	63
160.	Madavaram (M) WARD NO.-0003	1256	1118	138	1	10	4	0	14	0	1099	128
161.	Madavaram (M) WARD NO.-0004	437	414	23	1	4	7	0	2	0	404	19
162.	Madavaram (M) WARD NO.-0005	920	794	126	2	1	5	2	4	4	783	119
163.	Madavaram (M) WARD NO.-0006	617	597	20	1	2	2	1	22	1	572	16
164.	Madavaram (M) WARD NO.-0007	1495	1255	240	6	1	8	1	8	1	1233	237
165.	Madavaram (M) WARD NO.-0008	1559	1417	142	7	0	33	2	13	8	1364	132
166.	Madavaram (M) WARD NO.-0009	1044	912	132	10	2	17	1	15	1	870	128
167.	Madavaram (M) WARD NO.-0010	1611	1349	262	15	3	8	1	55	5	1271	253
168.	Madavaram (M) WARD NO.-0011	1575	1426	149	9	3	8	1	8	0	1401	145
169.	Madavaram (M) WARD NO.-0012	594	528	66	1	0	1	0	5	2	521	64
170.	Madavaram (M) WARD NO.-0013	1217	818	399	4	2	17	12	13	6	784	379
171.	Madavaram (M)	1232	1136	96	1	3	4	1	43	18	1088	74

	WARD NO.-0014											
172.	Madavaram (M) WARD NO.-0015	919	546	373	5	9	1	0	10	12	530	352
173.	Madavaram (M) WARD NO.-0016	973	787	186	0	3	2	0	6	3	779	180
174.	Madavaram (M) WARD NO.-0017	637	458	179	3	0	2	1	9	3	444	175
175.	Madavaram (M) WARD NO.-0018	1629	1449	180	6	5	10	1	17	4	1416	170
176.	Madavaram (M) WARD NO.-0019	857	791	66	1	0	2	1	37	3	751	62
177.	Madavaram (M) WARD NO.-0020	771	659	112	5	0	3	0	19	4	632	108
178.	Madavaram (M) WARD NO.-0021	2093	1738	355	2	6	4	5	27	70	1705	274
179.	Madavaram (M) WARD NO.-0022	1249	1143	106	3	1	4	2	11	4	1125	99
180.	Madavaram (M) WARD NO.-0023	4408	4038	370	9	6	13	5	43	11	3973	348
181.	Madavaram (M) WARD NO.-0024	3293	3048	245	5	1	9	0	57	18	2977	226
182.	Madavaram (M) WARD NO.-0025	1512	1400	112	0	1	4	1	49	19	1347	91
183.	Madavaram (M) WARD NO.-0026	2072	1874	198	1	1	7	3	49	3	1817	191

184.	Madavaram (M) WARD NO.-0027	1343	1100	243	5	5	11	16	45	3	1039	219
185.	Madavaram (M) WARD NO.-0028	774	733	41	0	12	0	1	4	0	729	28
186.	Madavaram (M) WARD NO.-0029	2887	2796	91	10	2	7	0	61	5	2718	84
187.	Madavaram (M) WARD NO.-0030	1158	887	271	0	0	6	3	55	11	826	257
188.	Chinnasekkadu (TP)	4490	3757	733	5	5	28	5	72	19	3652	704
189.	Chinnasekkadu (TP) WARD NO.- 0001	261	259	2	0	0	1	0	12	2	246	0
190.	Chinnasekkadu (TP) WARD NO.- 0002	185	174	11	0	0	0	0	15	1	159	10
191.	Chinnasekkadu (TP) WARD NO.- 0003	271	255	16	0	0	0	0	14	0	241	16
192.	Chinnasekkadu (TP) WARD NO.- 0004	191	177	14	0	0	0	0	0	0	177	14
193.	Chinnasekkadu (TP) WARD NO.- 0005	510	193	317	1	0	1	2	2	5	189	310

194.	Chinnasekkadu (TP) WARD NO.- 0006	355	160	195	0	2	0	0	5	3	155	190
195.	Chinnasekkadu (TP) WARD NO.- 0007	452	383	69	0	0	5	0	10	4	368	65
196.	Chinnasekkadu (TP) WARD NO.- 0008	176	172	4	0	0	4	1	0	0	168	3
197.	Chinnasekkadu (TP) WARD NO.- 0009	574	547	27	3	1	6	1	6	2	532	23
198.	Chinnasekkadu (TP) WARD NO.- 0010	352	341	11	0	0	3	0	0	1	338	10
199.	Chinnasekkadu (TP) WARD NO.- 0011	297	289	8	1	2	0	1	8	0	280	5
200.	Chinnasekkadu (TP) WARD NO.- 0012	166	147	19	0	0	8	0	0	0	139	19
201.	Chinnasekkadu (TP) WARD NO.- 0013	319	281	38	0	0	0	0	0	1	281	37
202.	Chinnasekkadu	246	245	1	0	0	0	0	0	0	245	1

	(TP) WARD NO.- 0014											
203.	Chinnasekkadu (TP) WARD NO.- 0015	135	134	1	0	0	0	0	0	0	134	1
Total		1565637	1395025	170612	7889	3212	8404	3117	24748	7423	1353984	156860

(Source: Census 2011)

3.12.9 Educational infrastructure within study area

The district has good primary and secondary education infrastructure in urban and rural areas. The people around the study area have well connected to educational infrastructures. **Table 3-35** shows the literates population.

Table 3-35 Details of Literacy population in the study area

Sl. No	Name	Literates Population Person	Literates Population Male	Literates Population Female	Illiterate Persons	Illiterate Male	Illiterate Female
0-5 Km							
1.	Chennai (M Corp.) WARD NO.-0018	13867	7115	6752	2557	1082	1475
2.	Chennai (M Corp.) WARD NO.-0019	11946	6368	5578	3511	1393	2118
3.	Chennai (M Corp.) WARD NO.-0022	20783	10793	9990	5394	2169	3225
4.	Chennai (M Corp.) WARD NO.-0023	15264	8214	7050	3170	1289	1881
5.	Chennai (M Corp.) WARD NO.-0024	17172	8835	8337	3830	1696	2134
6.	Chennai (M Corp.) WARD NO.-0025	15816	8124	7692	3445	1485	1960
7.	Chennai (M Corp.) WARD NO.-0026	16322	8700	7622	3917	1716	2201
8.	Chennai (M Corp.) WARD NO.-0027	18882	10425	8457	5544	2381	3163
9.	Chennai (M Corp.) WARD NO.-0028	20525	11314	9211	5631	2512	3119

10.	Chennai (M Corp.) WARD NO.-0029	16126	8778	7348	3289	1394	1895
11.	Chennai (M Corp.) WARD NO.-0030	20853	11779	9074	4433	1831	2602
12.	Chennai (M Corp.) WARD NO.-0031	24466	12794	11672	7686	3236	4450
13.	Chennai (M Corp.) WARD NO.-0041	16193	8609	7584	5357	2262	3095
14.	Chennai (M Corp.) WARD NO.-0042	20110	10639	9471	7747	3182	4565
15.	Chennai (M Corp.) WARD NO.-0043	12731	6880	5851	3104	1244	1860
16.	Chennai (M Corp.) WARD NO.-0044	10849	5969	4880	3442	1374	2068
17.	Chennai (M Corp.) WARD NO.-0045	12841	6917	5924	5030	1922	3108
18.	Chennai (M Corp.) WARD NO.-0046	10658	5561	5097	2089	862	1227
19.	Chennai (M Corp.) WARD NO.-0047	12057	6298	5759	2322	1072	1250
20.	Chennai (M Corp.) WARD NO.-0048	13981	7518	6463	4288	1867	2421
21.	Chennai (M Corp.) WARD NO.-0049	13401	7130	6271	3488	1547	1941
22.	Chennai (M Corp.) WARD	23403	11630	11773	2910	1276	1634

	NO.-0070						
23.	Chennai (M Corp.) WARD NO.-0071	10757	5405	5352	1334	583	751
24.	Chennai (M Corp.) WARD NO.-0072	25682	13690	11992	6764	2677	4087
25.	Chennai (M Corp.) WARD NO.-0078	20669	11147	9522	2807	1172	1635
26.	Chennai (M Corp.) WARD NO.-0079	15393	8003	7390	4355	1867	2488
27.	Chennai (M Corp.) WARD NO.-0080	14414	7970	6444	5904	2623	3281
28.	Chennai (M Corp.) WARD NO.-0081	14202	7282	6920	2921	1251	1670
29.	Chennai (M Corp.) WARD NO.-0082	13308	6937	6371	3030	1282	1748
30.	Chennai (M Corp.) WARD NO.-0083	15137	8331	6806	4003	1782	2221
31.	Chennai (M Corp.) WARD NO.-0084	15051	8312	6739	2774	1215	1559
32.	Chennai (M Corp.) WARD NO.-0085	9985	5367	4618	1319	566	753
33.	Chennai (M Corp.) WARD NO.-0086	13757	8422	5335	2428	1115	1313
34.	Chennai (M Corp.) WARD NO.-0087	11947	6245	5702	2428	1086	1342

35.	Chennai (M Corp.) WARD NO.-0088	18905	9917	8988	4713	1980	2733
36.	Chennai (M Corp.) WARD NO.-0089	14109	7212	6897	1905	836	1069
37.	Chennai (M Corp.) WARD NO.-0090	13165	6971	6194	4164	1666	2498
38.	Chennai (M Corp.) WARD NO.-0091	16234	8353	7881	6051	2559	3492
39.	Chennai (M Corp.) WARD NO.-0092	12977	6749	6228	3534	1484	2050
40.	Chennai (M Corp.) WARD NO.-0093	14043	7325	6718	3325	1345	1980
41.	Chennai (M Corp.) WARD NO.-0094	16882	8926	7956	5525	2359	3166
42.	Chennai (M Corp.) WARD NO.-0095	10275	5075	5200	1389	555	834
43.	Chennai (M Corp.) WARD NO.-0096	11196	5935	5261	1758	766	992
44.	Chennai (M Corp.) WARD NO.-0100	8065	4228	3837	1480	624	856
45.	Chennai (M Corp.) WARD NO.-0101	11115	5789	5326	1588	688	900
46.	Chennai (M Corp.) WARD NO.-0102	8132	4146	3986	1245	593	652
47.	Chennai (M Corp.) WARD	14078	7030	7048	2517	1081	1436

	NO.-0103						
48.	Chennai (M Corp.) WARD NO.-0104	17424	9020	8404	3473	1380	2093
49.	Chennai (M Corp.) WARD NO.-0105	14977	7714	7263	2988	1372	1616
50.	Chennai (M Corp.) WARD NO.-0106	16905	8301	8604	3118	1373	1745
51.	Chennai (M Corp.) WARD NO.-0107	18558	9654	8904	4344	1675	2669
52.	Chennai (M Corp.) WARD NO.-0108	17042	8622	8420	3000	1210	1790
53.	Chennai (M Corp.) WARD NO.-0109	15498	8055	7443	3048	1253	1795
54.	Chennai (M Corp.) WARD NO.-0110	11165	5801	5364	2702	1215	1487
55.	Chennai (M Corp.) WARD NO.-0111	15390	7857	7533	3090	1382	1708
56.	Chennai (M Corp.) WARD NO.-0112	12848	6548	6300	2064	896	1168
57.	Chennai (M Corp.) WARD NO.-0113	17032	8355	8677	2669	1125	1544
58.	Chennai (M Corp.) WARD NO.-0114	25742	13387	12355	7171	2811	4360
59.	Chennai (M Corp.) WARD NO.-0115	20115	10516	9599	4660	1878	2782

60.	Chennai (M Corp.) WARD NO.-0142	22907	11485	11422	3618	1467	2151
61.	Chennai (M Corp.) WARD NO.-0143	16486	8475	8011	3638	1445	2193
62.	Chennai (M Corp.) WARD NO.-0144	17604	8943	8661	3627	1504	2123
63.	Chennai (M Corp.) WARD NO.-0145	18942	9770	9172	5566	2363	3203
64.	Chennai (M Corp.) WARD NO.-0146	15162	7604	7558	2377	1035	1342
65.	Chennai (M Corp.) WARD NO.-0147	15774	8026	7748	2107	926	1181
66.	Chennai (M Corp.) WARD NO.-0148	15715	7937	7778	2199	932	1267
67.	Chennai (M Corp.) WARD NO.-0150	25106	12809	12297	6164	2564	3600
Total		1058116	554036	504080	243068	102353	140715
5-10 km							
Chennai							
1.	Chennai (M Corp.) WARD NO.-0001	63354	33027	30327	13406	5778	7628
2.	Chennai (M Corp.) WARD NO.-0002	54439	28397	26042	12458	5384	7074
3.	Chennai (M Corp.) WARD NO.-0003	40119	21270	18849	12876	5534	7342

4.	Chennai (M Corp.) WARD NO.-0004	11579	6047	5532	3607	1459	2148
5.	Chennai (M Corp.) WARD NO.-0005	34811	18268	16543	10393	4315	6078
6.	Chennai (M Corp.) WARD NO.-0006	15256	8003	7253	4267	1736	2531
7.	Chennai (M Corp.) WARD NO.-0007	17400	9022	8378	4761	2041	2720
8.	Chennai (M Corp.) WARD NO.-0008	24464	12769	11695	8575	3632	4943
9.	Chennai (M Corp.) WARD NO.-0009	16939	8780	8159	3367	1404	1963
10.	Chennai (M Corp.) WARD NO.-0010	30973	16459	14514	13774	5872	7902
11.	Chennai (M Corp.) WARD NO.-0011	22752	12306	10446	10535	4290	6245
12.	Chennai (M Corp.) WARD NO.-0012	12214	6315	5899	4040	1684	2356
13.	Chennai (M Corp.) WARD NO.-0013	15188	7928	7260	6641	2885	3756
14.	Chennai (M Corp.) WARD NO.-0014	24113	12637	11476	11017	4803	6214
15.	Chennai (M Corp.) WARD NO.-0015	16829	8770	8059	3123	1344	1779
16.	Chennai (M Corp.) WARD	19152	9909	9243	3795	1669	2126

	NO.-0016						
17.	Chennai (M Corp.) WARD NO.-0017	19494	10276	9218	5176	2261	2915
18.	Chennai (M Corp.) WARD NO.-0020	10850	5631	5219	2426	994	1432
19.	Chennai (M Corp.) WARD NO.-0021	11886	6206	5680	4158	1763	2395
20.	Chennai (M Corp.) WARD NO.-0032	23646	12368	11278	8623	3756	4867
21.	Chennai (M Corp.) WARD NO.-0033	32147	17005	15142	9470	3925	5545
22.	Chennai (M Corp.) WARD NO.-0034	40398	21064	19334	9161	3646	5515
23.	Chennai (M Corp.) WARD NO.-0035	32225	16931	15294	7850	3252	4598
24.	Chennai (M Corp.) WARD NO.-0036	40302	21057	19245	11960	5025	6935
25.	Chennai (M Corp.) WARD NO.-0037	23256	11720	11536	3235	1390	1845
26.	Chennai (M Corp.) WARD NO.-0038	28144	14550	13594	7043	2983	4060
27.	Chennai (M Corp.) WARD NO.-0039	23478	12385	11093	7095	3005	4090
28.	Chennai (M Corp.) WARD NO.-0040	36849	19610	17239	14630	6100	8530

29.	Chennai (M Corp.) WARD NO.-0048	13981	7518	6463	4288	1867	2421
30.	Chennai (M Corp.) WARD NO.-0050	44310	22610	21700	7217	3068	4149
31.	Chennai (M Corp.) WARD NO.-0051	37254	19232	18022	8996	3664	5332
32.	Chennai (M Corp.) WARD NO.-0052	19835	10191	9644	3398	1419	1979
33.	Chennai (M Corp.) WARD NO.-0053	20542	10343	10199	3289	1377	1912
34.	Chennai (M Corp.) WARD NO.-0054	33050	16793	16257	6008	2562	3446
35.	Chennai (M Corp.) WARD NO.-0055	18698	9543	9155	4522	1835	2687
36.	Chennai (M Corp.) WARD NO.-0056	32105	16397	15708	6018	2463	3555
37.	Chennai (M Corp.) WARD NO.-0057	18443	9394	9049	3362	1385	1977
38.	Chennai (M Corp.) WARD NO.-0058	23927	12242	11685	6650	2930	3720
39.	Chennai (M Corp.) WARD NO.-0059	18943	9822	9121	4652	1866	2786
40.	Chennai (M Corp.) WARD NO.-0060	22729	11825	10904	7092	2928	4164
41.	Chennai (M Corp.) WARD	14473	7587	6886	2848	1231	1617

	NO.-0061						
42.	Chennai (M Corp.) WARD NO.-0062	92248	47663	44585	18226	8026	10200
43.	Chennai (M Corp.) WARD NO.-0063	67830	35086	32744	13818	5846	7972
44.	Chennai (M Corp.) WARD NO.-0064	62046	31851	30195	10098	4767	5331
45.	Chennai (M Corp.) WARD NO.-0065	79480	41128	38352	16084	6936	9148
46.	Chennai (M Corp.) WARD NO.-0066	41197	21546	19651	9729	3671	6058
47.	Chennai (M Corp.) WARD NO.-0067	31023	15935	15088	6308	2628	3680
48.	Chennai (M Corp.) WARD NO.-0068	27353	14020	13333	5646	2313	3333
49.	Chennai (M Corp.) WARD NO.-0069	21503	11129	10374	5630	2219	3411
50.	Chennai (M Corp.) WARD NO.-0073	18986	9638	9348	3676	1561	2115
51.	Chennai (M Corp.) WARD NO.-0074	47220	24664	22556	9740	4135	5605
52.	Chennai (M Corp.) WARD NO.-0075	49442	25819	23623	10684	4607	6077
53.	Chennai (M Corp.) WARD NO.-0076	20384	10617	9767	4140	1738	2402

54.	Chennai (M Corp.) WARD NO.-0077	20434	10363	10071	3185	1404	1781
55.	Chennai (M Corp.) WARD NO.-0097	16724	8691	8033	4136	1725	2411
56.	Chennai (M Corp.) WARD NO.-0098	13662	7055	6607	3804	1560	2244
57.	Chennai (M Corp.) WARD NO.-0099	12724	6576	6148	2736	1089	1647
58.	Chennai (M Corp.) WARD NO.-0116	18817	9625	9192	4807	1944	2863
59.	Chennai (M Corp.) WARD NO.-0117	30201	15653	14548	5991	2631	3360
60.	Chennai (M Corp.) WARD NO.-0118	28586	14639	13947	5724	2439	3285
61.	Chennai (M Corp.) WARD NO.-0119	19431	9795	9636	4041	1641	2400
62.	Chennai (M Corp.) WARD NO.-0120	24143	12158	11985	4731	2086	2645
63.	Chennai (M Corp.) WARD NO.-0121	21856	11191	10665	4056	1705	2351
64.	Chennai (M Corp.) WARD NO.-0122	25376	12979	12397	4828	1942	2886
65.	Chennai (M Corp.) WARD NO.-0123	22453	11434	11019	3280	1404	1876
66.	Chennai (M Corp.) WARD	19619	10054	9565	3288	1340	1948

	NO.-0124						
67.	Chennai (M Corp.) WARD NO.-0125	18694	9333	9361	1722	746	976
68.	Chennai (M Corp.) WARD NO.-0126	15935	8649	7286	1783	732	1051
69.	Chennai (M Corp.) WARD NO.-0127	21118	11717	9401	3488	1380	2108
70.	Chennai (M Corp.) WARD NO.-0128	48872	24961	23911	9131	4026	5105
71.	Chennai (M Corp.) WARD NO.-0129	50121	26051	24070	9201	3886	5315
72.	Chennai (M Corp.) WARD NO.-0130	44119	23231	20888	11665	4951	6714
73.	Chennai (M Corp.) WARD NO.-0131	46607	24403	22204	11861	5006	6855
74.	Chennai (M Corp.) WARD NO.-0132	32959	17506	15453	8774	3520	5254
75.	Chennai (M Corp.) WARD NO.-0133	21870	11347	10523	3923	1638	2285
76.	Chennai (M Corp.) WARD NO.-0134	19256	10001	9255	3798	1598	2200
77.	Chennai (M Corp.) WARD NO.-0135	40338	21197	19141	9531	3971	5560
78.	Chennai (M Corp.) WARD NO.-0136	26406	14044	12362	6864	2827	4037

79.	Chennai (M Corp.) WARD NO.-0137	18738	9884	8854	3281	1386	1895
80.	Chennai (M Corp.) WARD NO.-0138	30451	15807	14644	7269	3085	4184
81.	Chennai (M Corp.) WARD NO.-0139	28581	15202	13379	6718	2812	3906
82.	Chennai (M Corp.) WARD NO.-0140	26003	14384	11619	7086	3366	3720
83.	Chennai (M Corp.) WARD NO.-0141	45729	26147	19582	8869	3727	5142
84.	Chennai (M Corp.) WARD NO.-0149	26625	13696	12929	5513	2197	3316
85.	Chennai (M Corp.) WARD NO.-0151	30144	15167	14977	4365	1946	2419
86.	Chennai (M Corp.) WARD NO.-0152	21819	11088	10731	3888	1604	2284
87.	Chennai (M Corp.) WARD NO.-0154	42254	22309	19945	11601	4762	6839
88.	Chennai (M Corp.) WARD NO.-0155	64181	32866	31315	11567	4871	6696
Kancheepuram							
89.	Nandambakkam	8892	4796	4096	3668	1488	2180
90.	Manapakkam (CT)	10623	5467	5156	2721	1248	1473
91.	Manapakkam (CT) WARD NO.-0001	10623	5467	5156	2721	1248	1473

92.	Nandambakkam (TP)	9223	4722	4501	2016	839	1177
93.	Nandambakkam (TP) WARD NO.-0001	749	405	344	213	82	131
94.	Nandambakkam (TP) WARD NO.-0002	433	220	213	82	37	45
95.	Nandambakkam (TP) WARD NO.-0003	666	343	323	189	79	110
96.	Nandambakkam (TP) WARD NO.-0004	682	329	353	92	44	48
97.	Nandambakkam (TP) WARD NO.-0005	626	317	309	111	44	67
98.	Nandambakkam (TP) WARD NO.-0006	297	123	174	59	17	42
99.	Nandambakkam (TP) WARD NO.-0008	721	358	363	58	27	31
100.	Nandambakkam (TP) WARD NO.-0009	629	317	312	96	39	57
101.	Nandambakkam (TP) WARD NO.-0010	851	455	396	260	94	166
102.	Nandambakkam (TP) WARD NO.-0011	733	368	365	138	62	76
103.	Nandambakkam (TP) WARD NO.-0012	794	395	399	103	50	53
104.	Nandambakkam (TP) WARD NO.-0013	478	263	215	111	43	68

105.	Nandambakkam (TP) WARD NO.-0014	452	241	211	43	23	20
106.	Nandambakkam (TP) WARD NO.-0015	371	189	182	77	41	36
107.	Manapakkam	1216	662	554	471	177	294
108.	Tiruvottiyur (M)	197146	103034	94112	52300	22266	30034
109.	Tiruvottiyur (M) WARD NO.-0001	1705	882	823	333	133	200
110.	Tiruvottiyur (M) WARD NO.-0002	2579	1380	1199	689	265	424
111.	Tiruvottiyur (M) WARD NO.-0003	4485	2406	2079	1308	525	783
112.	Tiruvottiyur (M) WARD NO.-0004	7518	3968	3550	3265	1375	1890
113.	Tiruvottiyur (M) WARD NO.-0005	3623	1886	1737	843	346	497
114.	Tiruvottiyur (M) WARD NO.-0006	2679	1474	1205	807	332	475
115.	Tiruvottiyur (M) WARD NO.-0007	4167	2178	1989	1027	442	585
116.	Tiruvottiyur (M) WARD NO.-0008	2261	1137	1124	516	212	304
117.	Tiruvottiyur (M) WARD NO.-0009	4578	2374	2204	724	345	379
118.	Tiruvottiyur (M) WARD NO.-	8000	4109	3891	1587	702	885

	0010						
119.	Tiruvottiyur (M) WARD NO.- 0011	4635	2409	2226	971	420	551
120.	Tiruvottiyur (M) WARD NO.- 0012	3254	1683	1571	895	354	541
121.	Tiruvottiyur (M) WARD NO.- 0013	2248	1160	1088	1543	706	837
122.	Tiruvottiyur (M) WARD NO.- 0014	4639	2405	2234	1325	586	739
123.	Tiruvottiyur (M) WARD NO.- 0015	3243	1671	1572	613	265	348
124.	Tiruvottiyur (M) WARD NO.- 0016	4086	2141	1945	953	373	580
125.	Tiruvottiyur (M) WARD NO.- 0017	4687	2415	2272	1099	468	631
126.	Tiruvottiyur (M) WARD NO.- 0018	3556	1838	1718	828	371	457
127.	Tiruvottiyur (M) WARD NO.- 0019	3913	2065	1848	750	323	427
128.	Tiruvottiyur (M) WARD NO.- 0020	4345	2263	2082	1083	485	598
129.	Tiruvottiyur (M) WARD NO.- 0021	4847	2469	2378	979	415	564
130.	Tiruvottiyur (M) WARD NO.- 0022	3181	1643	1538	518	232	286

131.	Tiruvottiyur (M) WARD NO.- 0023	2853	1466	1387	567	225	342
132.	Tiruvottiyur (M) WARD NO.- 0024	2027	1083	944	1011	432	579
133.	Tiruvottiyur (M) WARD NO.- 0025	3557	1908	1649	1302	524	778
134.	Tiruvottiyur (M) WARD NO.- 0026	2053	1099	954	1017	449	568
135.	Tiruvottiyur (M) WARD NO.- 0027	2915	1488	1427	1604	735	869
136.	Tiruvottiyur (M) WARD NO.- 0028	2618	1340	1278	621	275	346
137.	Tiruvottiyur (M) WARD NO.- 0029	3487	1860	1627	1398	594	804
138.	Tiruvottiyur (M) WARD NO.- 0030	3250	1629	1621	969	399	570
139.	Tiruvottiyur (M) WARD NO.- 0031	3619	1869	1750	637	288	349
140.	Tiruvottiyur (M) WARD NO.- 0032	4336	2227	2109	848	347	501
141.	Tiruvottiyur (M) WARD NO.- 0033	3218	1669	1549	576	253	323
142.	Tiruvottiyur (M) WARD NO.- 0034	6684	3514	3170	1449	600	849
143.	Tiruvottiyur (M) WARD NO.-	2617	1351	1266	633	264	369

	0035						
144.	Tiruvottiyur (M) WARD NO.- 0036	4519	2355	2164	1009	432	577
145.	Tiruvottiyur (M) WARD NO.- 0037	3918	2053	1865	874	351	523
146.	Tiruvottiyur (M) WARD NO.- 0038	3098	1577	1521	590	256	334
147.	Tiruvottiyur (M) WARD NO.- 0039	3808	1988	1820	706	293	413
148.	Tiruvottiyur (M) WARD NO.- 0040	1726	920	806	622	248	374
149.	Tiruvottiyur (M) WARD NO.- 0041	8706	4627	4079	2651	1171	1480
150.	Tiruvottiyur (M) WARD NO.- 0042	5520	2934	2586	1571	660	911
151.	Tiruvottiyur (M) WARD NO.- 0043	11163	5867	5296	2884	1233	1651
152.	Tiruvottiyur (M) WARD NO.- 0044	4400	2319	2081	1462	610	852
153.	Tiruvottiyur (M) WARD NO.- 0045	3895	2027	1868	1006	423	583
154.	Tiruvottiyur (M) WARD NO.- 0046	3129	1647	1482	727	294	433
155.	Tiruvottiyur (M) WARD NO.- 0047	6219	3300	2919	1472	595	877

156.	Tiruvottiyur (M) WARD NO.- 0048	5582	2961	2621	1438	640	798
157.	Madavaram (M)	96012	50348	45664	23093	9539	13554
158.	Madavaram (M) WARD NO.- 0001	3455	1865	1590	914	392	522
159.	Madavaram (M) WARD NO.- 0002	3615	1975	1640	1172	498	674
160.	Madavaram (M) WARD NO.- 0003	2968	1542	1426	533	222	311
161.	Madavaram (M) WARD NO.- 0004	1076	565	511	211	83	128
162.	Madavaram (M) WARD NO.- 0005	2058	1094	964	545	208	337
163.	Madavaram (M) WARD NO.- 0006	1421	738	683	327	125	202
164.	Madavaram (M) WARD NO.- 0007	3122	1675	1447	1215	508	707
165.	Madavaram (M) WARD NO.- 0008	3524	1842	1682	669	268	401
166.	Madavaram (M) WARD NO.- 0009	2141	1134	1007	648	227	421
167.	Madavaram (M) WARD NO.- 0010	3300	1732	1568	715	310	405
168.	Madavaram (M) WARD NO.- 0011	3552	1877	1675	873	374	499

169.	Madavaram (M) WARD NO.- 0012	1329	680	649	302	96	206
170.	Madavaram (M) WARD NO.- 0013	2130	1116	1014	701	258	443
171.	Madavaram (M) WARD NO.- 0014	3129	1636	1493	469	213	256
172.	Madavaram (M) WARD NO.- 0015	1953	1014	939	547	209	338
173.	Madavaram (M) WARD NO.- 0016	2205	1127	1078	388	167	221
174.	Madavaram (M) WARD NO.- 0017	1318	720	598	397	132	265
175.	Madavaram (M) WARD NO.- 0018	3499	1709	1790	519	222	297
176.	Madavaram (M) WARD NO.- 0019	1468	798	670	544	216	328
177.	Madavaram (M) WARD NO.- 0020	1584	829	755	391	163	228
178.	Madavaram (M) WARD NO.- 0021	4645	2354	2291	881	397	484
179.	Madavaram (M) WARD NO.- 0022	2775	1499	1276	772	305	467
180.	Madavaram (M) WARD NO.- 0023	9906	5178	4728	2042	880	1162
181.	Madavaram (M) WARD NO.-	7588	4017	3571	1730	729	1001

	0024						
182.	Madavaram (M) WARD NO.- 0025	3561	1832	1729	792	321	471
183.	Madavaram (M) WARD NO.- 0026	4951	2563	2388	1044	472	572
184.	Madavaram (M) WARD NO.- 0027	2873	1543	1330	982	397	585
185.	Madavaram (M) WARD NO.- 0028	1918	1014	904	537	233	304
186.	Madavaram (M) WARD NO.- 0029	6503	3404	3099	1594	666	928
187.	Madavaram (M) WARD NO.- 0030	2445	1276	1169	639	248	391
188.	Chinnasekkadu (TP)	9509	5152	4357	2887	1213	1674
189.	Chinnasekkadu (TP) WARD NO.-0001	619	340	279	150	60	90
190.	Chinnasekkadu (TP) WARD NO.-0002	343	182	161	94	37	57
191.	Chinnasekkadu (TP) WARD NO.-0003	521	281	240	201	80	121
192.	Chinnasekkadu (TP) WARD NO.-0004	342	190	152	137	52	85
193.	Chinnasekkadu (TP) WARD NO.-0005	943	554	389	323	139	184
194.	Chinnasekkadu (TP) WARD	692	379	313	242	104	138

	NO.-0006						
195.	Chinnasekkadu (TP) WARD NO.-0007	832	433	399	326	142	184
196.	Chinnasekkadu (TP) WARD NO.-0008	487	258	229	132	63	69
197.	Chinnasekkadu (TP) WARD NO.-0009	1371	750	621	367	154	213
198.	Chinnasekkadu (TP) WARD NO.-0010	786	413	373	165	80	85
199.	Chinnasekkadu (TP) WARD NO.-0011	605	332	273	178	68	110
200.	Chinnasekkadu (TP) WARD NO.-0012	364	180	184	94	38	56
201.	Chinnasekkadu (TP) WARD NO.-0013	608	333	275	228	91	137
202.	Chinnasekkadu (TP) WARD NO.-0014	651	341	310	141	69	72
203.	Chinnasekkadu (TP) WARD NO.-0015	345	186	159	109	36	73
Total		3268498	1703011	1565487	775875	327637	448238

(Source: Census 2011)

3.12.10 Dwelling within study area

Due to urbanization in nearby area and various Government Schemes, the standard of dwelling place has improved.

3.12.11 Urbanization within the study area

The public has mixed responses of urbanization in the area.

Summary

The Socioeconomic profile of the study area shows that majority of people in the study area work in other sector. They have good educational infrastructures and the people in the study area are well connected to the educational infrastructures. They have sufficient educational infrastructures and the people in the study area are well connected to the educational infrastructures. The people in the study area are well connected to Government primary health centres and Primary health sub-centres.

Table 3-36 Summary of Socioeconomic indicators within the study area

S.No	Particulars	Study Area	Unit
0-5 Km			
1.	Number of habitates	67	Nos.
2.	Total Households	304230	Persons
3.	Total Population	1301184	Persons
4.	Children Population (0-6 Years Old)	123220	Persons
5.	SC Population	255685	Persons
6.	ST Population	2174	Persons
7.	Total Working Population	508354	Persons
8.	Main Workers	446102	Persons
9.	Marginal Workers	62252	Persons
10.	Cultivators	4265	Persons
11.	Agricultural Labourers	4557	Persons
12.	Household Industries	11599	Persons
13.	Other Workers	487933	Persons
14.	Literates population	1058116	Persons
15.	Illiterates population	243068	Persons
5-10 Km			
16.	Number of villages and Town in the Study Area	203	Nos.
17.	Total Households	1027035	Persons

18.	Total Population	4044373	Persons
19.	Children Population (0-6 Years Old)	411822	Persons
20.	SC Population	637949	Persons
21.	ST Population	9637	Persons
22.	Total Working Population	1565637	Persons
23.	Main Workers	1395025	Persons
24.	Marginal Workers	170612	Persons
25.	Cultivators	11101	Persons
26.	Agricultural Labourers	11521	Persons
27.	Household Industries	32171	Persons
28.	Other Workers	1510844	Persons
29.	Literates population	3268498	Persons
30.	Illiterates population	775875	Persons

(Source: Census 2011)

CHAPTER 4
ANTICIPATED ENVIRONMENTAL
IMPACTS AND MITIGATION
MEASURES

4 ANTICIPATED ENVIRONMENTAL IMPACTS & MITIGATION MEASURES

4.1 Identification of Impacts

This Chapter deals with the identification and appraisal of various environmental and social impacts due to the proposed project based on the prevailing baseline setting and inventory of pollution sources described in the previous chapters.

Generally, the environmental impacts can be categorized as either primary or secondary. Primary impacts are those, which attributes directly due to the proposed project and the secondary impacts are those, which are indirectly induced and typically include the associated investments and changed patterns of social and economic developments.

The proposed project is likely to create impact on the environment in two distinct phases:

- During the construction phase, which may be regarded as temporary or short term; and
- During the functional phase which will have long-term effects.

The construction and functional phases of the proposed project comprises of various activities, each of which will have some impact on one or more environmental parameters. Various impacts during the functional phase of the project have been studied to estimate the impact on the environment and are discussed briefly in the subsequent sections.

4.2 Impacts during Construction Phase

The impact assessment during the construction phase of the project is important , as the construction activities lead to adverse effects on the environment , but on a temporary basis. The major activities that are undertaken during this phase are civil works, mechanical works, machinery works and transportation works.

4.2.1 Impact on Air Environment

The major source of air emission are :

- Suspended particulate matter from construction activities (leveling of land, cutting and filling activities)
- Operation of DG sets
- Increased vehicular movement

- Machineries operation equipped for constructing pillars.

4.2.2 Impact on Water Environment

- **The major source of impacts on marine water are :**
 - Direct discharge of construction debris.
 - Pollution from increased vessel traffic or release of contaminants from seabed sediments.
 - Sun light may not penetrate the water resulting in the reduced temperature.
 - The temperature influences biochemical processes and deep channels may create zone of poor conductivity that can serve as barriers to migrate for the demersal (living close to the bottom of the sea or a lake) species

4.2.3 Impact on Noise Environment

- The major sources of noise during the construction phase are :
 - Operation of construction equipments such as pneumatic tools, concrete mixers, cranes, generators, pumps, compressors, vibrators, etc., generating noise ranging between 70-85 dB (A).
 - Operation of DG sets
 - Vehicular movement for construction material conveyance.

4.2.4 Impact on Topography and Land Use

- The proposed project will be developed in 8551.13sq. m (2.11Acre) at Bay of Bengal off the coast of Marina Beach near Tripilicane Village, Chennai District.
- The site is devoid of any forest or trees and hence there will be no change in the land use pattern and no land acquisition or conversion is required.
- Further, the site is devoid of any human habitations hence evacuation of the project-affected persons is not involved in this project.
- Hence, no resettlement and rehabilitation issues are involved in the proposed project.
- However, there will be a significant improvement in the aesthetic values of the site.

4.2.5 Impact on Soil

- **The main source for soil contamination are :**
 - Dredging activities
 - Oil Dripping from construction vehicle

4.2.6 Impact due to Solid Waste Generation and Hazardous Waste Generation

- The only major source of impacts due to solid waste generation is the materials such as sand, blue metals, concrete, cement, bricks, etc., used for the construction and the wastes.
- Approximately 45.0 kg/day of municipal waste will be generated in premises.

4.2.7 Impact on Terrestrial Ecology

- The terrestrial ecology here mainly refers to the small grasses as the proposed project site is devoid of forest or thick vegetation.
- Therefore, no major impacts in terrestrial ecology are foreseen.

4.2.8 Impact on Aquatic Ecology

- The major source of impacts on aquatic ecology is the direct discharge of construction debris.

4.3 Impacts during Operational Phase

No severe environmental pollution such as air and water and wastewater pollution are envisaged during operation phase. However, the following activities related to the project are anticipated to have varying degree of impacts on the environment, hence considered for impact assessment:

- Topography;
- Land use and building construction;
- Soil quality;
- Water quality;
- Storm water drainage;
- Solid waste generation;
- Air quality;
- Noise levels; and
- Terrestrial and aquatic ecology

4.3.1 Impact on Air Quality

4.3.1.1 Fugitive and Gaseous emissions

- The sources of fugitive and gaseous emissions are :
 - Increase in vehicular movement
 - Usage of DG set in case of power failure.
- As these emissions are only contained in construction phase, impacts on operation phase are

minimal.

4.3.1.2 Impact of Traffic

- With the proposed project, the traffic is likely to increase on the existing road network during the functional phase on the nearest road.
- Since it is a tourism attraction site, the impact on traffic will be mainly on occasional days compared to normal day.
- The major impacts of traffic are:
 - Degrading the air aquality
 - Over population may even lead to accidents

4.3.2 Impact on Water Quality

- The water requirement for operation phase is 5 KLD and it is supplied through the water dispensers.
- The wastewater will be generated only from the sanitation facilities. As, all the sanitation facilities are equipped in the Dr. Kalaignar Karunanidhi Memorial (under construction), no adverse impacts are foreseen.

4.3.3 Impact on Soil Quality

- All the impacts related with soil are restricted only to the construction phase; hence there will not be any major impact on soil of the project site during the operational phase.

4.3.4 Impact on Noise Levels

- The noise generating sources from the proposed project in operation phase is DG set and vehicular movements.
- The noise levels at the source for these units will be in the range of 80-85 dB (A).

4.3.5 Impact due to Solid Waste Generation & Hazardous Waste Generation

- During operational phase approximately, 98 kg/day of municipal waste will be generated in premises should be disposed in local municipal/corporation bins on daily basis.
- Hence, the generation of solid wastes in the proposed project will not create adverse impacts.
- The hazardous materials used for the proposed project are :
 - Diesel for DG sets
 - Welding gas and panits (constrained only to the construction phase).

4.3.6 Impact on Topography and Land Use

- During the operational phase of the project, the project site with a well laid out with internal footpaths, beautiful landscaping, Water fountain, efficient air and water circulation systems, impressive lighting system, efficient firefighting system etc will be provided.
- Accordingly, there will be an immense positive impact on the land use pattern of the proposed project site due to the project and the aesthetics will be improved impressively.
- All the structures in the proposed project will be developed as per the prevailing stipulations laid by Govt. of India.

4.3.7 Impact due to Earth Quake

- The project site falls in the Seismic Intensity Zone-III, which is not prone for severe earthquakes. Hence, this project is not likely to face any impact due to severe earthquakes. .
- Adequate care will be taken in construction of structures to withstand tremors of earthquakes, if such eventuality occurs.
- The marine structure will be constructed as per:
 - IS 1893-2006 for Earthquake resistance and
 - IS 4651 parts I to V & IS 45

4.3.8 Impact due to Fire Accidents

- There are very minimal chances of the occurrence of fire accident.
- The chances of fire accidents may be due to :
 - Electrical Short circuiting
 - Fuel used for DG set
 - Carelessness of any visitors
- The impacts of fire accidents are :
 - Loss of life & damage
 - Plantation are affected
 - Structural view will be spoiled

4.3.9 Mitigation Measures

4.3.9.1 Construction Phase

- The construction phase is always the temporary phenomenon, which involves
 - Site survey and preparation,
 - Transportation of construction materials and equipment
 - Construction of the infrastructure

4.3.9.2 Land Environment

The total area of the proposed project is 8551.13 sqm (2.11 Acres). The following management measures will be adopted:

- There will be minimum/optimum concreting of the top surfaces so that sufficient scope for maximum groundwater recharge due to rainfall; and
- Aesthetics of the proposed project land will be improvised without changing the land use pattern.

4.3.9.3 Water Environment

The cause and source of water pollution in the area could be attributed mostly to the surface run-off during rainy season. The following mitigation measures are to be taken in controlling the water contamination:

- Construction activities will be sustained during heavy rains
- Construction material shall be properly covered to avoid the leakage and spillage.
- No overburden or loose sediments will be kept in the working benches particularly during monsoon months.
- Public toiletry will be equipped from the adjacent site (Dr. Kalaingar Karunanidhi Memorial, which got its clearance in 06.01.2022 and it's under construction), hence no sewage will be allowed to seep into the land.

4.3.9.4 Air Environment

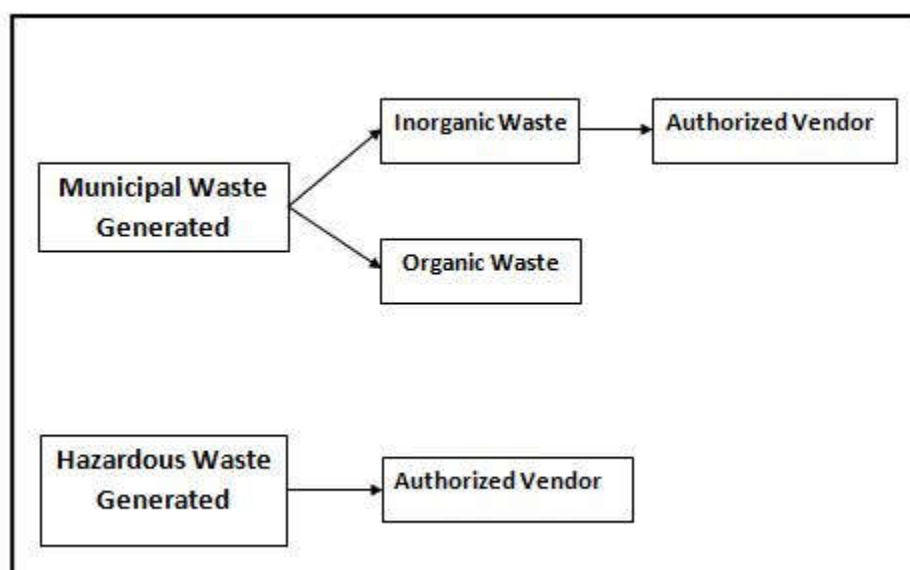
- Regular sprinkling of water on roads and waste dumps by tankers will be done at frequent intervals
- Construction equipment will be maintained and serviced regularly such that the gaseous emissions from these equipment are maintained within the design specifications; and
- Provision of dust collectors for the drilling machines
- Supply of dust masks for the drill operators
- Plantation of wide leaf trees, creepers, tall grasses around quarry sites, waste dumps, roads, colony and other surrounding barren zones.
- The transport vehicles using petrol or diesel should be properly maintained to minimize smoke in the exhaust.

4.3.9.5 Noise Environment

- Provision for insulating caps and aids at the exit of noise source on the machinery;
- The use of damping materials such as thin rubber/lead sheet for wrapping the work places like compressors, generator sheets;
- Shock absorbing techniques will be adopted to reduce impact;
- Inlet and outlet mufflers will be provided, which are easy to design;
- Earmuffs will be provided to the workers and it should be enforced to be used by the workers;
- No worker will be allowed to expose to more than 90 dB (A) in an 8-hour shift and under no circumstance the noise level from any equipment will be greater than 115 dB (A).
- In order to have less impact on noise levels in the area, the major works will be carried out during daytime as far as possible.

4.3.9.6 Storage of Solid Waste & Hazardous Material

- The solid waste being generated in the premises will be disposed in municipal/corporation bins on daily basis.
- As, no industrial process are involved , so no major quantity of chemicals will be equipped. Moreover, the chemicals equipped will be stored in the proper glass container and labeled accordingly.
- This storage of chemicals would be kept away from the public reach and stored in appropriate room temperature.
- Additional recommendations for the storage would be followed as per CPCB norms.



4.3.9.7 Green belt Development

The Greenbelt will be proposed at the project site taking into consideration the availability of area as the efficacy of green belt in pollution control mainly depends on width of green belt, distance from pollution sources, and site of the habitat from working place and tree height & density. The green belt development will be carried out in the consultation with a local forest department wherever feasible, which will help in minimizing adverse impact on the flora found in the area

4.3.9.8 Facilities to be provided by the Labor Contractor

- The contractor will provide following facilities to construction work force:
 - **First Aid:** First aid facilities will be maintained at a readily accessible place where necessary appliances including sterilized cotton wool etc will be available. Ambulance facilities will be kept readily available at workplace to take injured person to the nearest hospital.
 - **Potable Water:** Sufficient supply of water fit for drinking will be provided at suitable places.
 - **Security:** Security persons will be appointed 24 x 7 at the project site.

4.3.9.9 Aquatic Ecology

No sensitive aquatic species are being found in the proposed project site; The pen monument is to be placed in Bay of Bengal off the coast of Marina Beach at a distance of 360 m from the shore line in CRZ-IV (A) area, as per section 4(ii) (j) of CRZ Notification amended on March 22, 2016 for construction of memorials/ monuments and allied facilities by the concerned State. No major aquatic life is being envisaged in the distance of 360 m from the shore line.

4.3.10 Operational Phase

The specific control measures related to gaseous emissions, sewage discharges, noise generation, solid waste disposal, etc are described below:

4.3.10.1 Air Pollution Management

- As the entire project area will be covered with good landscaping and tree/grass cover, generation of major dust particulates within the premises is not anticipated.
- Further, all emissions are likely to be controlled to a great extent, through proper maintenance of tree plantations and the green belt development undertaken within the project.

4.3.10.2 Water and Wastewater Management

- The water requirement for the operation phase is 5 KLD and will be supplied through metro water tankers.
- The wastewater management is done in the proposed STP which is set up in Dr. Kalaignar Karunanidhi Memorial of capacity 10 KLD. The treated water from the STP is again recycled to sprinklers for watering the greenbelt region.

4.3.10.3 Noise Level Management

- As the minor generation of noise is only from the DG sets, no major management plan is required.

4.3.11 Environmental Impact Matrix

Activities	Environmental Impacts	Nature	Significance				Residual Impacts, after mitigation			
			Non-Sig.	Small	Mod	Maj or	Non-Sig	Small	Mod	Major
Construction Phase										
Constructed material procurement, storage and handling	Generation of dust and noise due to vehicular movement	Temporary	✓				✓			
Construction of onshore structures	1.Generation of Particulate Matter 2.Generation of noise and vibration 3.Chances of soil contamination 4. Generation of solid and liquid waste	Temporary			✓			✓		
Construction of offshore structures on piles	1.Generation of particulate matter 2.Generation of Noise and vibration 3.Impacts on Marine water quality • Diffusion from	Temporary				✓		✓		

	<p>construction works in water</p> <ul style="list-style-type: none"> • Suspension of sediments in water leads to an increase in level of suspended solids (SS) and the concentration of organic matter • Turbidity <p>4.Impacts on Marine Ecology</p> <ul style="list-style-type: none"> • Change in dissolved oxygen • Disturbance of benthic communities associated with bottom and sediments. • There is a high possibility of re-settlement of the same after the construction phase. • Smothering effect due to the settling of sediments <p>5.Obstruction of natural flow of water</p> <p>The structures will be built on piles which will not obstruct or block the natural flow of water in the area.</p> <p>6.Change in the sea bed profile</p> <p>Littoral Drift- Nearly 1.2 Lakh cum per year of sediments move from the South to North and will not be disturbed due to the construction of</p>									
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	<p>columns.</p> <p>The obstruction ratio is less than 2percent.</p> <p>7.Traffic</p> <p>Impact on free-movement of fishing boats</p> <p>Motor boats movement for fishermen will not be affected other than in the pedestal area other region is accessible to boat.</p>									
Operation Phase										
Tourism	Increase in water and energy consumption; increase in pollution (air, water, noise, etc.); increase in solid waste etc. Impact on marine ecology, if not controlled properly	Permanent	•	✓			✓			
Socio-Economic Environment (positive impacts)	Direct and Indirect Employment, raising the standards of living and improving the local economy,	Permanent				✓				✓
Natural Calamities like Tsunamis, Cyclones, Earthquakes etc.	<p>The study area falls under Zone-III (Moderate risk) according to the Indian Standard Seismic Zoning Map.</p> <p>Suitable seismic coefficients in horizontal and vertical directions respectively, to be adopted while designing the structures.</p> <p>The marine structure will be constructed as per:</p> <p>a.. IS 1893-2006 for Earthquake resistance</p> <p>b. IS 4651 parts I to V & IS 456</p>	General				✓		✓		

	<p>c. National disaster management guidelines for management of Tsunamis</p> <p>d Warning system for Tsunami , Cyclone etc will be strictly observed and informed</p> <p>e. Emergency preparedness and evacuation plan will be kept ready.</p>									
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CHAPTER 5
ANALYSIS OF ALTERNATIVES

5. ANALYSIS OF ALTERNATIVES

5.1 Introduction

A necessary part of the EIA process is the consideration of alternatives to the proposed activity. The many complex factors controlling the location of project site(e.g. surface and subsurface Geology, topography, communications) usually means that there are only a few viable alternatives that can be genuinely considered.

5.2 Choice of Alternate locations

- Extensive reconnaissance survey was carried out to identify a suitable site for the erection of Pen Monument in Bay of Bengal near Chennai.
- Based on the Bathymetry Survey, the minimum depth required for constructing the monument is 6m from HTL to sea bed which is achieved at the 360 m from LTL of the sea.
- Initially three sites were considered viz.,
 1. Site I- 360m away from the LTL of Cooum River Mouth
 2. Site II- 360m from the LTL of Bay of Bengal along the axis of existing Muthamizh Arignar Dr. Kalaignar memorial
 3. Site III- Approx. 360m from the LTL of Bay of Bengal near the Loop Road.
- The **Site I** was rejected due to its proximity to the Cooum River mouth, heavy siltation warrants frequent desiltation, free tidal flow of water in the Cooum River will be affected and laying of new road is required.
- The **Site II** falls in the CRZ IV A, due to its importance, proximity & significance of the existing memorial, no disturbance to any other nearby activities, also there will be no additional traffic congestion, community pollution load since the visitors will be common for all the attractions nearby including Marina Beach & other memorials, laying of new roads does not require and hence this site is considered.
- The **Site III** which falls under CRZ IV A was rejected due to its proximity to Olive Ridleys nesting sites, nearness to the fish market, fishing yard & nearer to Light house.

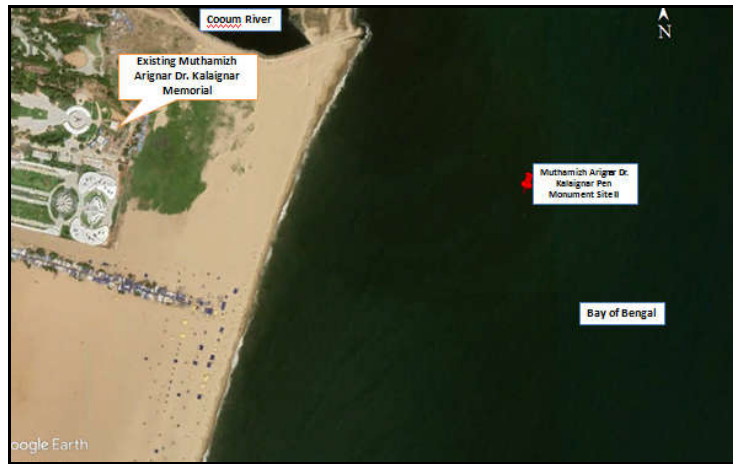


Figure 5-1 Site I, II and III falls under CRZ sites

Table 5-1 Weightage Matrix of site selection

Parameters	Brief information of the site	Disturbance to ecological factors	Proximity to the monument	Traffic congestion	Public movement	Tourist Attraction	Navigational impacts	Disturbance to non-ecological factors	Construction Conditions. i.e, Feasibility in construction
Muthamizh Arignar Dr. Kalaignar Pen Monument Site I	360 m from LTL on the axis of Cooum River mouth	Significant impact on tidal flow of water & siltation	New road formation and allied facilities are required	Congestions near Nappier Bridge	Nearby bus stand available	Not conducive to tourist attraction	Boat and fishermen movements will be affected	Significant impacts to PWD activities, swimming pool	Difficult
Muthamizh Arignar Dr. Kalaignar Pen Monument Site II	360 m from LTL on the axis of Kalaignar memorial	Monument designed in such a way to nullify the impacts	No new requirement as it will be located besides existing Memorial	No significant congestion	Nearby bus stand & parking facilities available	Four memorials are in the same area. So it will enhance tourist attraction	No boat yard existing	No settlements, no significant impact	Easy

Muthamizh Arignar Dr. Kalaigar Pen Monument Site III	Approx. 360 m from LTL on the axis of Lighthouse	Olive ridley nesting area & overlaps the light house	New road formation and allied facilities are required	Junction to Santhome church, Dr. Radha Krishnan Salai, Parthasarathy Temple more congestion	No bus stand nearby	Not conducive to tourist attraction due to fisherman habitation	Fishermen movements will be affected as there is natural boat movements terrain & yard	Significant impacts to nearby Government Hospital and settlements, visibility of the light house will be affected	Easy
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Parameters	Brief information of the site	Disturbance to ecological factors	Proximity to the monument	Traffic congestion	Public movement	Tourist Attraction	Navigational Impacts	Disturbance to non-ecological factors	Construction Conditions. i.e, Feasibility in construction	Total (Out of 40)	Percentage (%)
Muthamizh Arignar Dr. Kalaigar Pen Monument Site I	360 m from LTL on the axis of Cooum River mouth	2	2	3	4	2	3	3	2	21	53

Muthamizh Arignar Dr. Kalaignar Pen Monument Site II	360 m from LTL on the axis of Kalaignar memorial	4	5	5	5	5	5	4	5	38	95
Muthamizh Arignar Dr. Kalaignar Pen Monument Site III	Approx. 360 m from LTL on the axis of Lighthouse	2	4	1	2	3	2	2	4	20	50

CHAPTER 6
ENVIRONMENTAL MONITORING
PROGRAM

6. ENVIRONMENTAL MONITORING PROGRAMME

6.1 Implementation Schedule of Mitigation Measures

The mitigation measures suggested in the Chapter-4 will be implemented so as to reduce the impact on environment due to the operations of the proposed project. In order to facilitate easy implementation, mitigation measures are phased as per the priority implementation. The priority of the implementation schedule is given in **Table 6-1**.

Table 6-1 Implementation Schedule

Sl. No.	Recommendations	Time Requirement
1	Air pollution control measures	Before operation phase
2	Water pollution control measures	Before operation phase
3	Greenbelt and green cover development	Along with constructional phase of the project and during functional phase of the project

6.2 Environmental Monitoring

The Post Project Monitoring to be carried out at the project is discussed below:

6.2.1 Monitoring and Reporting Procedure

Regular monitoring of important and crucial environmental parameters is of immense importance to assess the status of environment during operational phase. With the knowledge of baseline conditions, the monitoring program can serve as an indicator for any deterioration in environmental conditions due to operational phase and suitable mitigatory steps could be taken in time to safeguard the environment. Monitoring is as important as that of control of pollution since the efficiency of control measures can only be determined by monitoring. The following routine monitoring program will be implemented under the post project monitoring. The proposed monitoring program is given below:

- **Air Pollution and Meteorological Aspects**

Both ambient air quality and DG set emission will be monitored. The ambient air quality will be monitored once in three months in the work zone, at the DG set location and surroundings through a reputed environmental laboratory recognized by CPCB/MoEF. Similarly, the stack monitoring will be carried out and the results will be reported to pollution control authorities.

- **Wastewater Quality**

The sewage emanating from the project will be monitored once in a month for physico-chemical characteristics.

- **Noise Level:** Noise levels near the DG sets will be monitored once in three months.

6.3 Cost Provision for Environmental Measures

For environment protection and management and pollution control and treatment and monitoring systems, appropriate budgetary provision would be made and provision for recurring expenditure for environment management of the project would be made.

CHAPTER 7
ADDITIONAL STUDIES

Responses to the issues raised during Public Hearing are given in **Table 7-1**.

Sr. No.	Name & Address of the Speaker	Points Discussed	Compliance
1.	Thiru. Kalyanaraman Triplicane, Chennai, from neighbourhood area of the project site	<p>He said that he is not a member in any of the political party. Purpose of establishing of monuments is not only to propagate the fame of the individual but also for the transmission of their principles followed to the next generation to emerge cultural and social changes in the society.</p> <p>He suggested that a museum maybe provided to keep his writings. Impact on ecology if any due to the pen monument project will be either minimized or eliminated, instead of raising objections. Establishing the project in the sea would attract the attention of international tourism and he welcomed the project.</p>	<p>Suggestions Noted.</p> <p>As suggested, the museum is proposed to be constructed within the Kalaignar Memorial complex. The impact on various aspects of ecology including shoreline accretion/erosion among the marine life, life of turtles, prawns etc., have been studied in detail by accredited experts and researchers and based on their recommendation; all necessary steps would be taken to completely minimize the impact on ecology due to this project.</p> <p>Further, based on the suggestions of the experts, necessary steps will be implemented to improve the quality of ecosystem around the area.</p>
2.	Thiru. Arul Muruganantham General Secretary, Satta Panchayat Iyakkam, a social organisation, Thiruvanmiyur, Chennai-41.	<p>He informed that he opposed the setting up of pen monument project. This project site falls within the CRZ area. As per the orders of the Government of India, construction of memorials is permissible only in exceptional situations.</p>	<p>As informed, the project site falls within the CRZ IA, CRZ II and CRZ IVA classifications. As per 4(ii)(j) of CRZ Notification dated 22.03.2016:</p> <p>(j) construction of memorials/ monuments and allied facilities by the concerned State Government in CRZ-IV (A) areas in exceptional cases, with adequate environmental safeguards, subject to the following, namely:-</p> <p>(A) The concerned State Government shall submit justification for locating the project in CRZ area</p>

		<p>He is of the view that this is not an exceptional situation, and no alternate location was explored as per the TOR of dt 27.09.2022 issued by the Ministry of Environment, Forest, and Climate Change, Government of India, he said.</p>	<p>along with details of alternate sites considered and weightage matrix on various parameters including environmental parameters to State CZMA who will examine the project and make recommendation to the Central Government (MoEF) for grant of Terms of Reference (ToRs) for preparation of an environmental impact assessment report by the State Government;</p> <p>(B) on grant of ToRs by the Central Government, the concerned State Government shall submit the draft Environmental Impact Assessment report (EIA) with Environmental Management Plan (EMP), draft Risk Assessment Report with Disaster Management Plan (DMP) including on-site and off-site emergency plan and evacuation plan during emergency, to the State Pollution Board for conduct of public hearing for the proposed project in accordance with the procedure laid down under the Environment Impact Assessment notification;</p> <p>(C)The concerned State Government shall submit final EIA, EMP, Risk Assessment and DMP after addressing the relevant issues raised by the public during the public hearing, to State CZMA for their examination and recommendation to MoEF.</p> <p>Further, during initial stages of proposal three sites were selected for locating the proposed monument and various studies pertaining to the impact of the monument on local ecology, socio-economy and cultural life of the fishermen and other people living</p>
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		<p>He informed that the project is proposed to be constructed over an extent of 0.5 acre nearer to the estuary of river Cooum which is the place of resources of fish and prawn and construction of the pen monument in sea could affect the marine eco system.</p> <p>Even though modernized equipment's deployed during construction of the project, impact due to solid waste in the sea cannot rectified and it will take more than 20 to 30 years to correct it, he said.</p> <p>Further, he informed that 70m near the sea coast is the place of turtles nesting, he said. Today this pen monument project is to be constructed to honour him but it will spoil his name tomorrow, he said.</p>	<p>around the area are carried out.</p> <p>Traffic study and connectivity to various parts of the city were considered and the present site has been selected based on the studies undertaken.</p> <p>Detailed reports have been submitted to TNPCB-DCZMA, Chennai, TNSCZMA and NCZMA-MoEF&CC. Based on the reports submitted, further deliberations by the appraisal committee, MoEF&CC have recommended Terms of Reference (ToR) for the project.</p> <p>The project lies near estuary of coovum river and impacts on marine life including life of turtles, prawns etc., have been studied in detail by accredited experts and researchers and based on their recommendation mitigation measures will be taken; so as marine ecosystem will not be affected.</p> <p>The proposed project is going to utilize modernized equipment for drilling operations for the foundation of the project, using encased drilling equipment; which would suck out the debris, so that debris could be segregated and collected separately; this would prevent spillage of debris and solid waste into the sea.</p> <p>No construction activity would be taken in the 70m wide intra-tidal zone under CRZ IA. The pillars would be placed suitably to prevent any ecological disturbance to this zone. The connecting bridge for</p>
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		<p>The public gathered in the meeting hall raised their voice against the above statement. The District Collector and the Member secretary convinced the public.</p>	<p>this 100m segment is proposed to be a lattice girdle bridge.</p>
3.	<p>Thiru. Shankar</p> <p>Advocate , State Legal Wing-member of Aaam Aadmi Party,a political party,Chennai-91</p>	<p>He informed that on behalf of the Aam Aadmi Party, he is opposing the project.</p> <p>On 24.08.2021 under Rule 110, 39 crore of funds was allocated to the Public Works Department for the construction of a Kalaignar memorial hall and the same is mentioned in the PWD policy note 2022-23. Further he spoke about the allocation fund of Rs. 81.0 crore for the pen monument project.</p> <p>He commented about Veena's pattern for designing of this project, and inclusion of Hindi language in the public announcement system proposed. The Member Secretary during the meeting requested Mr. Shankar, to express his views on environmental issue</p> <p>The occurrence of air pollution and noise pollution during construction phase could affect Madras University area located just opposite side of the project and he questioned that what is the alternative proposal of the Tamilnadu Pollution Control Board in this regard.</p> <p>A letter has been sent to the District Collector, Tamilnadu Pollution Control Board through mail today, he said.</p>	<p>The musical instrument pattern as notified by the speaker was not evolved intentionally, but to satisfy structural features and components, the shape has been evolved to withstand seismic and other forces.</p> <p>During construction phase, no drilling machinery or dredging equipment are to be used anywhere in the project. For that, no chances of air pollution do really exist in the memorial complex.</p> <p>Hence, there is no chance of air/noise pollution generation from this project having an impact on Madras University campus located about 500m away from the site. Further, two complexes are separated by 100feet wide Kamarajar Saalai which</p>

			<p>has been comprehensive source of noise/air pollution. Hence, it is retreated that no noise/air pollution really augments the noise/air pollution of Madras University campus. Minor noise pollution emanating will be mitigated in background noise pollution.</p> <p>However, necessary steps will be constantly undertaken to control the noise/air pollution in this complex in view of tourist importance of the monument.</p>
4.	<p>Thiru.Perumal, Nochikkuppam, Chennai, from neighbourhood area of the project site</p>	<p>He spoke about the contribution of Muthamizh Arignar Dr.Kalaignar to Tamil literature and he welcomed the project</p>	<p>Opinion Noted</p>
5.	<p>Thiru V.P. Mani, President, Triplicane Traders Association & State Additional Secretary, Federation of Tamil Nadu Traders Associations, Triplicane, Chennai</p>	<p>He spoke about the contribution of Muthamizh Arignar Dr.Kalaignar to the Tamil literature and welcomed the project on behalf of 21 lakhs traders' families.</p> <p>Further he made request during the meeting that the name of the Marina Beach shall be changed as Kalaignar Marina Beach.</p>	<p>Opinion Noted.</p> <p>However, the idea of name change will be put forth to the consideration of suitable competent authority</p>
6.	<p>Thiru. Munusamy, President,</p>	<p>He opposed the setting up of pen monument project in the sea</p>	<p>The height of the Pen Monument is only 30m and it is proposed to erect at a height of 12m above HTL.</p>

	Fishermen wing from political party of BJP, Neelankarai, Chennai.	<p>His speech triggered the audience during the meeting as he compared the height of pen monument structure with Thiruvalluvar statue in Kanniyakumari. The public raised their voice against his speech again and again</p> <p>The District Collector and the Member secretary convinced the public. The police intervened and brought the situation under control.</p>	
7.	Thiru. Dhanasekhar, State Secretary, Advocate Wing All Fishermen Association, Tondiarpet Chennai, from neighbourhood area of the project site.	<p>He spoke about the significant contributions of Muthamizh Arignar Dr.Kalaignar and welcomed the project</p> <p>The District Collector requested Thiru Dhanasekhar, to speak about the Environmental issues and requested all to avoid speech related to politics in this public hearing meeting. The Member Secretary convinced the public and asked them to sit in the chair</p>	Opinion Noted
8.	Thiru. Senathipathy Chinnathambi, National Coordinator, National Traditional Fisheries Confederation, Thangachimadam, Ramanathapuram District, one among the southern districts of Tamil nadu	<p>He informed that he opposed this pen monument project on behalf of the Association.</p> <p>Further, he stated that no structures shall constructed in estuaries CRZ-IA areas as per the rules notified in the CRZ Notification-2011</p>	Regarding construction necessary clearances under CRZ Notification have been sort from various statutory bodies including TNSCZMA, NCZMA, MoEF&CC. Based upon the Terms of Reference (ToR), recommended by MoEF&CC, all the pertinent studies and researchers including the impact on shoreline accretion/erosion, traffic study , risk assessment, DMP etc. have been carried out by accredited experts and consultants; their suggestions and recommendations will be completely implemented during execution and operation stages. Further, necessary efforts based on expert recommendation will enhance the biodiversity of ecosystem and quality of ecology will be implemented.

9.	Thiru. Elango, Royapuram, Tondiarpet Taluk, Chennai, from neighbourhood area of the project site	<p>He informed that the pen monument project will not affect the marine environment.</p> <p>Further he informed that the construction of pen monument project will enhance the biodiversity. He welcomed the construction of pen monument project</p>	Opinion Noted
10.	Thiru. Semmalar Sekar	<p>He informed that construction of pen monument to Muthamizh Arignar Dr.Kalaignar has to be done but not in the sea.</p> <p>He requested to consider the livelihood of the fisheries people and to identify the alternate place to put up this project.</p>	The various studies pertaining to the impact of the monument on local ecology, socio-economy and cultural life of the fishermen and other people living around the area.
11.	Thiru. Magesh, All India Traditional Fishermen Association, Nochikuppam, Chennai, , from neighbourhood area of the project site	<p>He spoke about the significant contributions of Muthamizh Arignar Dr.Kalaignar for social reforms and expressed his support for the pen monument project</p> <p>He spoke about the occurrence of sea erosion in North Chennai areas, and informed that whenever a construction of any structure obstructing the sea coast causes sea erosion on the Northern side and accretion in Southern side.</p> <p>We had seen from the video clippings played that the pen monument structures have been designed like a Pamban bridge. The method of design is favourable to the marine environment and pen monument project would not affect this area.</p> <p>He supported the project and requested for compensation to fishermen's of Chennai, Tiruvallur and Kanchipuram District who will be affected during the execution of the project.</p>	Opinion Noted

12.	<p>Thiru. Thirumurugan Gandhi,</p> <p>May 17 Movement, a social and political movement in Tamilnadu</p>	<p>Thirumurugan Gandhi expressed his thanks for facilitating the public hearing meeting to express the views on government policy and decisions by the public.</p> <p>Construction of monuments to commemorate our history to the next generation of Tamilnadu is indispensable because Tamilnadu only has to do it, and there is no alternate view on that. Further he said that the important historical events of Tamilnadu have not been covered in the curriculum. We would like them to take an effort to bring out such real history through this project to avoid distortion of history, he said.</p> <p>Marine environment of this area shall be taken in to consideration to come to a conclusion on establishing this pen monument project. He mentioned about the Intergovernmental Panel on Climate Change (IPCC) report and said the Indian Ocean has experienced rapid warming and the sea level along the coast are rising faster and has stated that Chennai would be affected. Prevention of rise of sea level will be possible only if the temperature is brought down to the required level and it is not possible because it is not in the hands of Tamilnadu alone.</p> <p>He informed that the pen monument project has to be constructed more widely, in such a way that the people shall know about the historical event of Tamilnadu and by considering the marine environmental issues in the sea coast including rise in sea water level.</p>	<p>The impact on various aspects of ecology including the marine life, life of turtles, prawns etc., have been studied in detail by accredited experts and researchers and based on their recommendation; all necessary steps would be taken to completely minimize the impact on ecology due to this project.</p>
13.	<p>Thiru.T.V.Babu, Besant Nagar, Adyar from the surrounding area of the project site</p>	<p>He informed that he is a Marine Biologist. Estuaries are the nursery for many fish species. Fishes migrate from the ocean into the estuaries and nearby rivers for reproduction so that the fish inflows are generally there.</p>	<p>The impact on various aspects of ecology including the marine life, life of turtles, prawns etc., have been studied in detail by accredited experts and researchers and based on their recommendation; all</p>

	,Chennai.	Up to 200m from the sea coast is the productive areas and it was destroyed, which it lead to deep sea fishing because of non-availability of fishes. Further he informed that the establishment of pen monument shall be in anywhere but not in the sea because of the ocean currents	necessary steps would be taken to completely minimize the impact on ecology due to this project.
14.	Thiru. Sagayaraj, Pazharaverkadu, Fishermen area of Ponneri Taluk ,adjacent to the Chennai District.	He informed that the proposed pen monument will act like a sea erosion preventive structure. Further he informed that the resources of fishes in the locality could be improved because of the construction and such structure leads to enhancement of bio diversity and he welcomed the project	Opinion Noted
15.	Thiru. Mugilan, Environmental Activist,fromChennim alai,of Erode District, one among the western district of Tamilnadu	<p>Thiru. Mugilan opposed the construction of the Pen monument in sea. Further, he said that authorities did not find an alternate location for the pen monument project as suggested by the central government. He questioned about the base line data mentioned in the report which is found to be prior to the project proposal announcement.</p> <p>He informed that the 382 page of draft Rapid Environmental Impact Assessment Report was prepared only in English and not in Tamil. The draft Tamil version of the report was received only today he said.</p> <p>Thiru.Mugilan requested more time to speak in the public hearing meeting. Though he had been requested to speak the important key issues repeatedly, but he disagreed with that. There is no time limit to speak in the public hearing meeting, he said</p>	<p>The study of baseline data has been continuously undertaken periodically, the studies are pertained to oceanic, marine and ecological parameters.</p> <p>Necessary references have been drawn from baseline studies carried out prior to the announcement of the project for sake of comparison and verification of data.</p> <p>Necessary reports have been duly submitted in this regard.</p> <p>Compilation of baseline data carried out from 27th May-28th July 2021; pertaining to pre-feasibility studies and the same has been utilized for construction pen monument which is the extension of construction of Kalaignar Memorial.</p>

		In order to give opportunity to others, he was requested to give views and suggestions in writing. Suddenly he sat in dharna on the stage and the police brought out him from the stage.	
16.	Thiru.Annadurai, President, All India People's Party. Mayiladuthurai, Mayiladuthurai District.	On behalf of the fishing community, he registered his opposition stating that the project decreases the fishing resources.	The various studies pertaining to the impact of the monument on local ecology, socio-economy and cultural life of the fishermen and other people living around the area.
17.	Thiru S.K.Elango, Nagooran Thoottam Fishing Area, Kasimedu, Chennai, from neighbourhood area of the project site	He supported the project on behalf of fishing community and informed that the pen monument project would not cause any environmental damage.	Opinion Noted
18.	Thiru.Nanjil Ravi, President ,All FishermenAssociation , Kasimedu, Chennai from neighbourhood area of the project site	He informed that fishermen are known well about spots of fishing resources, fishing and the marine biodiversity. He said that no impacts to the marine eco system as well as for their fishing activity due to the construction of pen monument project. He welcomed the project.	Opinion Noted
19.	Thiru Shankar, Fishermen People's Front Party,a welfare association ,Royapuram, Chennai	He informed that no one will object the construction of pen monument to Muthamizh Arignar Dr.Kalaigarnar because of his contribution to the society. But he raised his objection for construction of pen monument in the sea. Further, he informed that the establishment of pen monument shall be located	The impact on various aspects of ecology including shoreline accretion/erosion among the marine life, life of turtles, prawns etc., have been studied in detail by accredited experts and researchers and based on their recommendation; all necessary steps

		anywhere because we need a monument for him.	would be taken to completely minimize the impact on ecology due to this project.
20.	Thiru. Seeman, Chief Coordinator, Naam Thamizhar Katchi, a political party in Tamilnadu, Chennai,	<p>He informed that the pen monument structure shall be constructed anywhere they want, but should not be placed in the sea.</p> <p>An area of 8551. 13 Sqm is proposed to be taken from the shore and sea for the construction of the pen monument structure. Coral reefs will be affected due to the construction activity and it would pressure on the sea. Further he informed that 13 fishing villages will be affected if the project is executed.</p> <p>He expressed his objection for the pen monument project and said that he would break the pen monument if it was built in the sea.</p> <p>The public present in the meeting hall raised their voice against him. The District Collector and the Member secretary convinced the public and the police intervened and brought the situation under control.</p> <p>He gave a representation to the District Collector on behalf of his party during the meeting</p>	<p>The impact on various aspects of ecology including shoreline accretion/erosion among the marine life, life of turtles, prawns etc., have been studied in detail by accredited experts and researchers and based on their recommendation; all necessary steps would be taken to completely minimize the impact on ecology due to this project.</p> <p>From the various studies, coral reefs do not exist in this part of the sea.</p> <p>The various studies pertaining to the impact of the monument on local ecology, socio-economy and cultural life of the fishermen and other people living around the area.</p>

21.	Thiru. Thambidurai, Nochikuppam, Chennai, from neighbourhood area of the project site	<p>He informed that he was a former member of Zone-10 of Chennai Corporation. He spoke about the contribution of Muthamizh Arignar Dr.Kalaignar to the Tamil literature and about the occurrence of sea erosion in 1996 near Pattinappakkam, Mullikuppam, Dumeenguppam and Nochikuppam area of the sea coast.</p> <p>He informed that there will not be any adverse impact to the marine environment due to the setting up of Muthamizh Arignar Dr.Kalaignar pen monument project.</p> <p>Further he said that boating / fishing activity have not generally been taken in the place within 150 feet from the seashore and hence this project will not affect the fishing. He expressed his support for this proposed pen monument project.</p>	Opinion Noted
22.	Thiru. Parthiban, State propanganda Secretary, Tamilnadu Fishermen's Association, Kottivakkam,Chennai	<p>He spoke about the various welfare scheme implemented by the Muthamizh Arignar Dr.Kalaignar. Further he informed that the pen monument project involves only construction of bridge to reach the pen monument spot. No formation of roads to have a linkage with the pen monument spot and hence there will be no hindrance restriction for routine fish catching and boat movements in this area.</p> <p>The project will not cause any environmental pollution and he informed that on behalf of the fishermen community, he expressed his support for this project</p>	Opinion Noted
23.	Thiru.Prakash, Trichinanguppam, Tiruvottiyur, Chennai from neighbourhood	<p>He spoke about the wind pattern in the sea coast. He informed that fishermen's are very proud for constructing the pen monument in the sea and expressed their support for this project</p>	Opinion Noted

	area of the project site		
24.	Thiru. Manimaran, AyodhyaKuppam, Triplicane, from neighbourhood area of the project site	<p>He informed that fishermen's knows well than others about the marine ecology and fishing. No impacts to the marine eco system as well as for their fishing activity due to the construction of the project, he said.</p> <p>Construction of pen monument project will enhance the resources of fishes if the artificial reef structures (Pavazhapaaraigal) shall be constructed adjacent to each pillars of the bridge structure.</p> <p>He supported the project on behalf of Auoyathiyakuppam, Mathakupam and Nadukuppam village as it would not cause any environmental damage to the marine environment</p>	Opinion Noted
25.	Tmt. Meena, Palapatti of Virudhunagar District, one among the southern district of Tamilnadu	She opposed the project and requested the government to spend the fund for many other good schemes for the people.	Opinion Noted Further, opinion will be put forth for the consideration of the competent authority.
26.	Thiru. Mahimai Raj, Pazhaverkadu, fishermen area of Ponneri Taluk, adjacent to Chennai District.	He said that sea is the property for their livelihood and he expressed his support for setting up of pen monument	Opinion Noted

27.	Thiru. Chakkaravarthy, Chennai Sengai Singaravelar Power Boat Owners Association, Kottivakkam, from the surrounding area of the project site, Chennai	He informed that so many people have participated in this meeting but only the fishermen know well about the marine environment than others. The site is very nearer to the Chennai Harbour and nothing will happen due to the construction of the project. He welcomed and expressed his support for proposed monument project	Opinion Noted
28.	Thiru. Navakumar, Kasikoilkuppam, Ennore, from surrounding area of the project site, Chennai.	He informed that none of the fisheries people raised their objections on the proposed monument project. Even In environmental perspective, the resources will be promoted in this area because of the construction of monument project as it like a deployment of artificial reef structures (Pavazhparaigal) for restoration for the enhancement of Marine eco system. He expressed his support for the proposed monument project	Opinion Noted
29.	Thiru. K. Paramasivam, Treasurer. Palaniamman koil Fishermen's Association, Triplicane, Chennai, from neighbourhood area of the project site	Mr. K.Paramasivam, informed that site proposed for the construction of pen monument is an estuary area and it had been polluted earlier itself. In order to medicate and to restore the area, pen monument project has been proposed. The project shall not cause any harm in the area and expressed his support for proposed monument project.	Opinion Noted
30.	Thiru S.Pasumpon Pandian, Advocate, Madurai District.	He said that this government respects freedom of expression. We shall construct the Pen Monument to remember his contribution to Tamil literature.	Opinion Noted

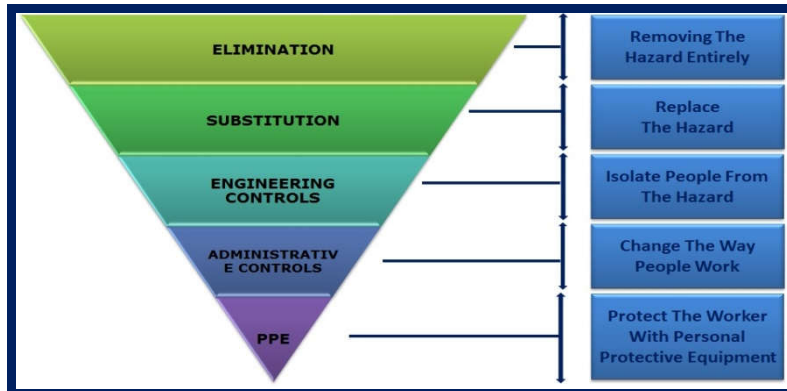
31.	Thiru. Vijayabalan, Palavakkam, Sholinganallur Taluk, Chennai, from surrounding area of the project site.	He expressed his support for setting up of this pen project in the sea.	Opinion Noted
32.	Thiru. Rupesh Kumar, from Meenavar Gram Sabai, Nochikuppam of Chennai, neighbourhood areas of the project site.	<p>He welcomed the pen monument project proposed to be located at the sea on behalf of Mayelai Nochikuppam Menava Grama Sabai.</p> <p>The site proposed for the construction of pen monument project is the area of higher fishery resources and assurance has been given to protect the resources in the area even after construction of the pen monument. He made a demand during the meeting that their livelihood should be protected and the fishermen's should not be restricted to carryout fishing in this region, since 10 fisheries villages totally depends only on fishing</p> <p>He made a demand that compensation shall be given to the affected fisheries people during construction period of the project. He requested to construct Singaraveler memorial hall within the premises of Vivekanandar Illam at the land allotted for this purpose.</p> <p>He again expressed their acceptance on behalf of the 10 fisheries villages for the construction of proposed pen monument project</p>	<p>Opinion Noted</p> <p>The pillars for supporting high level bridge (standing at a height of 6m above HTL) are placed at a distance of 16m having clear gap of 15m. Hence, the fishing vessels can be operated freely unrestricted between those pillars. Further, no restriction likely to be imposed in fishing boats</p>

33.	<p>Thiru. Kumaresan, Chennai, behalf of fishermen from the neighbourhood areas of the project site.</p>	<p>He said that on behalf of the fishermen, he welcomed the project.</p> <p>Further he added that around 593 fishermen villages were benefitted by availing residences, roads and other infrastructure facilities, he spoke about the welfare scheme made by Muthamizh Arignar Dr. Kalaignar</p> <p>It is the first time in the world history that the fisheries people availed relief fund during non-fishing period.</p> <p>Further he informed that it is well known to every fisherman that the resources of fish will be enhanced if there any construction of bridge taken place in the marine environment and he again welcomed the project</p>	<p>Opinion Noted</p>
34.	<p>Thiru. V. Prabhakaran, from an environmental organisation called Poovulagin Nanbargal, Chennai.</p>	<p>He pointed out the missing of one important point in the draft EIA Report and said that the Intergovernmental Panel on Climate Change (IPCC), comprising a team of scientists from 120 countries released a report on impact due to climate change, wherein the name of Chennai is specified 6 times, reflects the seriousness of the issue and we should take a note.</p> <p>He quoted the recent report on Chennai Action Plan and informed that there will be a sea water intrusion of 100 m towards the land during next 5 years and up to the road in the next 20 years. He expressed his apprehension on increase of salinity in the ground water due to sea water intrusion in Nojikkuppam, and Nadukuppam areas.</p>	<p>According to the IPCC report 2022, the global mean surface temperature is increased by 1.5⁰C by 2100.</p>

		<p>Further he expressed his apprehension that no incident shall happen for the relocation of the pen monument structure due to raise in sea level in the next 5 years.</p> <p>Further he also recalled about the book written by Muthamizh Arignar Dr. Kalaignar on climate change 2008, even before the agreement signed by the world countries 2014.</p>	
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7.2 Risk Assessment

Generally, risk assessment is estimating; what are the chances (probability) of an accident happening, and if it does happen, what are the chances that someone will be hurt? What will be the extent of equipment or environmental damage, and how bad will it be (severity) The level of risk is dependent on the exposure to the hazard and the probability and consequences of an event occurring.



The steps involved in the risk assessment are:

Carrying out risk assessment in a construction site is much more important to prevent the incidents occurring from it. The following steps can be considered as general measure to carry out the HIRA study.

1. Initiating the HIRA
2. Identify the hazard
3. Identify all parties affected by the hazard and determine how they can be affected
4. Evaluate or assess the risk

7.2.1 Approach to the Study

Risk involves the occurrence or potential occurrence of some accidents consisting of an event or sequence of events. The risk assessment study covers the following:

- Identification of potential hazard areas;
- Identification of representative failure cases;
- Visualization of the resulting scenarios in terms of fire (thermal radiation) and explosion;
- Assessment of the overall damage potential of the identified hazardous events and the impact zones from the accidental scenarios;
- Assessment of the overall suitability of the site from hazard minimization and disaster mitigation points of view;

- Furnishing specific recommendations on the minimization of the worst accident possibilities; and
- Preparation of broad Disaster Management Plan (DMP), On-site and Off-site Emergency Plan, which includes Occupational and Health Safety Plan.

7.2.2 Hazard Identification



Work domicile hazards can be notorious in a number of ways. Checks /Inspection provide a system of distinguishing hazardous conditions so that those conditions can be corrected. The data collected while performing inspections will be used to identify hazards and barriers to working safely and in an environmentally protective manner so that they can be addressed such as procedure changes or purchasing different PPE. The data also will be tracked as a protective measure of acceptable HSE behaviour on the site. Reports and safe work observation information will be shared with employees at toolbox safety meetings.

7.2.3 Identification of Hazard in Construction Unit

In a construction site hazards can be continuously present through the work time of labours, which can be fatal. The various reason triggering to the hazards are working at height, working on an unsupported beam, underground trench work without appropriate safety measures, the workers may be hit by the moving machineries, exposure to dust, chemicals etc.

The routine operations carried out in the construction site include:

1. Excavation work

2. Scaffolding work
3. Material handling
4. Hoisting work
5. Working at height.
6. Electrical work.
7. Underwater diving activity.

EXCAVATION WORK

Excavation is one of the most hazardous activities carried out in the construction site. There are high chances of fatalities in the trenching Work if there is lack of safety precaution. All the excavation activity deeper than 1.25 metres must be shored or battered. If the depth of the trench is more than 2 meters it should be guarded by guard rails or barriers to prevent the erosion of soil into the trench. Care should be taken to know the presence of underground cables or pipes in the excavation area to avoid any incidents by damaging them.

The movement of vehicles near the excavation work should be taken extra care as there are high chances of collapsing of the soil. There should be inspection of the trenches on a daily basis in the construction site and the stability of the shoring/guardrails must be ensured.

SCAFFOLDING WORK

Scaffolding is a temporary structure installed in any construction site to elevate or carry the workers during construction or maintenance activity. These structures are made up of steel, timber or bamboo. The scaffolding consists of horizontal and transverse members called as ledgers. Transverse cross bracing method is also used for erecting the scaffolds. The same process of erection of temporary structures should be followed for erecting scaffolds. The stability of the entire scaffolding depends on the strength of each member in the scaffolds. In case of defects in one of the member in scaffolding can lead to the collapse of the entire structure and can cause fatal incident. Daily inspection of the scaffolding structures should be ensured by a competent person.

The modern scaffolding structures are made up of steel braces and are pre-fabricated in convenient units. They are much safer and will give better stability on the platforms. While working on the scaffolding platform all the workers should adhere to PPE's such as full body harness, safety belts etc. to avoid any catastrophic incidents.

MATERIAL HANDLING

Handling of materials is an essential process in the construction sites which involves the movement of construction materials from place to place. Workers are continuously exposed to

hazards arising from the material handling equipment. Different types of cranes used in the construction site are

- i. Portable cranes
- ii. Tower cranes

Several cases of accidents have been reported involving the cranes and most of the cases can be avoided by following the safe operating methods.

Some of the safety to be followed during crane operation are listed below:

- The maximum load carrying capacity of the crane should be clearly estimated and ensured during every activity.
- Maximum safe load indicator must be fitted with the crane.
- The operation of crane should always be carried on a strong base platform.
- The loads and dead weights should be fitted properly on the equipment.
- There should be a well-trained signal man to give commands to the operator.
- The ropes, hooks, chains, slings used in the equipment should be regularly inspected and checked for worn outs. If any deviation found, then it should be replaced immediately.
- The crane operator should be familiar with the operating procedure of the particular equipment and should follow the Safe Operating Procedures.
- While using the mobile cranes extra care to be taken to prevent the overturning of the crane.
- Ground inspection should be done before installing the crane.
- The outer trigger of the crane should be completely extended and the minimum distance should be 1 metre from any excavation or trench hole.
- The crane should not be operated in case of high winds.
- High reflective jackets should be worn by the rigger always.
- Barricading should be done in the swinging radius of the crane and unauthorised entry should be prevented.
- There should be at least two taglines used for controlling the swinging of the load.
- No man movement is allowed under the suspended load of the equipment.

Regular inspection of cranes is important. The following points should be taken care while inspecting the cranes:

- There should a valid lifting wok permit obtained.
- Operator third party & license.
- Safety certificate and fire extinguishers of the crane.
- Anti-tube block/limit switch (it will stop the function of crane hook once it touches and it will prevent from hook from hitting to top boom pulley).
- Safety latch of a main and auxiliary hook.
- PPE of working crew especially leather gloves for rigger and safety harness.

- Safety latch of a main and auxiliary hook.
- Check for any leakages in the hydraulic oil.
- Check for the position of outriggers and mates.
- Safety latches should be checked in main and auxiliary hook.
- The cabin of the crane should be visible even from a blind spot.
- Limit switches should be examined.

HOISTING WORK

Hoists are used to move heavy objects and equipment. As the hoists consist of various components, failure of any one component can lead to disastrous accidents. It requires regular inspection and monitoring. Even if a small damage found in the hoisting equipment during inspection, it should not be used.

The hoist inspections should cover the following aspects:

- The hooks on all blocks, including snatch blocks, must have proper safety latches and it should be in good working condition.
- All hooks on hoisting equipment should be free of cracks and damage.
- There should be clear identification of the maximum load carrying capacity in every equipment.
- Electric cables and wiring of electrical equipment's should be intact and no damages to be found on the wiring.
- Equipment shall be fitted with appropriate safety devices.

There should be some mandatory safety measures followed during the hoisting operation which are listed as follows:

- There should not be any man movement beneath the hoisting equipment.
- The hoisting area should be completely barricaded and signage's should be placed.
- There should not be any unauthorised man movement inside the hoisting area.
- The load should never exceed the maximum load capacity of the equipment.
- Never stand or walk beneath a hoisting equipment.
- Wear gloves, helmets and other personal protective equipment's when working with hoists and cables all the time.
- There should be regular inspection of the hoists.
- The integrity and stability of loads shall be verified before lifting.
- Once the work is done, the rig should be hoisted down and secured properly.
- When the load hoist is at floor level or its lowest level, ensure that at least two turns of rope remain on the drum.

- Be prepared to stop operations immediately if signalled by the safety watch or another person.
- Ensure that the hoist is directly above a load before picking up. This keeps hoist from becoming stressed.
- Hoisting at poor angles might result in injury to the people and also damages the hoist.
- Make sure that there is no high voltage electrical cable running within 6 metres of hoisting area.
- In case of hoisting activity to be carried out near the electrical lines, there should be electrical clearance certificate obtained from electrical supervisor.

CRANE BARGES & FLOATING DERRICKS

- Floating cranes are generally used in the construction in water bodies for lifting heavy construction materials and machines. There should be regular inspection of the cranes before usage.
- The load rating of a floating crane/derrick shall be the maximum working loads at various radii as determined by the manufacturer or qualified person considering list and trim for each installation.
- The load rating shall specifically reflect the: design standard; machine trim; machine list; and dynamic/environmental loadings anticipated for the operational envelope of the floating crane/derrick or auxiliary shipboard crane.
- The load rating of the crane should be suitable to the type of construction activity performed in the site.
- The load rating is dependent upon the structural competence of the crane or derrick, rope strength, hoist capacity, structural attachment to the floating platform, and stability and freeboard of the floating platform.
- When deck loads are to be carried while lifting, the situation shall be analyzed for modified ratings.
- When mounted on barges or pontoons, the rated loads and radii of land cranes and derricks shall be modified as recommended by the manufacturer or qualified person. The modification shall be evaluated by the qualified person specific to the floating platform mounting the crane.

FORKLIFT OPERATION

Fork Lifts are very commonly used in construction sites for movement of heavier construction materials and stacking them at heights. The following measures should be available each forklift equipment.

- Daily checklist to be maintained.
- Proper inspection and Annual Maintenance Cost should be available.
- Reverse alarm should be fitted in the equipment.
- Spotlights should be fitted on the equipment.
- Load test certification should be available for the equipment.

While using the forklifts in a construction site, the following safety measures must be followed and adhered by the employees:

- Never walk, stand or work under the elevated portion of a fork lift even the fork is not loaded with material.
- Ensure that the fork lift has overhead barriers to protect the operator from falling objects from an elevated height while loading or unloading.
- Only authorised persons are allowed to operate the equipment.
- There should not be lifting of employees on the fork.
- Always wear the seat belt while operating the machine.
- Unless there is material on the forks, it should in lowered condition while in movement.
- The load carried should not exceed the maximum carrying capacity of the equipment.
- Do not operate a fork lift in an area with hazardous concentrations of acetylene, butadiene, hydrogen, ethylene or diethyl ether, or other explosive environment.
- Do not load a forklift while the equipment is in motion.
- The centre of gravity of the equipment must be maintained always while carrying the loads.
- While carrying the loads adjust the fork according to gain stability of the equipment.
- Make sure that you travel with loads at the proper height. A stable clearance height is usually 4 to 6 inches at the tips and 2 inches at the heels of the fork blades.
- When preparing to leave the equipment unattended, lower the mast, neutralize the controls, shut the power off, and set the brakes.
- If the load is oversized and blocking the pathway, drive the equipment in backward direction and donot try to look over the load.
- Do not raise or lower the load while travelling
- Have clear visibility of the work area and ensure you have enough clearance when raising, loading, and operating a forklift
- Be aware of other vehicles in the work area.
- Use horns at cross aisles and obstructed areas
- Watch for pedestrians and observe the speed limit while movement.

- Always keep a safe distance from the ramp edges and platform.

WORKING AT HEIGHT

Ladders are one of the most popular items used in the construction sites for working at heights. However, if there is improper usage the ladder can take many lives off. The following safe methods should be adopted while operating ladders:

- Always have a three-point contact while climbing on the ladder.
- Always have a firm grip on the ladder and keep a good balance.
- Make sure the climbing and gripping surfaces are clean and free of oil, grease, and other slip hazards
- Make sure that your shoes are clean of any substances which could cause you to slip
- Use the ladder at a correct angle and make sure it's secured
- Make sure you use your ladder on firm and level surfaces
- There should be always one person on a ladder.
- Only use ladders for their designed purpose.
- Do not lean out from the ladder in any direction.
- If you have a fear of height doesnot climb on a ladder.
- In case the ladder is found defective never use it.
- Do not carry objects that could cause loss of balance.

ELECTRICAL WORK

Electricity can cause great damage to both people working in the construction sites and property. Almost every construction work is associated with electrical hazards as most of the construction equipment's uses electricity for their operation. Contact with the electric current can trigger other incidents, like slips, trips or falls from ladders or other elevated platforms and injuring other persons. Electrical shocks or flashes can cause serious injuries such as burns. Electric shock may also cause the victim to stop breathing and nerve centres may be temporarily paralyzed.

In case of high voltage shocks it may lead to fatal incident. Apart from human injuries like shock, burns or falls, another major hazard is the situation in which an electrical fire or explosion may occur. Fires and explosions due to electricity generally cause extensive property & equipment damage. The hazards causing electrical failure are as follows:

1. Voltage fluctuation
2. Loose connection of wires
3. Usage of damaged or faulty appliance.
4. Use of extension chords for high voltage equipment's.
5. Cut powerlines

Electrical Fires often start when an overloaded circuit becomes overheated – igniting the insulation around the wires. If cords and cables are frayed or worn out, bare wires might touch each other, thus causing a short circuit that could spark a fire. If any faulty or malfunctioning equipment is found during inspection, it must be removed immediately. And maintenance activity must be carried out. Necessary training must be provided to workers in monitoring the electrical equipment's and replacing the faulty ones. Make sure that the workers at the construction site understand the importance of electrical safety. All the workers must be able to recognize that abusing or misusing electrical equipment is an invitation to an accident. The management should take necessary actions in ensuring that all the employees are provided with necessary Personal Protective equipment's to get prevention from the electrical hazards.

UNDERWATER DIVING WORK

The employer shall develop and maintain a safe practice manual, and make it available at the dive location for each dive team member. The employer shall keep a record of each dive. The record shall contain the diver's name, his or her supervisor's name, date, time, location, type of dive (scuba, mixed gas, surface supply), underwater and surface conditions, and maximum depth and bottom time.

Each dive team member shall have the experience or training necessary to perform assigned tasks safely. Each dive team member shall be briefed on the tasks, safety procedures, unusual hazards or environmental conditions, and modifications made to the operating procedures. The dive shall be terminated when a diver requests it, the diver fails to respond correctly, communication is lost, or when the diver begins to use the reserve breathing gas.

HEALTH RISKS IN DIVING

COMPRESSSION & DECOMPRESSION

The bends, also called decompression sickness. This is a condition where a diver rises too quickly. Nitrogen that is in his body, from breathing compressed air, needs time to leave the body. If this is not allowed then the diver can experience the bends. The only cure for this is a decompression chamber, which must be present whenever scuba work is being done. Warning signs are; sore joints, itchy skin, vision and hearing difficulty, paralysis, and death.

The best way to prevent decompression sickness is to avoid diving too deep, do not stay deep above the recommended time, ascend slowly with regular stops along the way, and limiting number of dives per day.

Nitrogen Narcosis

This is an affect similar to alcohol intoxication. This condition is caused because more gases are breathed, while underwater, from the oxygen supply. Because of the greater pressure, these gases are absorbed into the body easier than at sea level.

Oxygen Toxicity

This is a condition where higher levels of oxygen are breathed. This has an affect on the body, and can result in; disorientation, trouble breathing, trouble with vision, lung damage, seizures, and death.

SAFETY PRECAUTIONS TO BE CONSIDERED

- Only certified divers should be allowed to carry out the job.
- Proper site specific training should be provided to all the divers.
- Check working condition of equipment.
- Plan the dive: time, depth, work to be done and stick to the plan.
- Never dive alone. Always have at least one partner that you will stay close to.
- Site should have rescue plan in place for divers.
- Know where the nearest decompression chamber is located and how to get help.
- Descend slowly.
- Ascend slowly with the scheduled breaks.

7.2.4 Methodology

Following aspects have been studied during accidents :

- Flammable characteristics of HSD and LPG;
- Identification of accident scenarios;
- Analysis of past accidents taken place in similar conditions to establish credibility to identified scenarios

7.2.5 Common Causes of Accidents

Based on the analysis of past accident information, common causes of accidents are identified as:

- Poor housekeeping;
- Improper use of tools, equipment, facilities;
- Unsafe or defective equipment facilities;
- Lack of proper procedures;
- Failure to follow prescribed procedures;
- Jobs not understood;
- Lack of awareness of involved hazards;

- Lack of guides and safety devices; and
- Lack of protective equipment and clothing.

7.2.6 Failures of Human Systems

Major causes of human failures reported are due to:

- Stress induced by poor equipment design, unfavorable environmental conditions, fatigue, etc;
- Lack of training in safety and loss prevention;
- Indecision in critical situations; and
- Inexperienced staff being employed in hazardous situations.

Often, human errors are not analyzed while accident reporting and accident reports only provide information about equipment and/or component failures. Hence, a great deal of uncertainty surrounds analysis of failure of human systems and consequent damages.

7.2.7 Conclusion

Results of FE&TI analysis show that the storage of LPG cylinders and HSD falls into marginal and light category of fire and explosion index with zero toxicity index.

7.3 Hazard Assessment and Evaluation

7.3.1 Introduction

An assessment of the conceptual design is conducted for the purpose of identifying and examining hazards related to feed stock materials, major process components, utility and support systems, environmental factors, proposed operations, facilities and safeguards.

7.3.2 Methodology

An assessment of the conceptual design is conducted for the purpose of identifying and examining hazards related to feed stock materials, major process components, utility and support systems, environmental factors, proposed operations, facilities, and safeguards.

7.3.3 Preliminary Hazard Analysis (PHA)

A preliminary hazard analysis is carried out initially to identify the major hazards associated with storages in the proposed project. This is followed by consequence analysis to quantify these hazards. No major hazards with potential for any emergency situation exist in the project site.

7.3.4 Maximum Credible Accident Analysis (MCAA)

Hazardous substances may be released as a result of failures or catastrophes, causing possible damage to the surrounding area.

Table 7-1 Preliminary Hazard Analysis for Process and Storage Areas

Equipment	Process	Potential Hazard	Provision
Diesel Generator	Converts mechanical energy into electrical energy.	Mechanical hazards and fire hazards in 1. Lube oil system 2. Cable galleries 3. Short circuits	As above
Power Transformers	-	Fire and explosion	All electrical fittings and cables are provided as per the specified standards.
Switch Yard control room	-	Fire in cable galleries and switch	As above
HSD Storage	Used as start-up fuel for DG sets.	Fire & explosion	Leaks detection system will be provided.

Table 7-2 Preliminary Hazard Analysis in General

PHA Category	Description of Plausible Hazard	Recommendation	Provision
Environmental factors	If there is any leakage and eventuality of source of ignition.	-	All electrical fittings and cables will be provided as per the specified standards. All motor starters are flame proof.
	Highly inflammable nature of fuels may cause fire hazard in the storage facility.	A well designed fire protection including protein foam, dry powder, CO ₂ extinguisher should be provided.	Fire extinguisher of small size and big size are provided at all potential fire hazard places. In addition to the above, fire hydrant network is also provided.

It is intended to give an insight into how the physical effects resulting from the release of hazardous substances can be calculated by means of models and how vulnerability models can be used to translate the physical effects in terms of injuries and damage to exposed population and environment. A disastrous situation may arise due to outcome of fire, explosion or toxic hazards in addition to other natural causes, which eventually lead to loss of life, property and ecological imbalance.

Major hazards posed by flammable storage can be identified taking recourse to MCA analysis. Depending upon the effective hazardous attributes and their impact on the event, the maximum effect on the surrounding environment and the respective damage caused can be assessed. The MCA analysis

involves ordering and ranking of various sections in terms of potential vulnerability. Inventory analysis and fire, explosion and toxicity index (FE&TI) are the two techniques employed for hazard identification process in this study.

The results of consequence analysis are useful for getting information about all known and unknown effects that are of importance when some failure scenario occurs in the proposed project and also to get information as how to deal with the possible catastrophic events. It also gives the residents in the project and people living in the vicinity of the area, an understanding of their personal situation.

7.4 Disaster Management Plan

A disaster is a catastrophic situation in which suddenly, people are plunged into helplessness and suffering, as a result, need protection, clothing, shelter, medical and social care and other necessities of life.

Disasters can be divided into two main groups. In the first, disasters resulting from natural phenomena like Tsunamis, earthquakes, volcanic eruptions, storm surges, cyclones, tropical storms, floods, avalanches, landslides, forest fires etc. The second group includes disastrous events occasioned by man, or man's impact upon the environment. Examples are armed conflict, radiation accidents, campus fires, and river pollution, air, sea, and rail and road transport accidents and can reach catastrophic dimensions in terms of human loss.

There can be no set criteria for assessing the gravity of a disaster in the abstract since this depends to a large extent on the physical, economic and social environment in which it occurs. What would be considered a major disaster in a developing country, ill equipped to cope with the problems involved may not mean more than a temporary emergency elsewhere. However, all disaster brings in their wake similar consequences that call for immediate action, whether at the local, national or international level, for the rescue and relief of the victims. This includes the search for the dead and injured and removal of debris and social care, the provision of temporary shelter to the homeless food, clothing and medical supplies, and the rapid re-establishment of essential services.

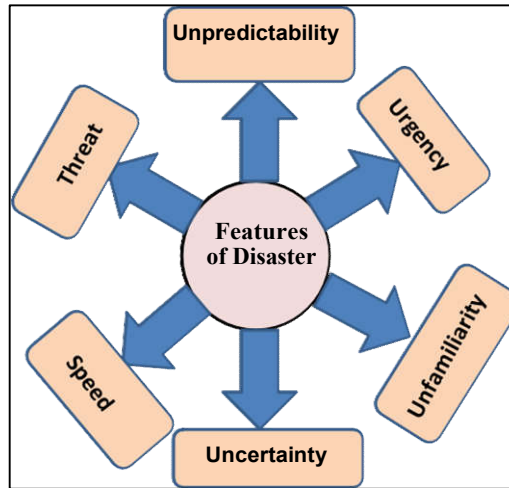


Table 7-3 Seasonal Disaster Mapping

Type of Disasters	Vulnerability Mapping	Seasonal Mapping
Flood,	The vulnerability of floods at the proposed site would depend on the drainage pattern, sewerage system, and heavy rainfall and others	Mainly from October-November as the responsibility of heavy rainfall, and area affected
Cyclone, Tsunami	The vulnerability of cyclone, tsunami at the proposed site depend on the north east monsoon winds.	This is a natural calamity that could take place at any point of time. The affect is seen on H, A and I
Earthquake	Proposed site is located in Chennai which falls under Earthquake Zone III, moderate risk zone, as per the map showing seismic zones of India IS1893(PartI): 2002.	This is a natural calamity that could take place at any point of time. The affect is seen on H, A and I
Fire	Fire accidents could take place due to improper maintenance of electrical wiring, faulty wiring and gas leakage etc. Carelessness is one of the major factors for fire hazards.	It can occur at any point of time and H,A and I are affected by it

H: Human, A: Animals, I: Infrastructure

The proposed project is located in Chennai. It could face various challenges from both natural and man-made hazards as highlighted in previous section. Some of the precautionary measures that could be taken in case of disasters in terms of social aspects are highlighted in consequence section of this chapter.

7.4.1 Objectives of Disaster Management Plan (DMP)

The Disaster Management Plan is aimed to ensure safety of life, protection of environment, protection of installation, restoration of production and salvage operations in this same order of priorities. For effective implementation of the Disaster Management Plan, it will be widely circulated and personnel training given through rehearsals/drills.

The Disaster Management Plan would reflect the probable, consequential severalties of the undesired event due to deteriorating conditions or through 'Knock on' effects. Further the management should be able to demonstrate that their assessment of the consequences uses good supporting evidence and is based on currently available and reliable information, incident data from internal and external sources and if necessary the reports of outside agencies.

To tackle the consequences of a major emergency inside the site, a Disaster Management Plan has to be formulated and this planned emergency document is called "Disaster Management Plan".

The objective of the Disaster Management Plan is to make use of the combine resources of the plant and the outside services to achieve the following:

- Effect the rescue and medical treatment of casualties;
- Safeguard other people;
- Minimize damage to property and the environment;
- Initially contain and ultimately bring the incident under control;
- Identify any dead;
- Provide for needs of relatives;
- Provide authoritative information to the news media;
- Secure the safe rehabilitation of affected area; and
- Preserve relevant records and equipment for the subsequent inquiry into the cause and circumstances of the Emergency.

In effect, it is to optimize operational efficiency to rescue rehabilitation and render medical help and to restore normalcy.

7.5 Social Impact Assessment

The impact of the proposed project will begin with the starting up of the construction activities at the site. The proposed construction will provide employment to considerable number of skilled, semi-skilled and un-skilled construction laborers. In normal circumstances, the local people will be given preference for the unskilled activities, as there are many construction laborers in the vicinity of the

project and are expected to be available with normal wages. Presently, a large number of skilled and semi-skilled technicians and laborers who in-migrated from various parts of India have been engaged in many companies on wages/contract basis. Similar technicians and skilled workers will either be brought or sourced from the local area for construction of the proposed project.

The labor force required during the construction period will be about 100 and it is anticipated that about two thirds of the labor force will be sourced from the local area. Provision of wage employment to the local populace during construction period of the project will benefit the local area to some extent. This will enhance the income levels of the construction laborers and lead for their socio-economic well being during the construction phase of the proposed project, which will be positive impact due to the project.

In addition, the real estate in the region will get a boon and the land prices are likely to shoot-up as part of speculation.

Normally, the construction activity will benefit the local populace in a number of ways, which include the requirement of skilled, semi-skilled and un-skilled construction laborers, tertiary sector employment and provision of goods and services for daily needs including transport. In line with the above, some more recommendations are given below:

- Local people will be given preference;
- All the guidelines under the Labour Act and Safety Rules as specified under Factories Act, 1948 will be implemented during the construction work to avoid any accidents;
- The contractor will be instructed to provide cooking fuel to the workers to prevent damage to trees. This will be part of the contractual agreement between the project proponent and the contractor engaged for construction; and
- The construction site will be secured with fencing and will have guarded entry points.

7.6 Rehabilitation & Resettlement Action Plans

The proposed project does not involve any Rehabilitation & Resettlement issues, as the entire land required for the proposed project and it is available under Greater Chennai Corporation.

7.7 Bathymetry Survey

7.7.1 Introduction

Hubert Enviro Care System Ltd (HECS) and the Indian Institute of Technology, Madras (IITM) are currently investigating the feasibility of constructing a Dr.Kalaingnar Karunanithi Monument off the Chennai coast, Tamil Nadu (Figure 1).In collaboration with IITM, the HECS was commissioned to conduct a bathymetry survey to assess the physical characteristics of the proposed development

area. The date of survey taken was 2nd September 2021 at 7:00 am. The boat type employed was fishing boat (5 knots).

7.7.2 Nature of Survey

- To identify the depth profile in sea at the Monument.
- Bathymetric survey to be carried out in the sea proportionate to Dr. Kalaingnar Karunanithi Monument to the seaward distance from the shoreline
- The survey conducted from Royapuram fisherman harbor to near Dr. Kalaingnar Karunanithi Monument (9 Km) and Horizontal length of 500m along the shore to be covered with 10-12 bathymetric transects from Cooum river mouth to near Dr. Kalaingnar Karunanithi Monument . (Refer Figure).
- The Field Survey Instrument used is Edgetech 4125 Portable Digital Side Scan Sonar (400/900KHz).

7.7.3 Bathymetry Survey

HECS conducted a bathymetric survey using a fishing boat on September 2, 2021, at 7 a.m. The bathymetric survey in the sea, proportionate to the Dr.Kalaingnar Karunanithi Monument, near marina beach, has been carried out by a team from the HECS, IITM and Pacific Blu Subsea services. The survey will cover a distance of 500 meters from the shoreline, up to a depth of 17.46 meters and 10-12 bathymetric transects. The bathymetric survey was sub-contracted, using Edgetech 4125 Portable Digital Side Scan Sonar (400/900 KHz).



Figure 7-1 Bathymetry Survey Transects

A depth contour chart was created based on the interpolation, clearly defining changes in bathymetry across the site (Figure 2 & 3). The depth varies between 0.92 m and 17.46 m. Up to 200 m, 250 m, 300 m, 400 m, and 500 m from shore, the depth is less than 2 m, 3 m, 4 m, 7.1m, and 9.4m respectively.

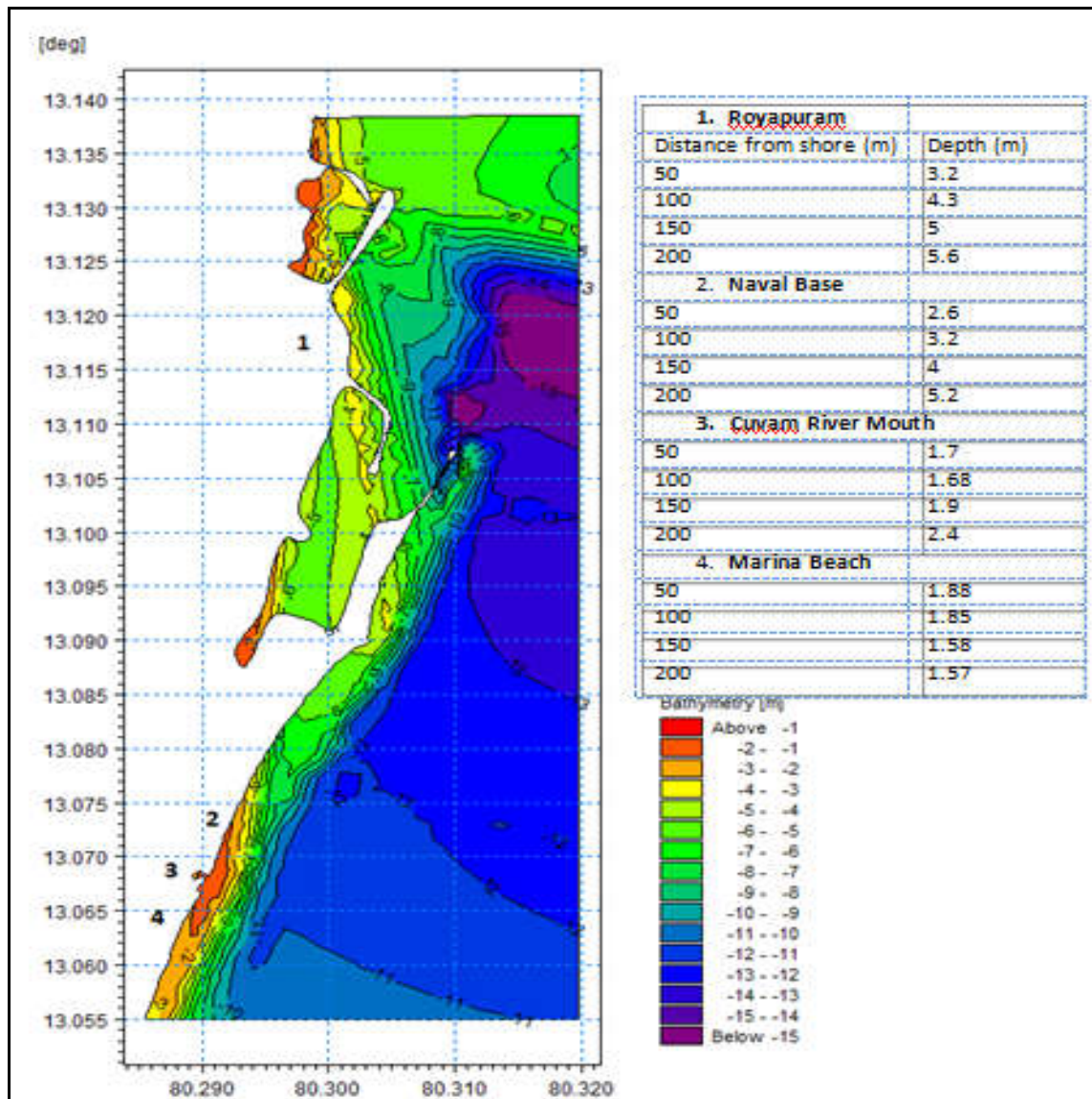


Figure 7-2 Interpolated depth measurements



Figure 7-3 Bathymetry survey transects (Proposed site)

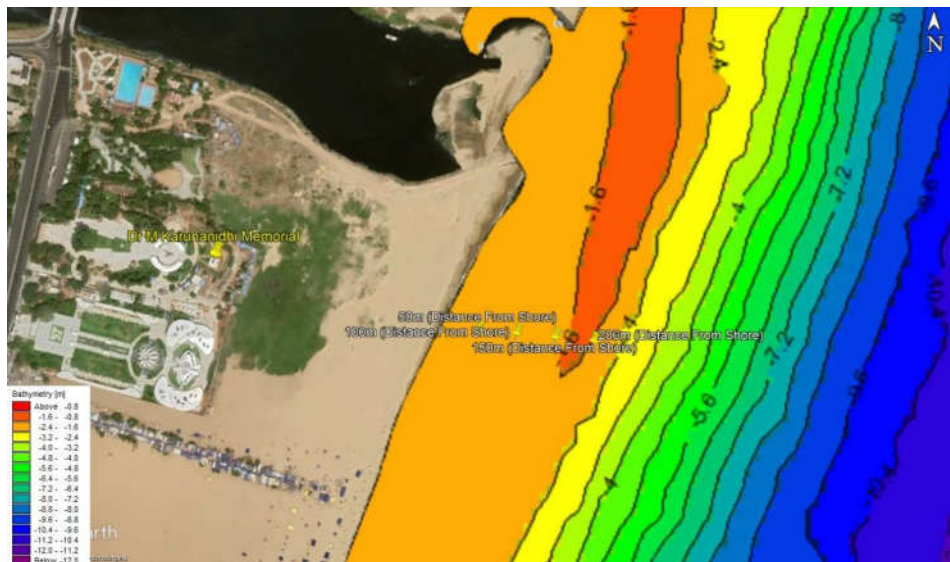


Figure 7-4 Interpolated depth measurements at Marina Beach

7.7.4 Findings of Bathymetric Study

The table below shows the distance from sea shore and corresponding depth for considering the suitable location for the monument.

Distance from shore (m)	Depth (m)
50	1.88
100	1.85
150	1.58
200	1.57
250	3.40
300	4.50
350	5.77
360	6.00
400	6.80
450	7.80
500	9.10

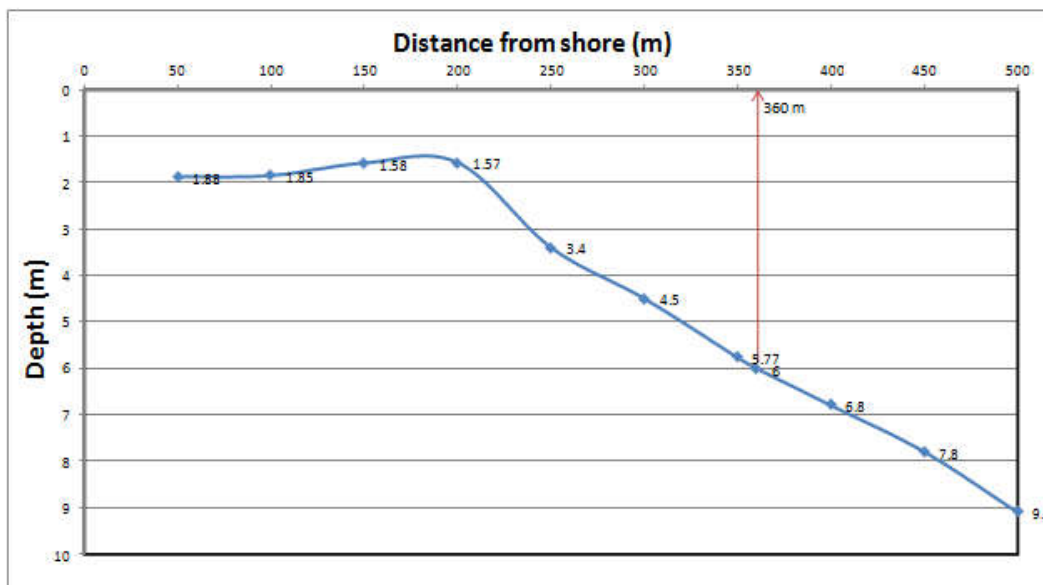


Figure 7-5 Distance from sea shore and corresponding depth

7.7.5 Field survey photos



Transducer Fixing



GPS and transducer in a same line fixing



Draft measurement and fixing transducer



Configured with Hypack

Survey Started

Figure 7-6 Distance from sea shore and corresponding depth

CHAPTER 8
PROJECT BENEFITS

8. PROJECT BENEFITS

8.1 Improvement in the Physical Infrastructure

- The proposed project will enhance tourism and will be a great privilege to the late chief minister Muthamizh Arignar Dr. Karunanithi for his tremendous contribution in improvising the welfare of the people in Tamil Nadu.
- To create an environment that could support the culture of good standards;
- To enhance aesthetics profile of the area due to Green Belt, Landscape and Water fountain.

8.2 Financial Benefits of the Project

As the proposed site is tourism attractive one, moreover it is situated in the prime location of the Chennai district. The population influx would be high along with the direct and indirect employment generation which would subsequently increase the financial status of the particular region.

8.3 Social Benefits of the Project

The significance of the proposed site is to symbolize the remembrance of tremendous contribution of Dr. Kalaignar Karunanidhi in the various fields of literature, art, social works, politics and cinema industry. This will indent the minds of people to enhance their morality.

- Chennai Marina Beach, the second longest beach in the world and this project adds value to tourism, education, culture, literature & economy of the state with approximately 10,000 visitors per day.
- This monument not only providing a place for people to visit, but also create an international acclaimed landmark of our country.
- This project will increase direct and indirect employment opportunities.

CHAPTER 9
ENVIRONMENTAL COST BENEFIT
ANALYSIS

9. ENVIRONMENTAL COST BENEFIT ANALYSIS

(Not recommended for scoping stage)

CHAPTER 10
ENVIRONMENTAL MANAGEMENT
PLAN

10. ENVIRONMENTAL MANAGEMENT PLAN

Environmental Management Plan (EMP) is special significance in proposed development because of the pollution potential especially in terms of Air, Water, Soil, Noise and Solid waste. This chapter presents an overview of Environmental Management Plan.

The main objectives of Environmental Management Plan are to:

- Identify key environmental issues envisaged to be encountered during construction and operation phases of the project.
- Provide guidelines for appropriate mitigation measures.
- Establish systems and procedures for implementing mitigation measures
- Ensure that the mitigation measures are being implemented
- Monitor the effectiveness of mitigation measures
- Institutional framework includes the responsibilities for environmental management as well as responsibility for implementing environmental measures
- Take necessary prompt action when unforeseen impacts occurs

The anticipated environmental impacts and mitigation measures for each likely impact on the prevailing environment have been discussed in detail at the respective sections in Chapter 4. The Environmental Monitoring Programme for implementation of proposed mitigation measures has been discussed. Following specific environmental management plan/measures are discussed in this chapter:

- Landscaping and Greenbelt development
- Waste Water Management

10.1 Landscaping and Greenbelt Development

The proposed structure is a Pen Monument and governed by the Town and Country Planning norms of Government of Tamil Nadu and Building by laws of Chennai Metropolitan Development Authority.

About 572.07 Sq.m (6.69 %) areas will be reserved for green cover / lawn development in the proposed. Suitable plant species of local varieties will be planted with adequate spacing and density for their fast growth and survival.

The greenbelt helps to capture the fugitive emissions and to attenuate the noise generated in the premises apart from improving the aesthetics of the site. Plantation program is undertaken in all available areas. This would include plantation in the premises.

The plant species selected for greenbelt will include the native species. These saplings will be planted in rows. The plantation at the proposed project will be taken into consideration of the existing social forestry in the region.

10.2 Wastewater Management

STP of 10 KLD capacity is proposed and the treated sewage will be reused for Landscaping and greenbelt development within the Pen Monument.

10.3 Proposed Cost of the project

Sr.No.	Description	Amount
1	Ramp from Land memorial, Buggy drop off area & Bridge – Landward side	14,60,00,000
2	Provision for Lattice bridge arrangements	10,00,00,000
3	Bridge & Pen monument podium area-seaward side	31,25,00,000
4	Working platform arrangements for construction works in marine environment	8,66,58,400
5	Provision for Pen Monument	40,00,000
6	Provision for Buggy Vehicles	16,80,000
7	Provision for Lightining arrangements & Lamp Post	17,50,000
8	Provision for Landscaping & Gardening	11,00,000
9	Provision for SS Handrails & Glass Ballustrade	1,00,00,000
10	Provision for Structural Laminated Glass	1,25,00,000
11	Provision for Ferrari Roof Canopy	20,00,000
12	Provision for Electrical , Fire & Service	2,00,00,000
13	Provision for DPR , Feasibility report, Environmental related works & PMC.	2,50,00,000
Sub Total		72,31,88,400
Add 12% GST		8,67,82,208
Round Off		28,992
Total Value of Work		81,00,00,000

10.4 Cost Provisions made in EMP

Sr.No.	Description	EMP Cost (INR Lakhs)			
		Capital cost	Recurring cost 2024-2025	Recurring cost 2025-2026	Recurring cost 2026-2027
1	Greenbelt	5	3	3	3
2	Marine Monitoring	10	10	10	10
3	Terrestrial Monitoring	6	2	2	2
4	Solid waste Management	5	2	2	2
Sub Total		26	17	17	17
Total		77			

10.5 Mitigation Measures

10.5.1 Construction Phase

The construction phase involves site preparation, transportation of construction materials and equipment and construction of the infrastructure. This is not a long-term impact as this is a temporary phase.

10.5.2 Operation Phase

The proposed project involves construction and function of the monument. This does not involve any manufacturing or chemical processes, hence does not involve in any severe environmental pollution such as air and water and wastewater pollution.

Table 10-1 Impact Analysis on various parameters with Mitigation measures

Sr.No.	Parameters	Impacts on Construction Phase	Impacts on Operation Phase	Mitigation Measures
1.	Air Environment	4. Generation of suspended particles during the site development activities such as levelling of land, transportation of construction materials, drilling etc. 5. Operation of DG sets 6. Increase in vehicular movement which increases the concentration of pollutant level of SO ₂ , NO _x and CO.	1. Only controllable fugitive emissions are noticed. 2. Operation of DG set, in case of power failure.	1. Regular sprinkling of water will be done at frequent intervals for eliminating the fugitive emissions. 2. Proper maintenance of construction equipments will be done. 3. The vehicles equipped for conveying construction materials will be duly serviced and maintained. 4. During operation phase, no machinery or equipment are to be used anywhere in the project. For that, no chances of air pollution do really exist in the monument complex.
2.	Water Environment	Water requirement for the construction phase will be of 15KLD.	No major impacts on water environment will be witnessed during the operation phase	3. The proposed project is going to utilize modernized equipment for drilling operations for the foundation of the project, using encased drilling equipment; which would suck out the debris, so that debris could be segregated and collected separately; this would prevent spillage of debris and solid waste into the sea. 4. The impact on various aspects of ecology have been studied in detail by accredited experts and researchers and based on their recommendation; all necessary steps would be taken to completely minimize the impact on ecology due to this project.

5.	Noise Environment	The major source of noise will be due to the operation of construction equipments and drilling operations.	During operation phase, no machinery or equipment are to be used anywhere in the project. For that, no chances of noise pollution do really exist in the monument complex	3. In the construction equipments, to minimize the noise level, acoustic enclosure will be installed within. 4. Moreover, all the labourers will be provided with PPEs.
6.	Land Environment	No major impacts on land are envisaged. The minor impacts may include accumulation of construction debris and other materials.	There will be positive impact in the land environment of the project site, by improvising the aesthetics around the project site.	The proposed project is going to utilize modernized equipment for drilling operations for the foundation of the project, using encased drilling equipment; which would suck out the debris, so that debris could be segregated and collected separately; this would prevent spillage of debris and solid waste in the land.
7.	Soil Environment	Accumulation of soil due to drilling works Dripping of oil from construction vehicles	The impacts in the soil will be restricted to construction phase only	Continuous monitoring of the soil accumulation will be carried out. The vehicles equipped for conveying construction materials will be duly serviced and maintained.
8.	Social Environment	Fishermen can engage in their fishing activities even during the construction period. Direct and indirect employment will be generated.	It will be known as the international acclaimed landmark tourism site. Aesthetics of the project site and around the Marina Beach will be improved	The various studies pertaining to the impact of the monument on local ecology, socio-economy and cultural life of the fishermen and other people living around the area are carried out.
9.	Marine Ecology	Chances of the accumulation of debris and other materials into the sea Construction activities may affect the life of Olive Ridley Turtles and marine ecology.	No major impacts during operation phase	The impact on various aspects of ecology including shoreline accretion/erosion among the marine life, life of turtles, prawns etc., have been studied in detail by accredited experts and researchers and based on their recommendation; all necessary steps would be taken to completely minimize the impact on ecology due to this project. From the marine survey, it is observed that seabed was devoid of any sensitive species like coral

				<p>reefs, sea grass and olive ridley turtles at the time of survey conducted. Sea bed sediment was sandy in texture; based on the physical observations.</p> <p>The sensitive species like sea grass, sea weeds, coral reefs and turtle which were not identified at all locations the depth of 2.5m to 9m from the shoreline</p>
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10.6 Safety measures taken for the Visitors and Monument:

1. Width of the Bridge: The width of the bridge has been increased from initially designed 7m with two unidirectional walkways of 3.5m each and the width of glass is reduced to 2m.

The configuration will be 3.5m walkway – 2m Glass- 3.5m Walkways

However, in emergency, the entire area will be used for evacuation.

2. Hand Rails: Removable hand rails will be provided to separate the glass area and walkways. The movement will be restricted as 'unidirectional'.

3. Flooring of Bridge: The flooring will be constructed with anti-skid materials like semi-polished rough granite stones to reduce the chances of slips even during rainy season.

4. Alarm & Public Address System: Alarm system along with Public Address System for communicating in emergency will be installed. The complete area will be under surveillance and the PA system will be utilized to control the crowd and regulate the crowd that will be used for Fire alarm, Tsunami, cyclone, heavy wind and rain announcements and any other natural calamities.

5. Emergency Exit at key points: Emergency exits will be provided in equal intervals with proper signage and emergency lightings.

The evacuation plan with necessary instructions, in Monitors will be kept at the entrance and in walkways to induct the visitors.

6. Availability of life rafts and life boats: The life rafts will be made available near by the emergency exists. Life boat will also be kept ready at the proximity of the emergency exists.

This will be done with the support of Department of Information and Public Relations and more assistance will be provided by coast guard and police during any emergency /distress.

7. Controlled Entry: The entry to the monument will be restricted with check points and automatic counters. The automated gates will be linked with the counters and it will be opened only when it matches the criteria of allowable strength within the project area.

The maximum number of visitors will be limited to 800 at a time, so as to evacuate them easily in case of any emergencies.

8. 24x7 safety surveillance & security system: CC TV system will be installed and the project will be monitored from the control room by the security personnel.

Proper communication system will be made between this control room and the Tamil Nadu State Disaster Management Authority. (TNSDMA)

The security personnel deployed within the project site will be connected with the control room to pass timely instructions.

9. Provision of First Aid kit and competent first aiders: First Aid Kits will be kept at suitable places along with log books. This will be handled by competent personnel. The emergency management cell will be formed and appointed at site.

The roles and responsibilities will be clearly defined and proper training will be given.

10. Provision of buggies: Two buggies are proposed at the site to support elderly and specially-abled persons. The same will be utilised to move persons in emergencies and those who need medical care during their visit.

However, during Evacuation, this will be used to evacuate the especially abled/vulnerable group, if it feasible.

11. Display of meteorological data and warnings at the entrance: Met data will be monitored and displayed at the entrance and nearby the monument.

A Display will be kept in control room and warning note will be given by the authorised security personnel, through PA system.

12. Display of evacuation routes at equal intervals: Evacuation route will shown with:

1. You are here note
2. Easiest way to exit
3. Location of Fire extinguishers, fire hydrant system, first aid kits
4. Emergency numbers such as Ambulance, Fire Extinguisher, Child Help , Traffic police, Accident Helpline, Disaster Helpline, Chennai Corporation Complaints etc., will be displayed
5. Video and schematic emergency route will be displayed.

The emergency procedure will continuously be shown during the visiting hours, in Tamil, English and Hindi.

13. Provision of metal detector scanning while entering the monument: Security team will be trained to detect and report to the department concerned, with no time, in any case of threats including terrorist attacks.

14. Earthquake resistant construction: The construction of pen monument will be complied with earthquake resistant construction standards, viz:

- a.. IS 1893-2006 for Earthquake resistance
- b. IS 4651 parts I to V & IS 456

15. Provision for Lightning arrester: Proper lightning arrester will be installed at the top of the pen to protect the monument from the lightning.

16. Corrosion resistant construction material: The chances of corrosion are quite high as the pen monument will be located in Bay of Bengal off the Coast of Marina Beach. So as to mitigate, anti-corrosion material will be implemented to prevent the corrosion.

17. Provision of proper inspection and maintenance of the structure: A maintenance team will be appointed to execute this. Periodical review meetings shall be conducted to evaluate the strength of the project and any other issues.

18. Provision of shades on the walkway: There will be two shades given in the bridge /walkways to take rest, especially during sunny days.

First aid may be facilitated at this place, if needed. Provision of drinking water will also be provided.

19. Spiral ladder within the pen monument for maintenance: Entry will be restricted only to the service men with proper Permits to Work and under strict supervision.

Strict Permit To Work (PTW) system will be implemented including that for confined space entry.

CHAPTER 11

SUMMARY & CONCLUSION

11. SUMMARY & CONCLUSION

Proposed Construction of Muthamizh Arignar Dr.Kalaignar Pen Monument in Bay of Bengal off the coast of Marina Beach near Triplicane village, Chennai District.

The pen monument is to be placed in Bay of Bengal off the coast of Marina Beach at a distance of 360 m from the shore line in CRZ-IV (A) area, as per section 4(ii) (j) of CRZ Notification amended on March 22, 2016 for construction of memorials/ monuments and allied facilities by the concerned State.

Tamil Nadu Public Works Department was entrusted M/s. Hubert Enviro Care System Pvt. Ltd., Chennai to undertake Environmental Impact Assessment (EIA) studies for assessing the impact of the entire project on various environmental parameters in the study area and to prepare an Environment Management Plan for negating the adverse impacts of the proposed project

11.1 Conclusion

- The total area is **8551.13Sq.m (2.11 Acres)**. The proposed pen monument requires CRZ Clearance because it involves both onshore and offshore construction.
- As per the CRZ delineation map and CRZ report, the project site covers CRZ-IVA, CRZ IA & CRZ II areas.
- The proposed cost of the project is INR 81 Crore.

- **Water Requirement**

Construction Phase:

For domestic purposes, 10 KLD of water will be required; whereas for construction 5 KLD will be required and the source of water is met through Chennai Metro water tankers.

Operation Phase :

Domestic: 5 KLD and source of water is met through water dispensers kept at various locations within the site.

- **Power Requirement**

Construction Phase:

- 500 kV will be sourced from TANGEDCO
- DG set of 125 kVA capacity is used for power backup.

Operation Phase:

- Power supply and DG backup will be used for lighting load
- 100 kV will be sourced from TANGEDCO

- There will be no withdrawal of water from surface as well as subsurface.
- Approximately 45 kg/day of solid waste will be generated in the premises during construction phase and it will be disposed in local municipal bins.
- Approximately 98 kg/day of solid waste will be generated in premises during operational phase and it will be disposed in local municipal/corporation bins on daily basis.
- Domestic sewage will be sent to STP of 10 KLD capacity that is already been proposed in (Dr. Kalaignar Memorial, which got its clearance vide dated on 06.01.2022 and started its construction) for treatment and the treated water will be used for green belt. The sludge will be used as manure for green belt. No discharge of effluents on land/Sewer/Marine environment.
- There will be marginal impact on Air, Noise, Biodiversity, Soil, Land and Water Environment which could be fully mitigated by Environment Management Plan (EMP).
- The Environmental Impact Assessment (EIA) study has been carried out and assessment made for the proposed project based on the baseline quality data collected for the study area. Identification and anticipation of the potential environmental impacts due to the proposed project with a delineation of appropriate impact mitigation measures is provided in the EIA report prepared.

12. DISCLOSURE OF CONSULTANTS

In order to assess the potential environmental impacts due to the “Proposed construction of Muthamizh Arignar Kalaignar Pen Monument in Bay of Bengal off the Coast of Marina Beach near Triplicane Village, Chennai District” by Public Works Department, engaged M/s. Hubert Enviro Care Systems (P) Limited, Chennai to undertake EIA study. The nature of consultancy service rendered covers terrestrial and Marine environmental assessment.

12.1 Brief Profile of Hubert Enviro Care Systems (P) Limited (HECS)

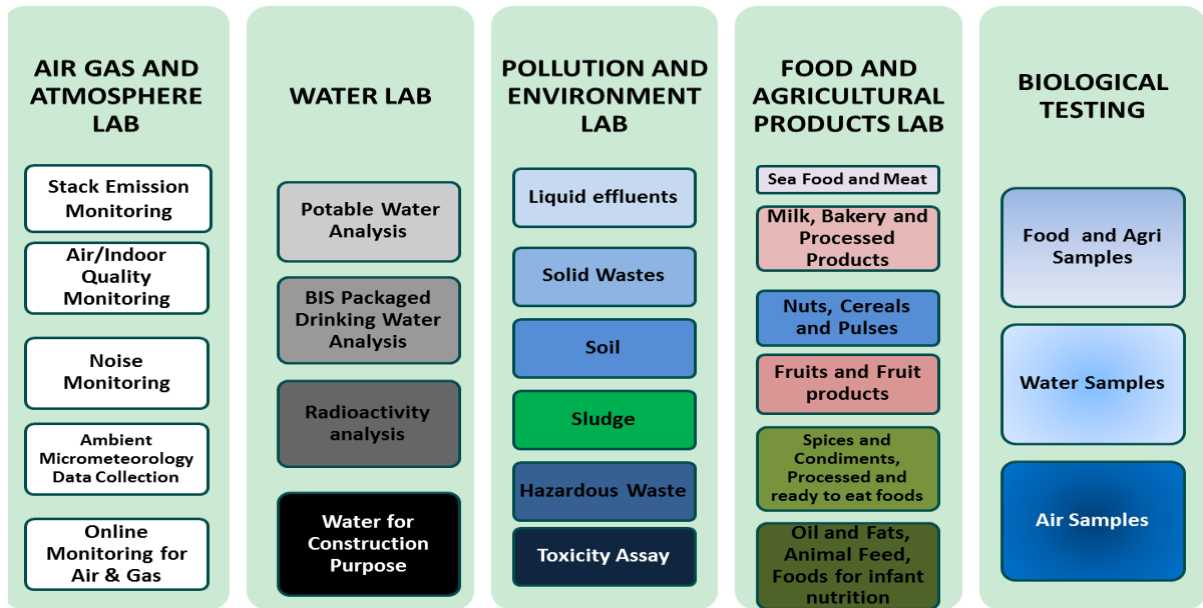
HECS is a total Environmental management company which provides Environmental consultancy services, Analytical testing services, turnkey solutions and Operation-Maintenance services for water and wastewater facilities.

The company provides solutions to several industries like Refineries, Thermal Power Plant, Pharma, R&D Facilities, Electroplating and Manufacturing, IT Parks, Residential Complexes, Mines, Dairies, Food Processing, Textile mills, Breweries, etc.

The company is specialized in executing projects right from concept development, supply, erection, commissioning and operation on turnkey basis. HECS has successfully executed more than 300 environmental engineering projects for various industrial sectors both in India and overseas.

12.2 Consultancy Profile


- HECS is accredited by QCI-NABET
- An approved consultant for carryout EIA studies across India
- India’s leading multidisciplinary Environmental Consultancy organization
- HECS- Consultancy division comprises of technical skilled and competent Team of 40 people. The team consists of Three Doctorates & about thirty postgraduates
- HECS has industry specific prominent expert to provide solutions & recommendations
- Serving client more than 25 years & pan India presence in the following sectors:
 - Environmental Clearance
 - Coastal Regulation Zone
 - Risk Assessment, DMP, HAZOP studies
 - Feasibility/ treatability studies
 - Due diligence studies
 - Ground water Clearance
 - DISH, PESO and other statutory approvals
 - Consent to Establish, Consent to Operate
 - Hazardous waste, bio medical waste authorization
 - Other environmental approvals
- Has an in-house laboratory wherein the following activities are being carried out:




QCI – NABET Accreditation

Consultancy	Hubert Enviro Care Systems Pvt. Ltd., Chennai
NABET Certificate No	NABET/ EIA/2224/ SA 0190 Valid up to 27.07.2024
MoEF Reg. Lab	F.No. Q-15018/13/2016-CPW

National Accreditation Board for Education & Training (NABET) is a constituent board of the Quality Council of India (QCI). QCI, NABET has accredited HECS for carrying out Category 'A & Category B' EIA studies in the following sectors:




**QUALITY COUNCIL
OF INDIA**
Creating an Ecosystem for Quality



NABET

**National Accreditation Board
for Education and Training**



NABET

Certificate of Accreditation


Hubert Enviro Care Systems Pvt. Ltd.,
A-21, (Behind Lions Club School) III Phase, Thiru Vi Ka Industrial Estate, Guindy, Chennai - 600 032.

The organization is accredited as **Category-A** under the QCI-NABET Scheme for Accreditation of EIA Consultant Organization, Version 3: for preparing EIA-EMP reports in the following Sectors –

S. No	Sector Description	Sector (as per)		Cat.
		NABET	MoEFCC	
1	Mining of minerals including open cast/ underground mining	1	1 (a) (i)	A
2	Offshore and onshore oil and gas exploration, development & production	2	1 (b)	A
3	River Valley projects	3	1 (c)	A
4	Thermal power plants	4	1 (d)	A
5	Mineral beneficiation	7	2 (b)	A
6	Metallurgical industries (ferrous & nonferrous)- both primary & secondary	8	3 (a)	B
7	Cement plant	9	3 (b)	A
8	Petroleum refining industry	10	4 (a)	A
9	Pesticides industry and pesticide specific intermediates(excluding formulations)	17	5 (b)	A
10	Petro-chemical complexes (industries based on processing of petroleum fractions & natural gas and/or reforming to aromatics)	18	5 (c)	A
11	Petrochemical based processing (processes other than cracking & reformation and not covered under the complexes)	20	5 (e)	A
12	Isolated storage & handling of hazardous chemicals (As per threshold planning quantity indicated in column 3 of Schedule 2 & 3 of MSIHC Rules 1989 amended 2000)	28	-	B
13	Synthetic organic chemicals industry	21	5 (f)	A
14	Industrial estates/ parks/ complexes/ Areas, export processing zones (EPZs), Special economic zones (SEZs), Biotech parks, Leather complexes	31	7 (c)	A
15	Ports, harbours, break waters and dredging	33	7 (e)	A
16	Highways	34	7 (f)	B
17	Common Effluent Treatment Plants (CETPs)	36	7 (h)	B
18	Common municipal solid waste management facility (CMSWMF)	37	7 (i)	B
19	Building and construction projects	38	8 (a)	B
20	Townships and Area development projects	39	8 (b)	B

Note: Names of approved EIA Coordinators and Functional Area Experts are mentioned in SAAC minutes dated Feb 3, 2023 posted on QCI-NABET website.

The Accreditation shall remain in force subject to continued compliance to the terms and conditions mentioned in QCI-NABET's letter of accreditation bearing no. QCI/NABET/ENV/23/2696 dated March 6, 2023. The accreditation needs to be renewed before the expiry date by Hubert Enviro Care Systems Pvt. Ltd, following due process of assessment



Sr. Director, NABET
Dated: March 6, 2023

Certificate No.
NABET/EIA/2224/SA 0190

Valid up to
July 27, 2024

For the updated List of Accredited EIA Consultant Organizations with approved Sectors please refer to QCI-NABET website.

Further details may be seen on the following URL: www.hecs.in.

350
SHORELINE CHANGES AND DREDGE DISPOSAL STUDIES

FOR

**PROPOSED CONSTRUCTION OF PEN MONUMENT OFF THE COAST OF
MARINA BEACH, CHENNAI, TAMIL NADU**



Submitted to



**Public Works Department
Government of Tamil Nadu**

Submitted by



National Centre for Coastal Research, Chennai

&

Indian National Centre for Ocean Information Services, Hyderabad

**Ministry of Earth Sciences
Government of India**

Final Report

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Contents

1.0	Background	09
2.0	Objectives.....	09
3.0	Study Area	10
4.0	Layout and Configuration of Proposed Structure	11
5.0	Shoreline Change Analysis	13
	5.1 Methodology for Shoreline Change Analysis.....	13
	5.2 Results and Discussion	17
6.0	Oceanographic Measurements.....	18
	6.1 Climate	18
	6.2 Beach Profiles.....	18
	6.3 Bathymetry.....	19
	6.4 Tides	20
	6.5 Waves.....	20
	6.6 Currents.....	22
	6.7 Sediments.....	25
7.0	Long-term Shoreline Morphology.....	26
	7.1 Model Domain.....	26
	7.2 Estimation of Littoral Drift	27
	7.3 shoreline evolution for 10 years	29
8.0	Summary and Conclusion.....	31

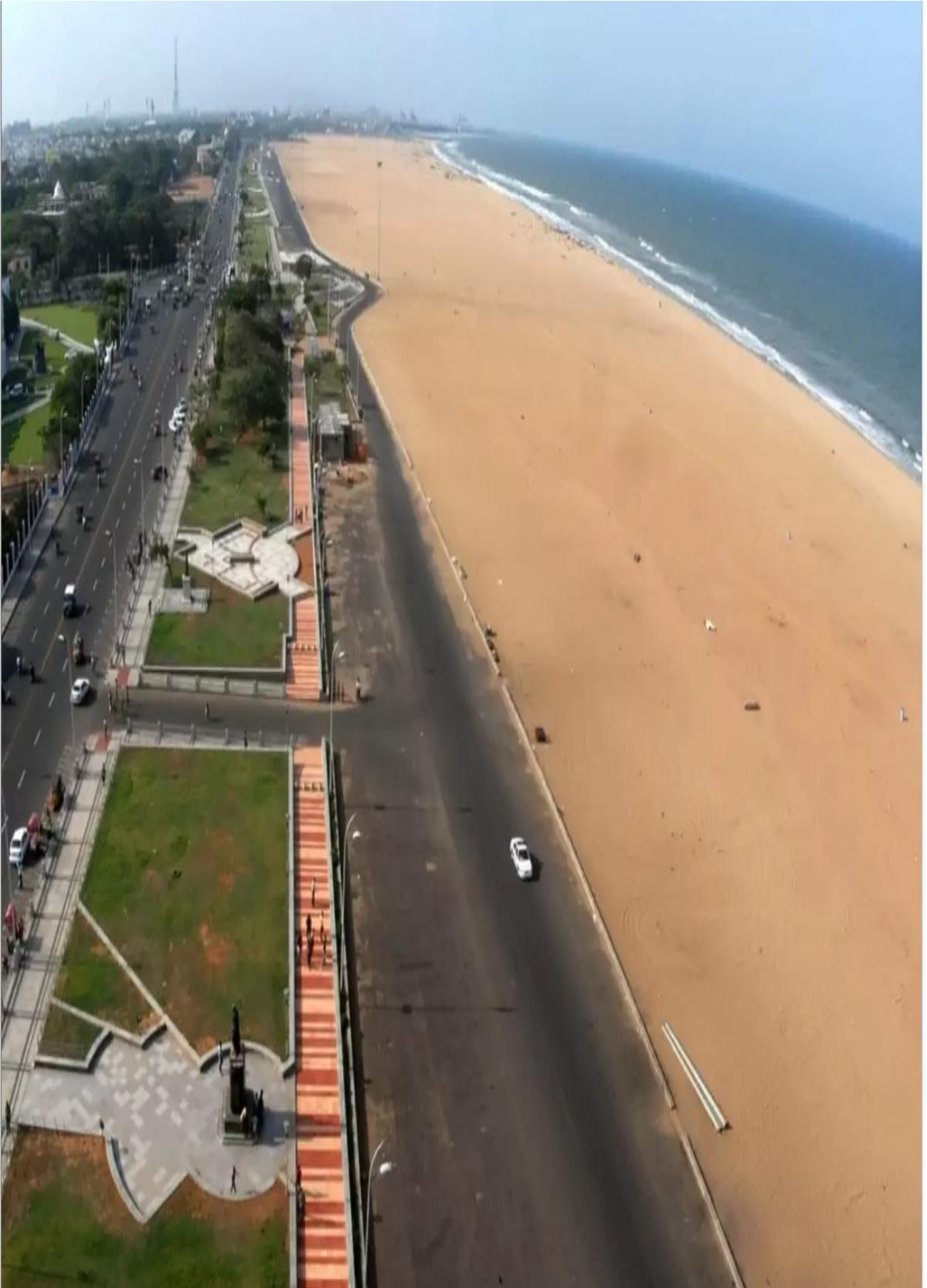
List of Figures

Figure 1: Study Area of Proposed Project.....	10
Figure 2: Location and Layout of Proposed Jetty	11
Figure 3: General Arrangement Drawing of Proposed Jetty.....	12
Figure 4: Shoreline tracking during the field visit along marina beach.....	14
Figure 5: Post field survey for validation of shoreline results.....	15
Figure 6: Shoreline changes along Marina beach shore and the location of the Proposed Pen Monument.....	16
Figure 7: Shoreline position during 1990 and 2022 and status of coast along the location of Proposed Pen Monument	17
Figure 8: Location of the cross-shore beach morphology collected and the profiles along the investigation site on 18th March 2023 using RTK-GPS	18
Figure 9: Bathymetry along Chennai coast.....	19
Figure 10: Time series of water level measured off Chennai coast.....	20
Figure 11: Time series of plot of (a) Significant wave height, (b) Peak wave period, (c) Mean wave period and (d) Mean wave direction along Chennai 01 April 2017 to 31 December 2020	21
Figure 12: Wave rose diagram based on significant wave height at Chennai during different months.....	23
Figure 13: Wave rose diagram based on peak wave period at Chennai during different months.....	24
Figure 14: Sediment grain-size distribution along the site.....	25
Figure 15: Model Domain for Proposed Scenario	26
Figure 16a: Baseline, Coastline & Profile locations in Domain.....	28
Figure 16b: Cross-shore profiles used for modelling.....	28
Figure 17: Shoreline evolution for 10 years along the study region with and without Pen Statue.....	29
Figure 18: Shoreline evolution for 10 years with proposed Structures.....	30

List of Tables

Table 1: Details of satellite data used from 1988 to 2018 for shoreline change analysis	15
Table 2: Shoreline classification schemes used in the analysis	15

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1.0 Background

Government of Tamil Nadu has proposed to Construct Pen Monument in Bay of Bengal off the coast of Marina Beach near Triplicane village, Chennai District. This Pen Monument construction will be implemented for enhancing tourism, which is known for coastal stretch of marina beach. The project is being executed by the Public Works Department, Chennai.

The pen monument is to be placed in Bay of Bengal off the coast of Marina Beach. The Pen is about 42-metre-tall monument, surrounded by landscaped gardens and located in into the sea a distance of 360 m from the shore. There will be a pedestrian bridge from land to the PEN at an elevation of 6 m from the High Tide Line built on stilts (supported on piles) to allow free flow of water and sediments. The length of the bridge over the Land is 290 Mts and over the Sea is 360 m, with a distance of 650 m. The width of the Bridge will be 7 m with 3 m of glass flooring to facilitate tourists. The entire structure is proposed to be constructed on the pile foundations, which allows free flow water and sediment.

The proposed pen monument requires CRZ Clearance because it involves both onshore and offshore construction. In this regard, Public Works Department has requested National Centre for Coastal Research (NCCR) to take-up studies related to Dredge Disposal and Shoreline changes and suggest mitigation measures, if any impact is noticed in the study.

2.0 Objectives

The objectives of the present study are:

1. To study the Impact of dredging and disposal of dredge material during construction activities.
2. To study the impact of proposed structure on Shoreline Erosion/Accretion pattern at adjoining areas of the bridge.

3.0 Study Area

The study investigates an integral part of the Chennai coast, which extends from the southern breakwater of Chennai Port to the end-point of the Marina beach shore (Fig. 1). Prevailing winds are northerly from March to September and southerly from October to February. Chennai experiences semi-diurnal tides having the average micro-tidal neap. The coast experiences seasonal currents with monsoon.

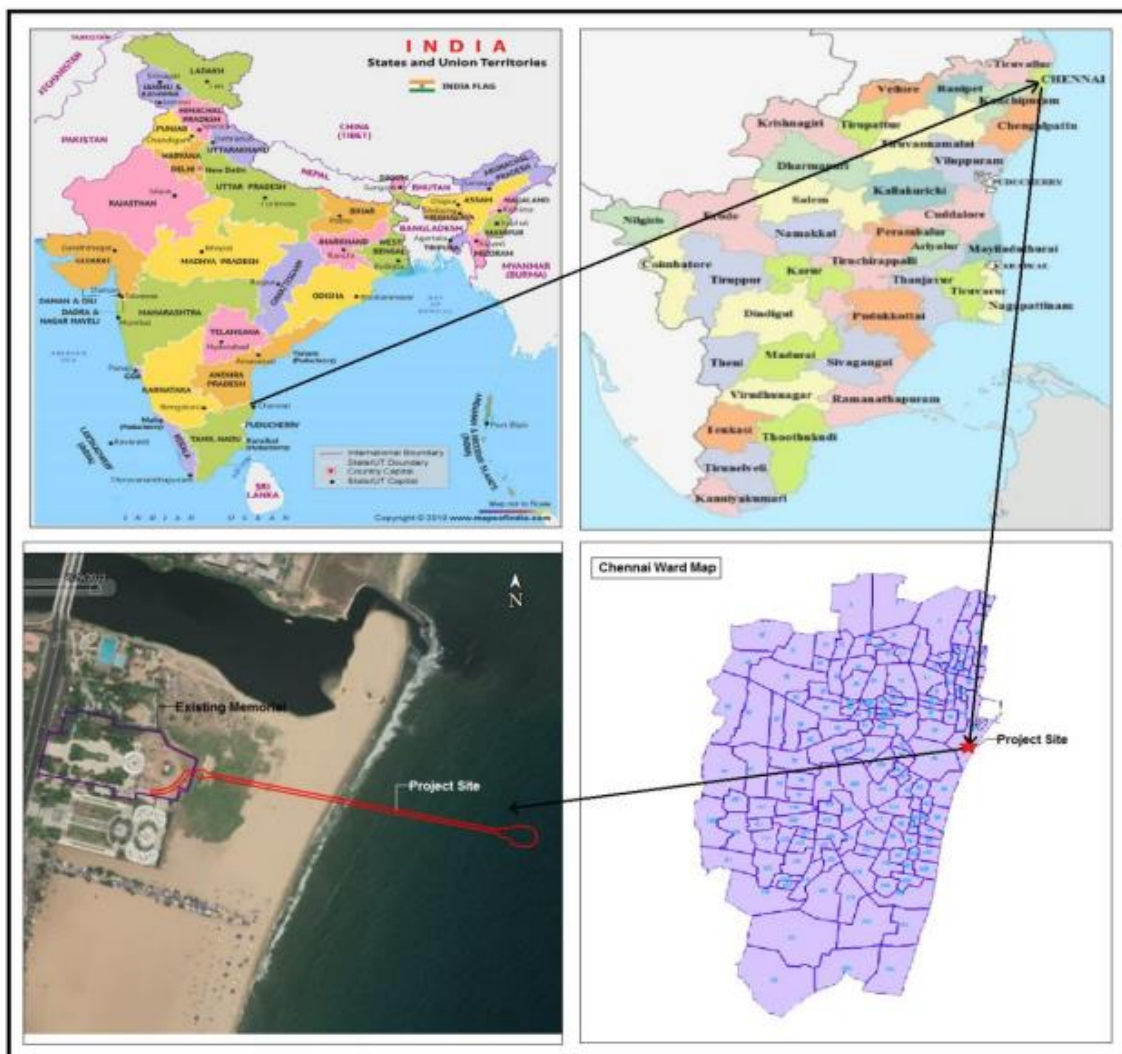


Figure 1: Study Area of Proposed Project

4.0 Layout and Configuration of Proposed Structure

The Location and Layout of the proposed Jetty is shown in Figure 2 & 3. The proposed Jetty is about 650m long with 290m on Land and 360m into the sea. The jetty is support on 1m diameter piles spaced at 16m. The higher spacing is chosen to have minimal influence on nearshore coastal processes and effectively bypass the sediment and for the benefit of fisheries. At the intertidal zone the spacing between piles is further increased to 80m and supported on 1.5m diameter piles. As the structure is supported by piles and they are cast in situ bored driven piles, no dredging of sand is not anticipated in this project, however minimal quantity of sand will be bailed out during the boring of pile.



Figure 2: Location and Layout of Proposed Jetty

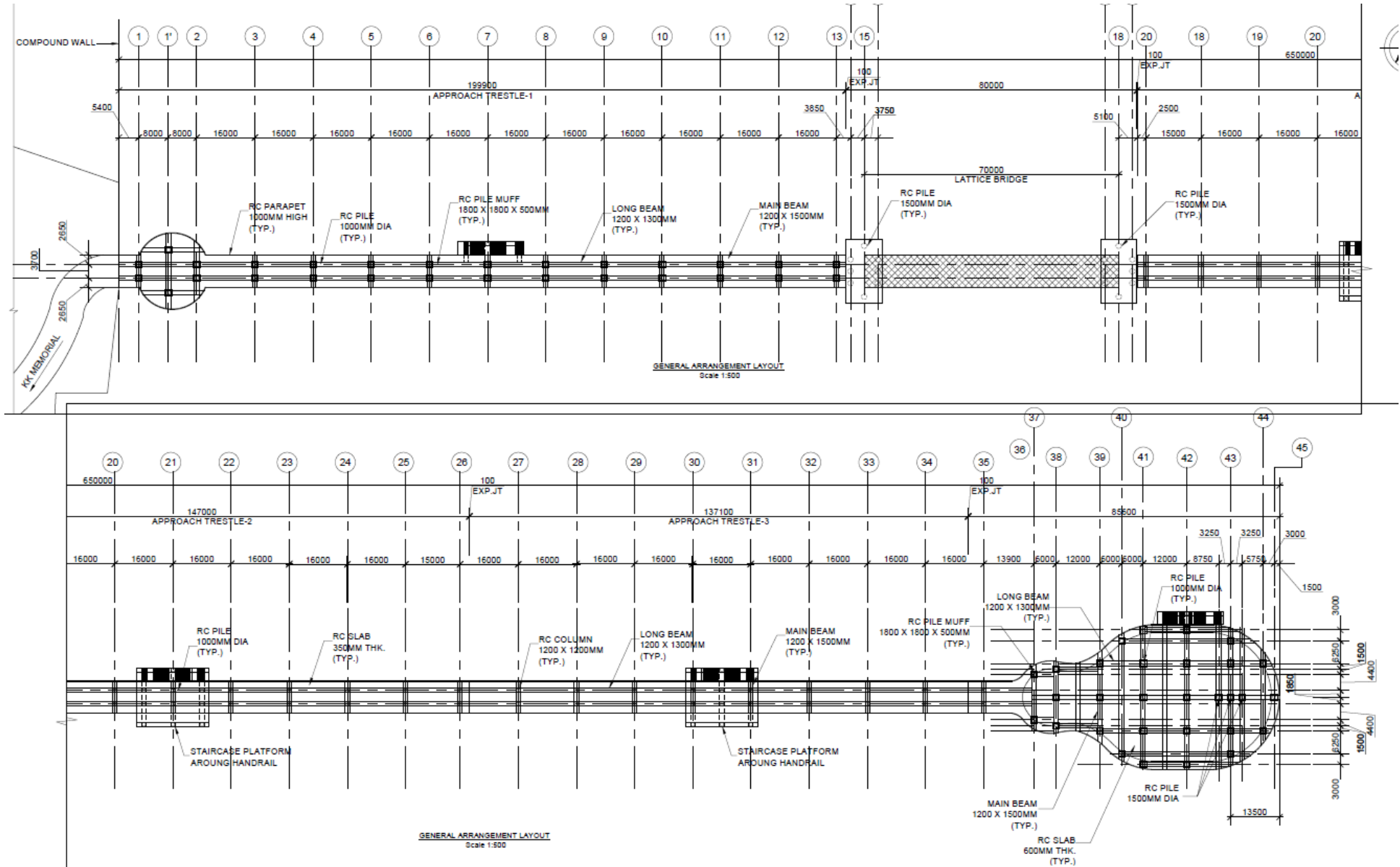


Figure 3: General Arrangement Drawing of Proposed Jetty

5.0 Shoreline Change Analysis

The shoreline change analysis using satellite images is carried out to understand the present status of the coast at which the project is proposed.

5.1 Methodology for Shoreline Change Analysis

Shoreline change analysis is carried out from 1990 to 2022 using Landsat–TM (30 m), Landsat–ETM+ (30 m), Resourcesat–I LISS-III (23.5 m), Cartosat–1 PAN (2.5 m), Resourcesat–II LISS-IV (5.8 m), and Sentinel-2A (10 m) satellite images (Table 1). The satellite image processing and shoreline change analysis was carried out as per the methodology adopted in National Assessment of Shoreline Changes along Indian Coast (www.nccr.gov.in) as detailed. Using ERDAS Imagine software all the satellite images are rectified for image distortion and edge matching with reference to ground control points (GCP) collected using Trimble GeoXH handheld Global Positioning System (GPS) with accuracy of $\leq \pm 5$ m. Extensive field verification was done and compared with shorelines derived from satellite data (Fig.4 & 5). Second-order polynomial transformation method was applied for each image.

Once rectified data has Root Mean Square Error (RMSE) error of less than a pixel value, on screen digitization of shoreline (wet/dry line or high water line) is done manually with map scale of 1:2500 (Cartosat), 1:5000 (LISS-IV; Sentinel), and 1:10000 (LISS-III, Landsat). By fixing the map scale, digitization error (linear-jagged edges) is minimized to get smooth splines in shoreline extracted from high and low resolution images. In the ArcGIS v.10.3 platform (<https://www.esri.com>), before and after port shoreline geodatabase were created. The baseline layer was generated with buffer distance of 160m landward from the oldest shoreline, and seaward transects (perpendicular lines) were generated at every 20 m interval along the coastline. Shoreline change statistics is evaluated using Digital Shoreline Analysis System v.4.0 (Thieler et al. 2009) using the weighted linear regression (WLR) method which takes into account the uncertainty field to calculate the rates of shoreline change. The position and measurement errors are considered (Equation 1) to calculate the uncertainty field associated with the shoreline.

$$U_t = \pm \sqrt{(E_s^2 + E_{td}^2 + E_d^2 + E_p^2 + E_r^2)} \quad (1)$$

Where, seasonal error (E_s) is quantified by using seasonal beach profiles, tidal fluctuation error (E_{td}) is calculated for each satellite image, digitizing error (E_d) is the error associated with digitizing the shoreline, pixel error (E_p) is the pixel size of the image, and rectification error (E_r) is calculated from the ortho-rectification process.

The results obtained from the analysis of shoreline changes are in the form of numbers i.e., \pm m/yr, where (+) is for accretion, and (-) is for erosion. The shorelines towards seaward are referred as “accretion” and shoreline towards landward are referred as “erosion”. This phenomenal change defines the shoreline classification from high to low based on rate (m/yr). Shoreline change rates (accretion/erosion) are classified into seven sub-classes considering the magnitude of changes (Table 2) similar to National Assessment of Shoreline Changes along Indian Coast (www.nccr.gov.in). The marginal change of ± 0.5 m/yr is considered as no change or stable coast, in view of uncertainties in the data. The intermitted distance between ± 0.5 to ± 3 m are considered as low accretion / low erosion. Subsequently, the area between ± 3 to ± 5 m is considered as moderate accretion / moderate erosion. The rates of change above ± 5 m are considered as high accretion / high erosion.



Figure 4: Shoreline tracking during the field visit along marina beach



Figure 5: Post field survey for validation of shoreline results

Table 1: Details of satellite data used from 1988 to 2018 for shoreline change analysis

Year	Data (resolution)	Source
1990	Landsat-TM (30 m)	United States Geological Survey (USGS) Earth Explorer
2000	Landsat-ETM+ (30 m)	
2006	CartoSat-1 PAN (2.5 m)	National Remote Sensing Centre (NRSC) Data Centre
2008	ResourceSat-1 LISS III (23.5 m)	
2012 to 2019	ResourceSat-II LISS IV (5.8 m)	
2020 to 2022	Sentinel-2A (10 m)	European Space Agency (ESA) Copernicus Data Hub

Table 2: Shoreline classification schemes used in the analysis

Classification	Rate (m/year)	Colour Schemes
High Erosion	< -5.0	Red
Moderate Erosion	-5.0 to -3	Orange
Low Erosion	-3.0 to -0.5	Yellow
Stable Coast	-0.5 to 0.5	Green
Low Accretion	0.5 to 3.0	Cyan
Moderate Accretion	3.0 to 5.0	Blue
High Accretion	> 5.0	Dark Blue

Source: National Centre for Coastal Research (www.nccr.gov.in)



Figure 6: Shoreline changes along Marina beach shore and the location of the Proposed Pen Monument

5.2 Results and Discussion

Shoreline change assessment was carried out from 1990–2022 period to understand the temporal changes (Fig. 6). The rate of shoreline changes from 1990-2022, signifies the coast is undergoing moderate to high accretion. It is observed that in the last 32 years the Marine beach has accreted showing 93 meters of wide beach with total increase in area of 5.40 hectares (Fig. 7).



Figure 7: Shoreline position during 1990 and 2022 and status of coast along the location of Proposed Pen Monument

6.0 Oceanographic Measurements

6.1 Climate

Chennai experiences two monsoons, NE monsoon being dominant. Prevailing winds are northerly from March to September and southerly from October to February.

6.2 Beach Profiles

The beach profiles were collected by topography survey using Real Time Kinematic-Global Positioning System (RTK-GPS). The base station was established with known elevation reference of the Chennai marina light house. The beach profiles were collected with alongshore spacing of 100 to 200 meters based on the beach changes observed. The profiles are collected on the south of Cooum River which shows beach width of about 100 to 140 meters with gentle slope of 1:100. The location and cross-shore beach profiles are presented in Figure 8.

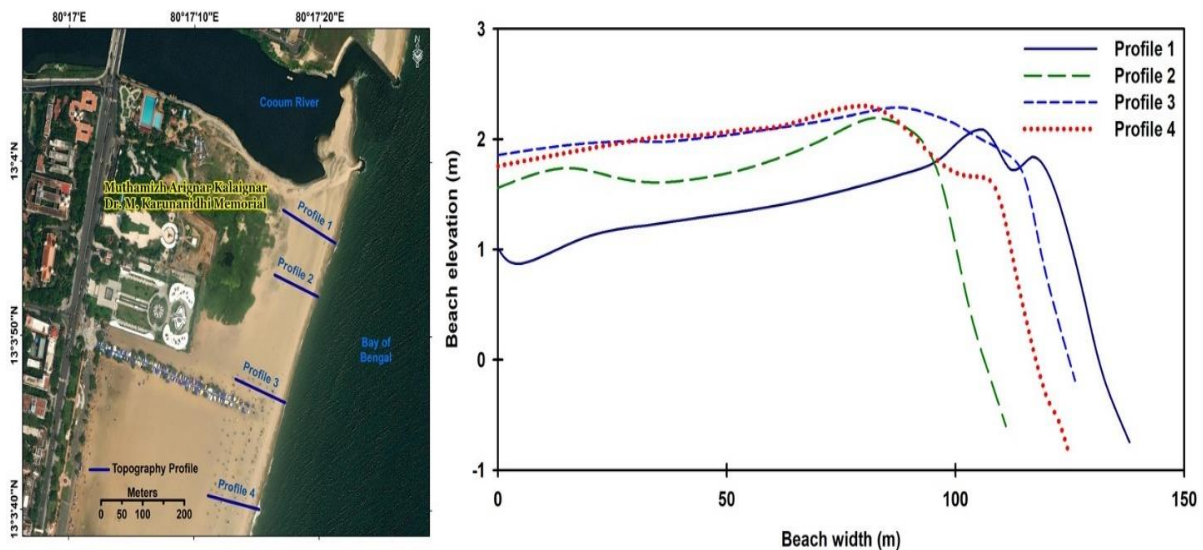


Figure 8: Location of the cross-shore beach morphology collected and the profiles along the investigation site on 18th March 2023 using RTK-GPS

6.3 Bathymetry

Figure 9 shows the bathymetric map along Chennai coast. The study area is characterized by gentle slope with 10m water depth at a distance of 600 meters from the coast.

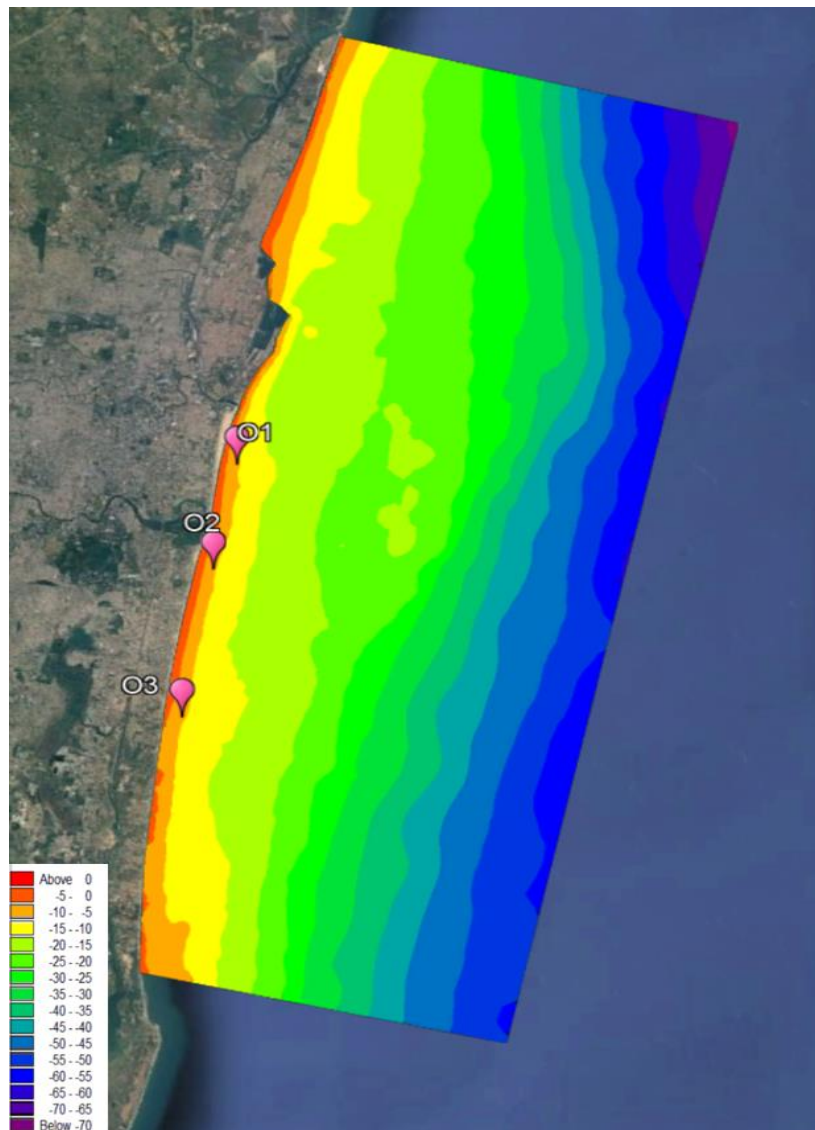


Figure 9: Bathymetry along Chennai coast

6.4 Tides

Time-series data of sea-level recorded with tide gauges at location near Chennai coast during was shown in Figure 10. Analysis of sea level data indicates that the Chennai experiences semi-diurnal tides having the average neap and spring tidal ranges of 0.6 and 1.15 m.

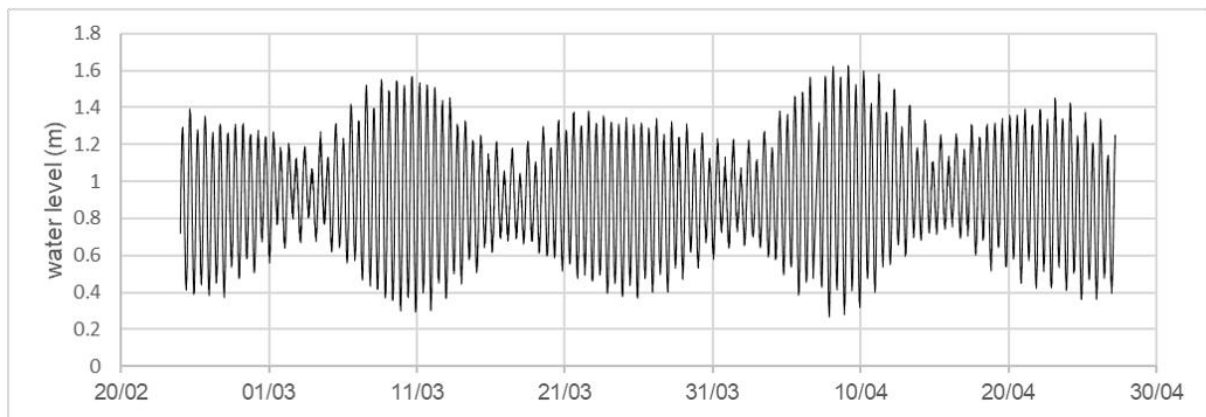


Figure 10: Time series of water level measured off Chennai coast

Highest High-Water Spring	-	1.555m
Highest High-Water Neap	-	1.215m
Mean Sea Level	-	0.875m
Lowest Low Water Neap	-	0.684m
Lowest Low Water Spring	-	0.212m

6.5 Waves

The eastern coast of India undergoes seasonal variations in wind direction, with winds blowing from the southwest during the summer monsoon season (June-September) and from the northeast during the winter monsoon season (October-January). The period between the summer and winter monsoons is referred to as the pre-monsoon period (February-May). The occurrence of tropical cyclones is a frequent event along the eastern coast of India. These seasonal changes in wind intensity and tropical cyclones have a direct impact on wave characteristics such as significant wave height (H_s), mean wave period (T_m), peak wave period (T_p), and wave direction (M_{Dir}). Wave parameters collected from a directional wave rider buoy located near the Chennai port (13.101N, 80.317 E) between 01 April 2017 and 31 December 2019 were analysed.

The significant wave height (H_s) in the region varied from 0.34 to 2.93m during the observation period, with an average value of 0.94m (Figure 9, a). The highest H_s (ranging from 2.23 – 2.93 m) was recorded from 14-16 December 2018 due to the impact of severe Cyclonic Storm Phethai, followed by very severe Cyclonic Storm Ockhi's effect on 30 November 2017 (H_s of ~ 2 m). H_s generally exceeded 1.5m during both summer and winter monsoons, while during other periods, H_s was less than 1.5m (Figure 11, a). The peak wave period (T_p) varied from 2.7 to 21s during the observation period, with an average value of 9.04s (Figure 11, b), while the mean wave period (T_m) ranged from 6.2 to 17s, with an average value of 8.8s (Figure 11, c). Throughout the observation period, the majority of the wave direction along the region ranged from 50-170° (Figure 11, d).

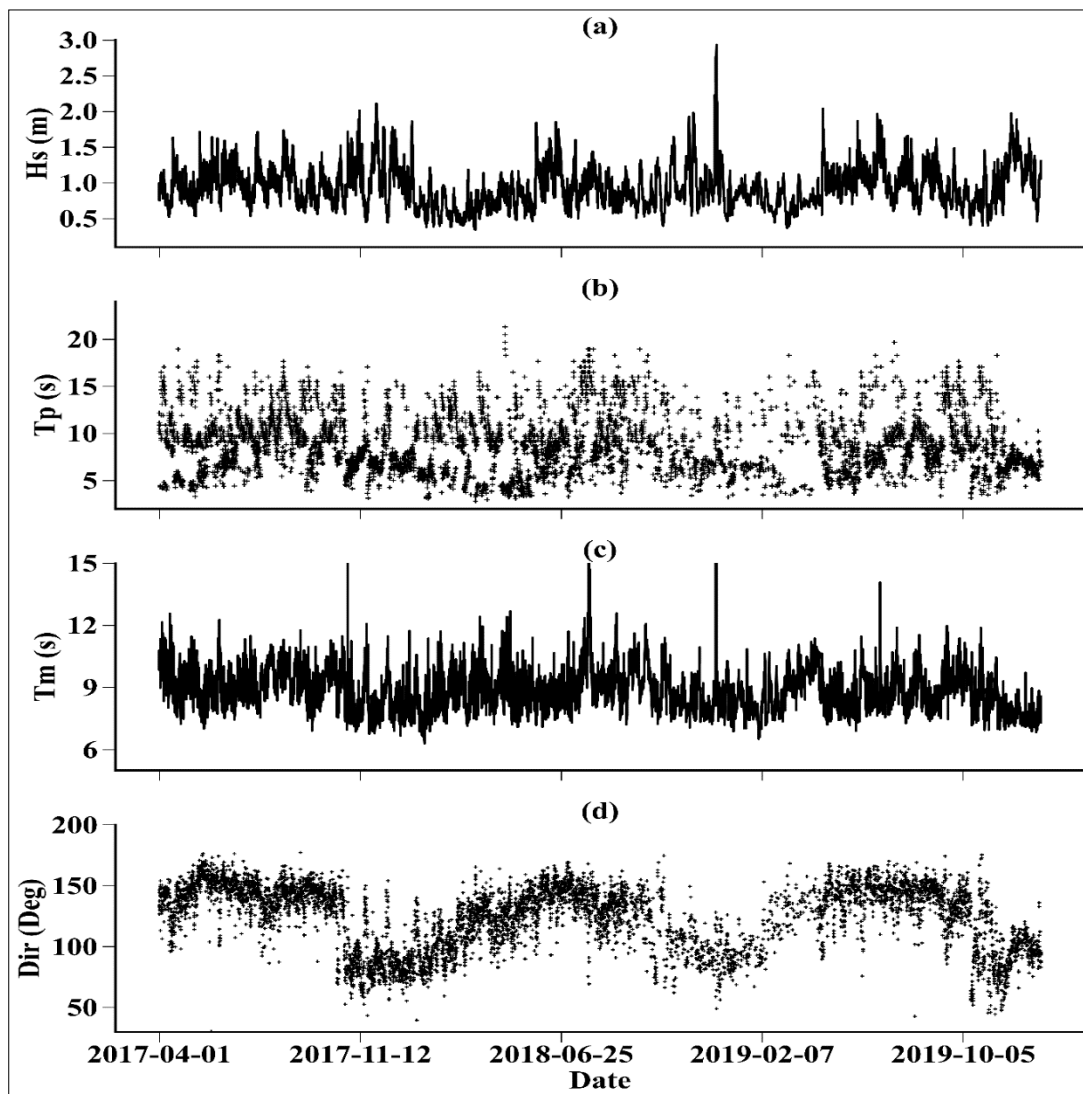


Figure 11: Time series of plot of (a) Significant wave height, (b) Peak wave period, (c) Mean wave period and (d) Mean wave direction along Chennai 01 April 2017 to 31 December 2020

During the pre-monsoon period, when conditions were relatively calm, H_s was generally $< 1.5\text{m}$ (Figure 10, b-e), and $T_p > 15\text{s}$ (Figure 12, b-e), and these waves were predominantly approaching the region (more than 30%) from easterly-south easterly direction ($90\text{-}150^\circ$). H_s ranging from $0.5\text{-}1\text{m}$ and T_p between $6\text{-}9\text{s}$ were predominantly (more than 20% of the time) observed along this region. Additionally, long-period swells exceeding 15s were also noted from the easterly-south easterly direction during this period. During the summer monsoon season (Figure 12& 13, f-e), waves generally approached the region from the southeast direction, predominantly between $140\text{-}155^\circ$ (more than 40% of the time). H_s typically ranged from $0.5\text{-}1.5\text{m}$ along this region, although there were a few instances where H_s exceeded 2m . During the winter monsoon season (Figure 12& 13, j – i, a), the majority of the waves generally approached from the east, except during the month of October, where the waves approached from the southeast. H_s exceeded up to 2m along this region during this season (Figure 10). During November and December, H_s typically ranges from $1\text{-}2\text{m}$ for most of the times. Except during October, $T_p < 15\text{s}$ were observed along this region (Figure 13).

6.6 Currents

The Chennai coast experiences seasonal changes in the coastal current patterns. The currents were northwards (18 to 45°) from March to October, southwards (196 to 227°) from November to February, and current speed varied from 0.5 to 41 cm/s with an average of 17 cm/s during the SW-monsoon, whereas 0.3 to 42 cm/s during the NE-monsoon with an average of 10 cm/s (Kankara et al. 2013).

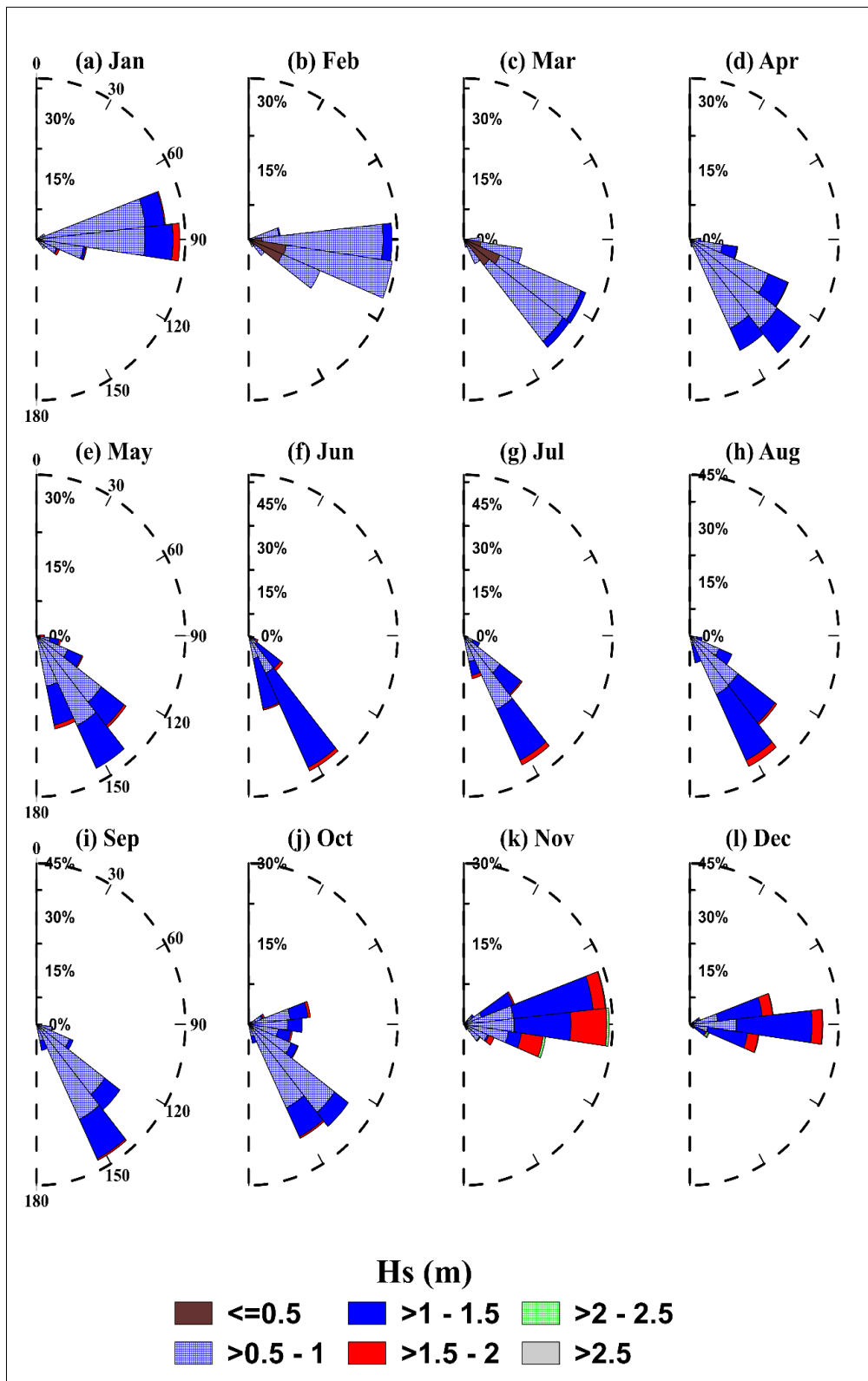


Figure 12: Wave rose diagram based on significant wave height at Chennai during different months

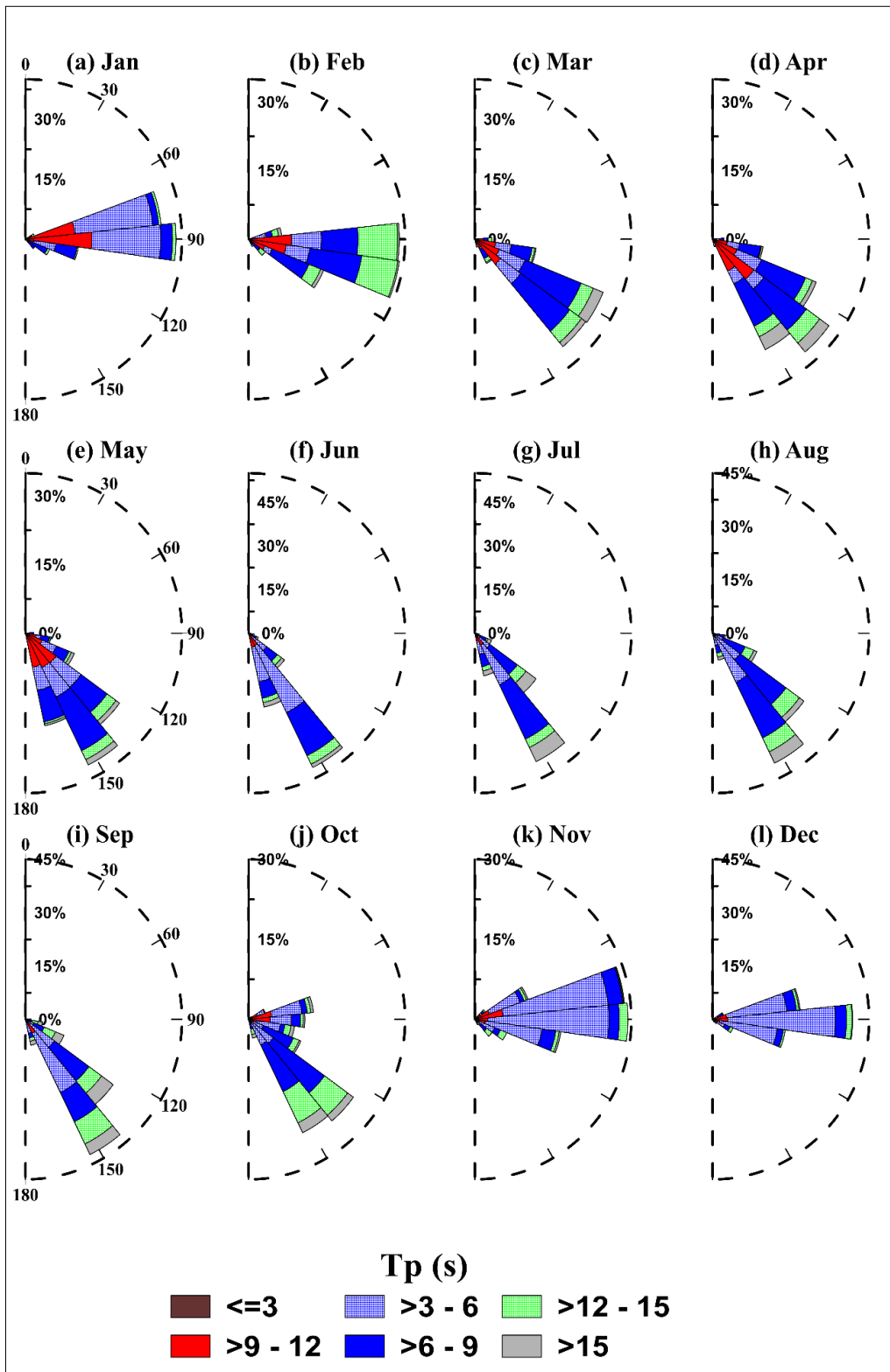


Figure 13: Wave rose diagram based on peak wave period at Chennai during different months

6.7 Sediments

The foreshore and mid-shore sediment samples are collected for the grain-size distribution analysis. Standard procedures are followed in the collection and analysis of the sand samples. The foreshore sediments are unimodal with median sediment size (d50) of 0.399 mm and the mid-shore sediments are bimodal with d50 of 0.354 mm (Figure 14). The sediments are moderately sorted medium sand, which are symmetrical to coarse skewed and platykurtic to mesokurtic.

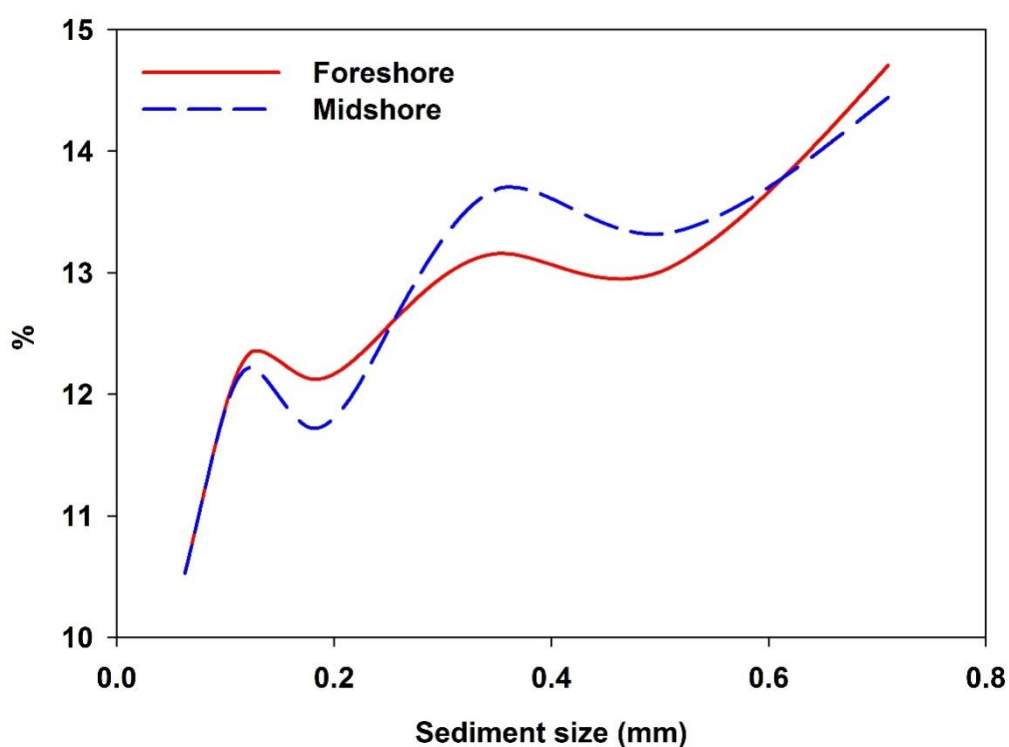


Figure 14: Sediment grain-size distribution along the site

7.0 Long-term Shoreline Morphology

Investigations were carried out using numerical computer modeling, which included an assessment of wave climate and coastal processes. The simulation of shoreline changes resulting from the construction of the Pen Statue was performed using LITPACK.

7.1 Model Domain

The domain for LITPACK ranges from latitude $13^{\circ} 3.178' N$ to $13^{\circ} 4.049' N$ and longitude $80^{\circ} 17.105' E$ to $80^{\circ} 17.372' E$. The bathymetry and topography data from field surveys were applied, and the model domain is shown in Figure 15. A total of 1600 meters of shoreline was considered with a grid spacing of 20 meters. A jetty located 370 meters from the shoreline with an effective bypassing length of 340 meters was modeled to simulate sediment bypassing due to the proposed Pen Statue.

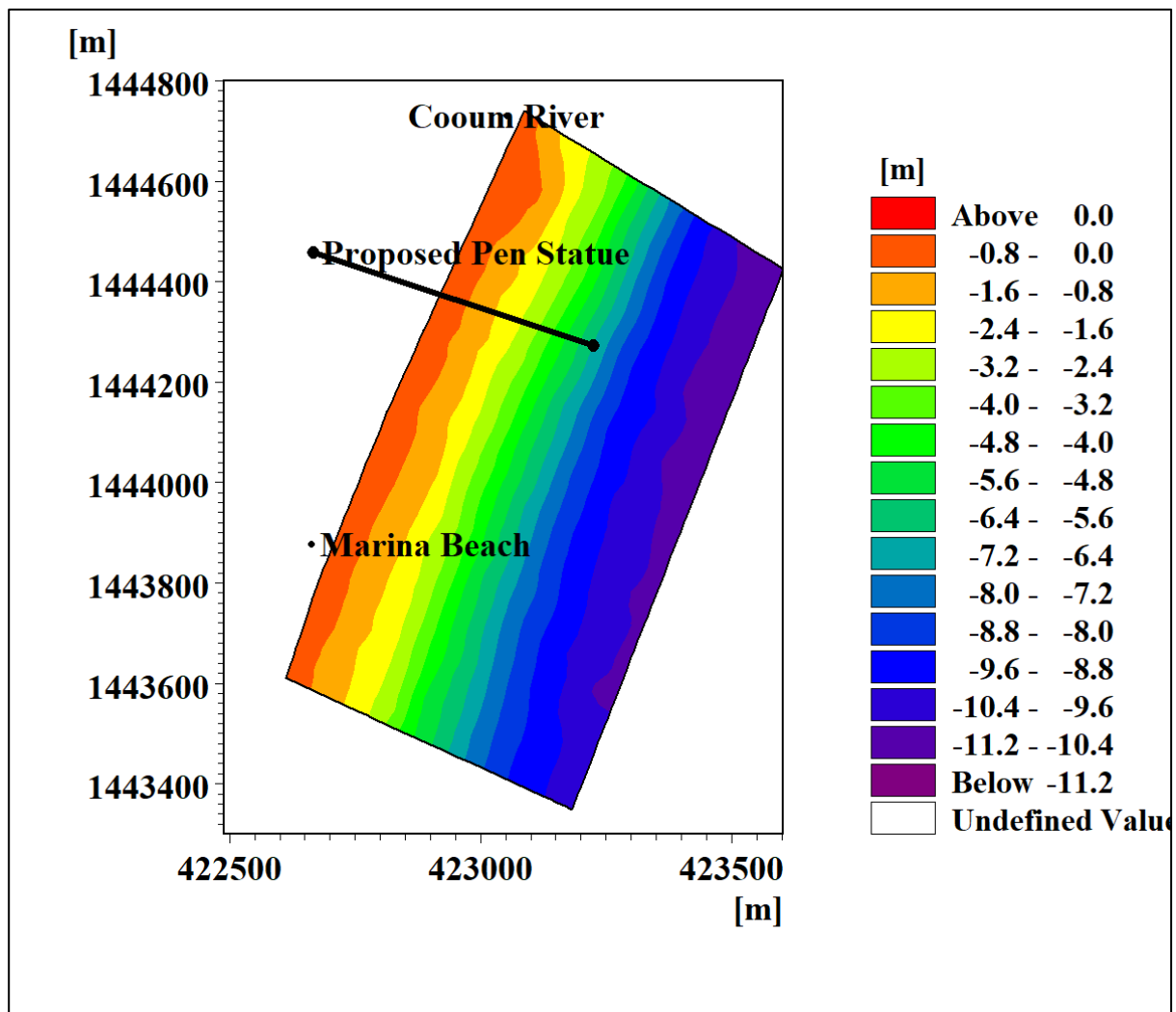


Figure 15: Model Domain for Proposed Scenario

7.2 Estimation of Littoral Drift

When waves approach the coast, they break and release energy, which can re-suspend sediment and generate a wave-driven current along the coast. The LITtoral Processes and Coastline Kinetics (LITPACK) numerical model in the MIKE-21 software package, developed by the Danish Hydraulic Institute (DHI), is used to estimate sediment transport of non-cohesive sediments due to waves and currents, littoral drift, and coastline evolution.

The LITDRIFT module is used to estimate longshore sediment transport rates, incorporating important sediment transport mechanisms such as nonlinear wave motion, the turbulent bottom boundary layer, wave breaking, and sediment grading (DHI, 2019). It combines a one-dimensional (1D) wave model, a 1D hydrodynamic model, and an intra-wave sediment transport model (STP).

Suspended sediment transport is calculated as the product of sediment concentration and the mean circulation current averaged over the wave period. When updating the morphology using the one-line model, the sediment conservation equation is integrated across the active part of the surf-zone, following Pelnard-Considere (1956), such that any longshore gradients in the littoral drift lead to a change in the shoreline position.

$$\frac{\partial y}{\partial t} = -\frac{1}{h_a} \frac{\partial Q_l}{\partial x} + \frac{Q_s}{h_a \Delta x}$$

The position of the shoreline is represented by y , time by t , littoral drift including pore volume by Q_l , active height of the coastal profile by h_a , and longshore coordinate by x . The source/sink term is represented by Q_s , and the longshore discretization step by Δx . The input data for the LITDRIFT module includes wave climate as a time-series data, cross-shore profile, and sediment characteristics. The LITDRIFT profile is created using nearshore bathymetry, and the profiles considered in the study are shown in Figures 16a and 16b.

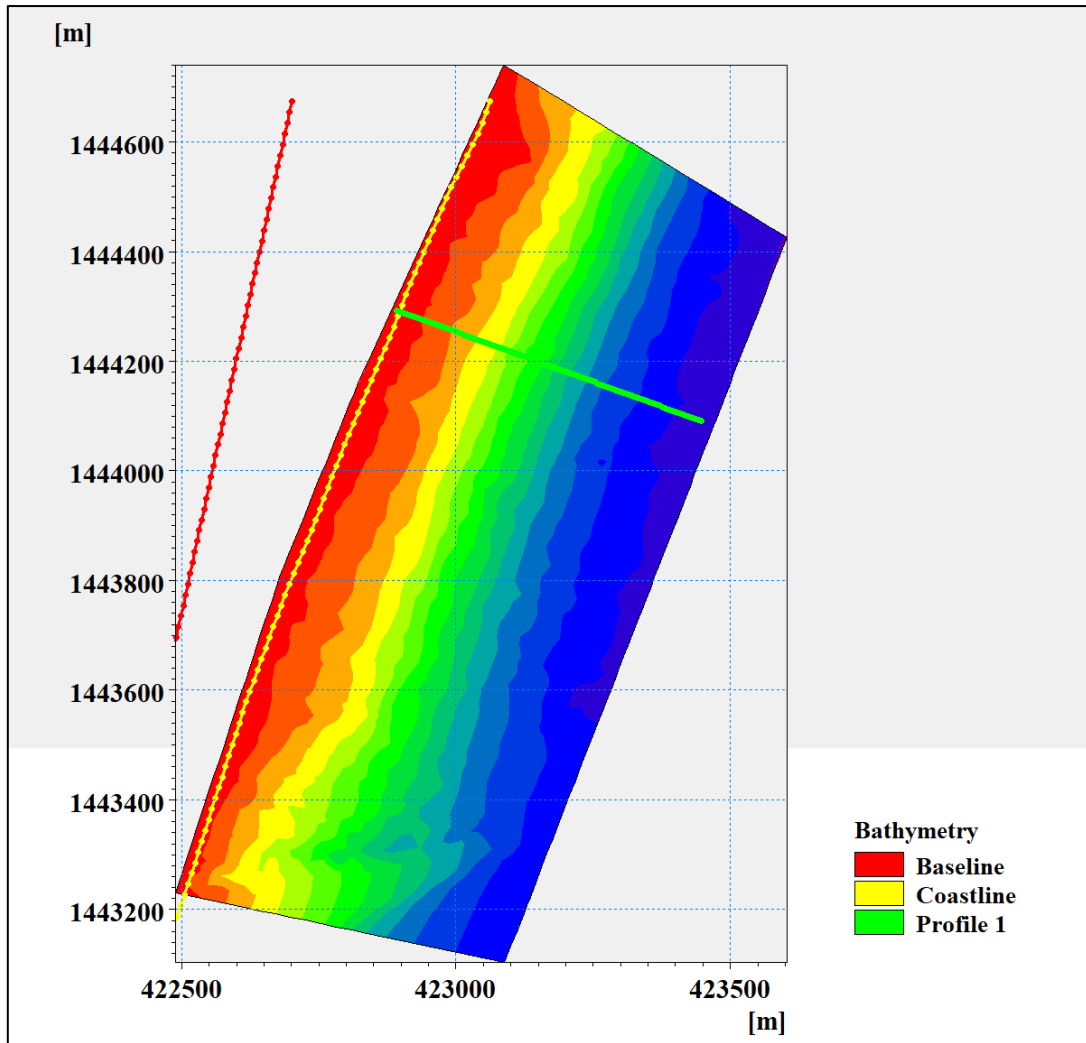


Figure 16a: Baseline, Coastline & Profile locations in Domain

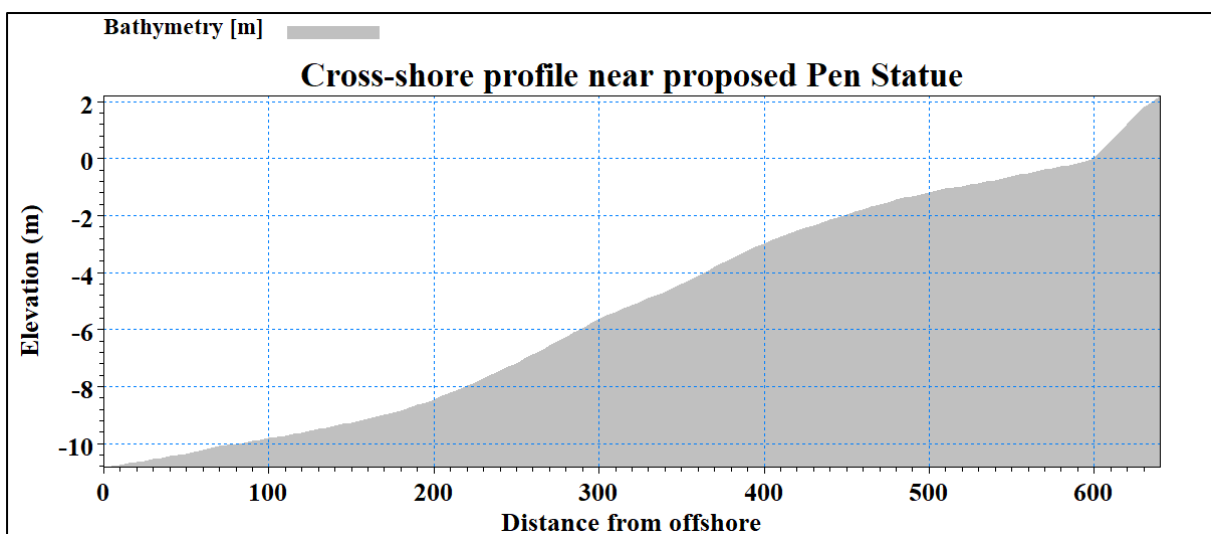


Figure 16b: Cross-shore profiles used for modelling

The field data analysis results provided the median grain size (d_{50}) and geometrical spreading factor. For this study, a d_{50} value of 0.2 mm and a hydraulic bed roughness of 0.004 m were assumed for all grids across the cross-shore profile. The model was simulated for 10 years with input wave climate data based on an offshore wave rider buoy. The coastal orientation of the study area is approximately 110 degrees with respect to North. The model simulation showed an average gross sediment transport of 203824 m³/yr along the project site. The net sediment transport was found to be 33586 m³/yr towards the north.

7.3 Shoreline evolution for 10 years

The evolution of the shoreline for 10 years was modeled using the Littoral Process FM module of the LITPACK software. The modelling was carried out in three different ways: without any structures (Run 1), with only a proposed Pen Statue (Run 2), and with both a proposed Pen Statue and a proposed Cooum groin (Run 3). The effective length of the Cooum groin field was given as 130 meters from the shoreline, and the Pen Statue was given as 40 meters from the shoreline. As described earlier, the total study area was 1.6 Km, and the coastline extended from the Cooum River to the south towards Marina Beach.

When the Pen Statue was installed at the designated location, the beach advanced by approximately 5 to 15 m over 600 m stretch (Fig. 17). The Pen Statue, designed as a small jetty-like structure, had minimal impact on the downdrift side as most of the sediments bypassed it.

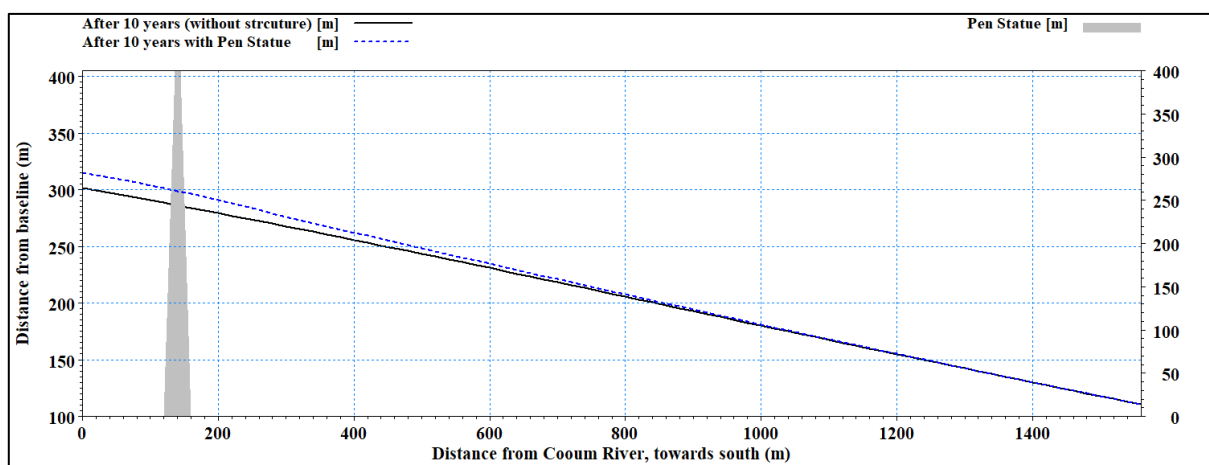


Figure 17: Shoreline evolution for 10 years along the study region with and without Pen Statue

When the Coovum groin was added a beach advancement of 50-80 meters was observed near the groin which tapered southwards. Accretion was observed throughout the stretch after incorporating the groin in the model (Fig. 18). A slight accretion was observed across the 1 km stretch after incorporating the Pen Statue in the model along with Groin. Northerly transport dominates this coast and so substantial beach development is expected due to construction of southern groin at the Coovum River. Therefore, no serious erosion issues are anticipated due to the proposed Pen Statue, either to the north or south of the designated location.

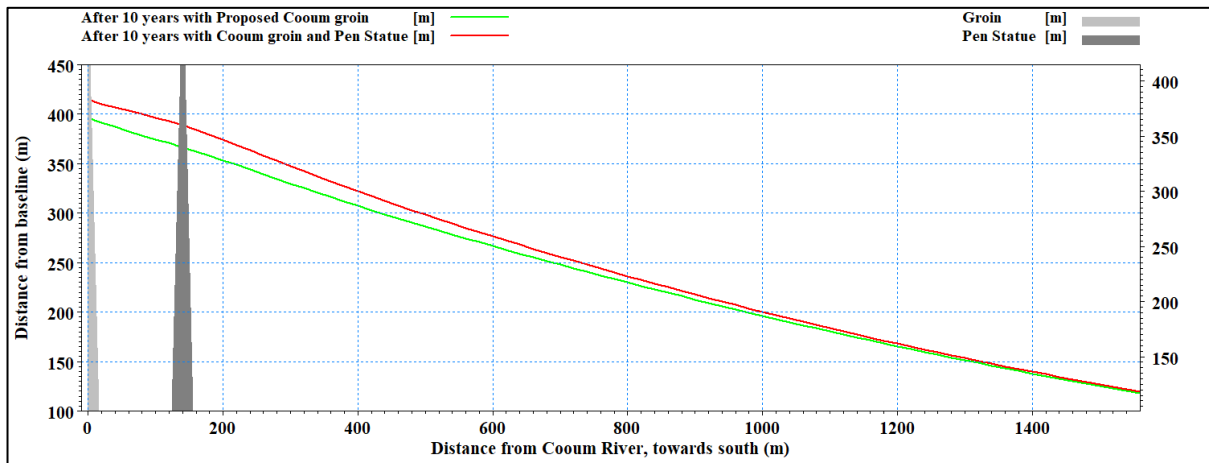


Figure 18: Shoreline evolution for 10 years with proposed Structures

Summary and Conclusion

Shoreline change analysis (1990–2018) was carried out for the stretch from the southern breakwater of Chennai Port to the end-point of the Marina beach shore as per the methodology adopted in National Assessment of Shoreline Changes along Indian Coast by NCCR (www.nccr.gov.in). From the analysis of the long-term datasets, it is evident that this stretch is an accreting coast as accretion is observed in the coastal stretch in the last 28 years.

Numerical modelling studies indicate that since the proposed pedestrian bridge from land to the proposed Pen Monument is supported on open piles spaced at sufficiently large distance both in longitudinal and lateral direction, no significant impact is observed on the nearshore currents.

Hence, no significant impact on the coast is anticipated due to structure. Moreover, since the construction of open bridge is supported on stilts (piles), no dredging is anticipated during the construction, except sand bailed out during piling operations.

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&
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Ministry of Earth Sciences
Government of India

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Page 744 of 1270

PROPOSED CONSTRUCTION OF MUTHAMIZH DR. KALAINGAR PEN MONUMENT IN BAY OF BENGAL OFF THE COAST OF MARINA BEACH NEAR TRIPPLICANE VILLAGE, CHENNAI

Report on Construction, Detailing and Mitigation Measures



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March 2023**



TABLE OF CONTENTS

1	PROPOSED KALAINAR MEMORIAL STRUCTURE	4
2	PROBLEMS FACED DURING CONSTRUCTION.....	4
3	SUMMARY OF MEASURES TO BE TAKEN AT VARIOUS STAGES ...	5
3.1	Measures taken at Pre-Construction stage:.....	5
3.2	Key Mitigation measures during Construction:	5
4	MITIGATION MEASURES DURING CONSTRUCTION	7
5	MITIGATION MEASURES POST CONSTRUCTION	10
6	DETAILED MITIGATION MEASURE.....	11
6.1	Construction Waste/Debris.....	11
6.1.1	Mitigation measures – For Construction.....	11
6.2	Pile Driving operations	12
6.2.1	Mitigation measures for Pile driving.....	12
6.3	Noise Control.....	13
6.3.1	Mitigation measures for Noise control.....	14
6.4	Water Pollution	15
6.4.1	Mitigation measures for Water pollution	16
6.5	Air Quality & Dust Control	19
6.5.1	Mitigation measures – Dust control	19
6.6	Coastal and Marine Ecology.....	21
6.6.1	Mitigation measures for Marine ecology	22
6.7	Prohibited activities within CRZ	23
6.8	Safety and Health Mitigation measures.....	23
6.9	Safety improvement measures.....	25
6.10	Personal protective Equipment (PPE)	27
6.11	Other Mitigation measures	31
6.12	Precautionary Signage at the construction site.....	32
7	Post-Construction Mitigation.....	33
7.1	Site clearance and operations	33
7.2	Solid Waste management	34



8	BRIEF OUTLINE OF CONSTRUCTION REQUIREMENTS & METHODOLOGY:.....	35
9	CONSTRUCTION DETAILING	36
10	SHORELINE MANAGEMENT	43
10.1	Stability of Shoreline through Satellite Imagery and Beach Profile ...	43
10.2	Shoreline Assessment.....	43
10.3	Shoreline Analysis.....	43
10.4	Mapping the shoreline	44
11	Dredging requirements	45
12	Visualisation of Key Stages during Execution of Construction activities - Sample	46

1 PROPOSED KALAINAR MEMORIAL STRUCTURE

The Kalaignar Memorial consist of an Approach Structure and a Pen monument pad structure. The Overall length of the structure is 650m in which the approach structure with length of 575m and the pen monument structure with a length of 75m. The approach structure with a dimension of 575m x 9m, will consist of 2 rows of RCC bored cast-in-situ piles, transverse beam, longitudinal beams, and slab. The Pen monument pad structure with a dimension of 75m x 40m, will consist of rows of RCC bored cast-in-situ piles, transverse beam, longitudinal beams, and slab. The overall layout of the proposed structure and the typical general arrangement and cross section of the proposed structure is included as a separate report.



Figure 1 Figurative representation of the proposed development

2 PROBLEMS FACED DURING CONSTRUCTION

The common problems encountered for sites near coasts area,

- Spillage of construction material during transport.
- Deposition of debris on & offshore.
- Sediment transportation.
- Improper disposal facilities.
- Maritime navigation (site closer to port & defence facilities)
- Marine life disturbance.



- Spilling of construction materials (concrete, bars ...) into the sea.
- Tourist disturbance at the site.

3 SUMMARY OF MEASURES TO BE TAKEN AT VARIOUS STAGES

3.1 Measures taken at Pre-Construction stage:

Stage	Description
Site selection	<ul style="list-style-type: none"> • The proposed site was selected as it will not affect the Cooum River mouth and Olive Ridleys nesting sites, nearest fish market, fishing yard.
Bathymetry	<ul style="list-style-type: none"> • Bathymetry was done distance of 500 meters from the shoreline, up to a depth of 17.46 meters and 10-12 bathymetric transects. • The depth of seabed in 360 from line is determined as 6m.
Water Environment	<ul style="list-style-type: none"> • The ground water and marine water was tested for pH, TDS, Chloride content, Sulphate content, the total hardness.
Soil Environment	<ul style="list-style-type: none"> • The soil in the site is tested for pH, TDS, Chloride content, Sulphate content, the total hardness.

3.2 Key Mitigation measures during Construction:

Description	Mitigation measures
Construction Waste	<ul style="list-style-type: none"> • Segregate the waste and dispose. • The dumping of waste in the site for long period should be avoided



	<ul style="list-style-type: none"> • A silt curtain should be given to trap the sediment movement
Noise control	<ul style="list-style-type: none"> • Providing a noise barrier around the construction site. • The machinery should be well lubricated. • Providing earplugs/ earmuff to the workers.
Air Quality & Dust control	<ul style="list-style-type: none"> • The equipment should be well maintained. • Sprinkling of water would avoid the dust emission. • Vehicle carrying the waste and the construction equipment should be closed.
Water/ Marine Pollution	<ul style="list-style-type: none"> • Build an erosion control blanket. • Providing debris trap. • Providing marker buoys
Marine ecology	<ul style="list-style-type: none"> • The unexpected waste disposal is cleared as soon as possible. • Pile driving should be done with noise insulation to avoid noise vibration to the marine fauna.
Safety and health	<ul style="list-style-type: none"> • Proper camping area and facilities should be provided for the workers. • Proper waste disposal system for the working area. • Personal protective equipment should be compulsory. • Safety management plan and proper evacuation plan should be done.
Management plans	<ul style="list-style-type: none"> • Alternate navigation plans for the vessels during the construction period should be arranged • Environment Impact Assessment should be done



	<ul style="list-style-type: none"> • Alternate route for the fishing boats, local community & tourists must be pre-planned during all stages of construction
--	---

4 MITIGATION MEASURES DURING CONSTRUCTION

Following mitigation measures shall be taken into account and planned for, to mitigate potential hazards.

- Adequate safety precautions will be ensured during transportation of quarry material from quarries to the construction site. Vehicles transporting / Boats transporting the material should be covered to prevent spillage.
- For construction and material storage sites, fencing should be installed so that it doesn't obstruct tourists' access to the area. To prevent dust and smog, stockpiles must be covered.
- Laying down a debris trap close to the location will stop the debris from leaving the sites. To reduce tourist disruption, the debris traps should be placed away from the shore.
- Silt curtain to be installed parallel to the site to reduce sediment movement.
- Within the boundaries of the protected regions, no building waste should be disposed of. The location of disposal locations, if necessary, should be done to guarantee that the disposal of the material does not influence surface water bodies or low-lying areas, and that no endangered or rare marine species is harmed by such materials.
- Because the location is close to a major functioning port (Chennai port), precautionary preparations in accordance to scheduled maritime navigation plans should be considered.
- Due to the site being close to key tourist hubs (state memorials) and renowned Marina beach, proper traffic management plans should be planned before commencement of works.



- Proper servicing and maintenance of vehicles should be undertaken to avoid any leaks or spills of oil, petrol or concrete due its proximity to eco-sensitive region.
- All shuttering shall be securely installed and inspected for leaks prior to concrete being poured and all pouring operations shall be supervised always to monitor for spills and leaks.
- To prevent sea water splashing on the structure, the deck level should be kept at specific heights above the high tide mark.
- Consider safety precautions like installing handrails and ladders on the structure.
- Precautionary measures will be undertaken to minimise the risk of injury or disturbance to marine ecology and fisheries in the area of operations.
- Prior to start of excavation work, a study would be made to evaluate the expected vibration level and thereby devise the best method for excavation to minimise vibration impacts on the surrounding area and minimise risk of damage to existing structures if any.
- Proper signage and warning tapes would be affixed to demarcate restricted areas. A safety exclusion zone, delineated by cautionary buoys would be observed to restrict access to fish boat operators.
- Adequate security arrangement shall be made to ensure that the local inhabitants and the stray cattle are not exposed to the potential hazards of construction activities.
- Safe and secure camping area shall be provided for the migrant laborers during the construction period. Contractors shall be directed to provide adequate arrangements for water supply, sanitation, and cooking fuels. The construction site shall be provided with sufficient and suitable toilet facilities for workers to allow proper standards of hygiene. These facilities would be connected to a septic tank and maintained to ensure minimum



environmental impact.

- The project site terrain is flat and plain and therefore some levelling may only be to some extent. Vegetation on topsoil will be removed prior to commencement of bulk earth work. During dry weather conditions, dust may be generated by activities like excavation and transportation through un-bituminized roads. The dust suppression would be arrested by using water sprinklers.
- As soon as construction is finished, the surplus earth shall be utilized to fill up low lying areas, the rubbish shall be cleared, and all un-built surfaces reinstated. Appropriate vegetation shall be planted, and all such areas shall be landscaped. Hazardous materials [e.g., acids, paints, etc.] shall be stored in proper and designated areas.
- During land side construction period, the water quality is likely to be affected due to the construction work and loosening of topsoil. This is likely to increase the suspended solids in the run-off during heavy precipitation. In order to reduce the impact on water quality, temporary sedimentation tanks shall be constructed for the settlement of the suspended matter.
- The noise impact on the surrounding population during the construction phase will be within the acceptable limits. High noise generating equipment, if used, shall not be operated during the night to eliminate any possible discomfort to the nearby residents. The following recommendations shall be implemented:
 - Provision for insulating caps and aids at the exit of noise source on the machinery.
 - The use of damping materials such as thin rubber/lead sheet for shielding the workplaces like compressors, generator sheets
 - Adoption of Shock absorbing techniques to reduce impact.
 - Provision of Inlet and outlet mufflers which are easy to design; and



- Provision of Earmuffs or earplugs to the workers, Operators of noise producing equipment and enforcement of personal protective equipment use by the workers to be ensured.

5 MITIGATION MEASURES POST CONSTRUCTION

- Consider safety precautions like installing handrails, ladders, fire extinguishers on the structure and upkeep of the fixtures.
- Precautionary measures will be undertaken to minimise the risk of injury or disturbance to marine ecology and fisheries around memorial by ensuring safe disposal of wastes generated every day and educating through proper signage.
- Plan and provide proper evacuation and escape routes, protocols in the event of natural calamities such as fire, earthquake and immediately once the tsunami warning is issued.
- Public visitors and tourists should be restricted and prevented from the walkway and memorial deck during periods of Cyclonic conditions, heavy rainfall, and heavy winds.



6 DETAILED MITIGATION MEASURE

6.1 Construction Waste/Debris

- During construction, waste will be generated which is an inert and non-biodegradable material such as concrete, plastic, metal, wood etc.
- Types of wastes which are generated can be classified in to four categories
- Construction waste which includes spilled concrete, metals packing and paper products, wood beam, joists, studs, etc.,
- Municipal waste which includes domestic waste by the works in the site like food, plastic, clothes etc.
- Hazardous Waste which are paints, cleaners, Tar and tar products, etc.,
- E-waste like batteries, any scrap part of the equipment etc.,
- Since the construction area falls under the CRZ II, CRZ IA, CRZ IVA waste dispersion in this area should be carried out as per the guidelines of the Ministry of Environment and forests.
- The site is near the tourist area (Marina beach and State leaders memorial place), so the construction waste should not affect the aesthetic view of the area.

6.1.1 Mitigation measures – For Construction

- The dumping of construction waste in the CRZ is prohibited. The waste produced during construction and other activities can be collected in site for temporary, but proper care should be taken.
- All the construction waste should be sorted and stored within the site itself. A proper screen should be provided so that the waste will not scatter and pollute the sea shore and sea water.
- The construction waste stored in the shore should be removed on daily or certain interval basis based on the storage capacity.



- The waste generated by the labours should be collected and disposed as per the municipal waste management.
- Solid waste shall be segregated as hazardous waste, municipal waste and disposed as per the municipal solid waste criteria.
- The hazardous waste should be isolated and stored separately in the site with a proper barrier. A fire extinguisher is necessary for the hazardous storage place.
- Plastic, broken glass, scrap metals can be sent to recycling.
- The waste which can't be recycled can be transported to landfills.
- The landfills should be away from the seashore and public usage area.
- The landfills can be lined using the construction waste like concrete.

6.2 Pile Driving operations

- Dredging can be done in the installation of pile in the seabed up to the founding level.
- During the piling work sediment will be spilled into the water and transported away forming sediment plumes.
- Sediment plumes generated are determined by the type of sediments and flow condition during the piling work.
- Because of the formation of the plumes, the turbidity of the sea water will increase which will affect the diversity of the aquatic fauna in the area.
- Sedimentation spills have effect on fishing ground.

6.2.1 Mitigation measures for Pile driving

- Silt curtains can be provided around the construction area to the transport of the sediment out of the work site
- Reducing the sediment outflow from dredger by using green valve technology and ensuring the well-maintained equipment without any leakage.



Figure 2 Silt Curtains

6.3 Noise Control

- The Noise pollution means the sound produced by the activity affects the health and wellbeing of the worker and the marine life.
- Exposure of more than 85dB noise for 8 hours termed as noise pollution.
- The machinery used in the construction may exceed the level and may cause vibration also.
- Due to excessive exposure of more noise can lead to loss of hearing and also affect the marine life.



- The marina beach which is near to the site, is a place where the people use to jog and walk in the morning, the noise due to the construction shall not disturb the people.
- Since the major port (Chennai port) is near, the construction noise should not affect the activity of the port.

Table 1 Noise emitted from the construction equipment

Construction Equipment	Noise from 50 feet from the source (db)
Pile Driver (Impact)	101
Concrete mixer	85
Pneumatic tool	85
Air compressor	81
Concrete Vibrator	81

6.3.1 Mitigation measures for Noise control

- The machinery choose for the construction work should be well maintained and well lubricated.
- Providing noise barrier or acoustic enclosures which may block the direct path of sound wave. It can reduce the level of noise.
- Noise shield can be used around the noise producing equipment. The noise shield can be any physical barrier which can reduce the noise level.
- Provide earplugs/ earmuff to the worker.
- Exposure time of the worker who work with high noise equipment should be reduced or shift basis can be arranged.
- If the construction site near the human settlement, the construction can be stopped between 10.00 pm and 6.00 am. If work has to be continued at night, a proper noise barrier should be installed to avoid disturbance.

- Ambient Noise quality monitoring can be carried out at certain intervals.
- If the noise of the working area increases above 85db, the required measures should be taken to reduce the noise pollution.



Figure 3 Noise barrier



Figure 4 Hydro hammer with Noise shield

6.4 Water Pollution

- The waste generated in the process of the construction waste thrown in the sea causing water contamination.
- The concrete may spill into the sea during the construction may cause the water pollution

- The leakage of oil or petrol from the construction equipment may cause water pollution.
- The effluent of the oil/grease due to working of equipment may cause water pollution hindering local
- The marina beach is the second largest beach and the marine ecology consists of large variety of fauna like mullets, sharks, silver bellies, rays, ribbonfish, skates, whitebait, horse mackerel, crabs, , lobsters sabrefish, , Indian salmon, , catfish, prawns polluting it will end up in the loss of the ecology and also affect the people who visit it.

6.4.1 Mitigation measures for Water pollution

- Built erosion control blankets, sedimentation ponds and silt fences to avoid erosion of construction material to the sea.



Figure 5 Erosion Control Blankets

- The transportation of the construction materials should be demarcated by marker buoys. Thus, the unexpected spill can be cleared easily.



Figure 6 Marker buoys

- Laying debris trap close to the location will stop the debris from leaving the site. To avoid tourist disruption, the debris trap should be placed away from the shore.



Figure 7 Debris trap



Figure 8 Debris trap

- The vessel and construction equipment should be monitored at regular interval to check any leakage or any disturbance to avoid leaking of oil or petrol to marine water.
- The effluent of the oil/grease from the machinery can be collected in a trap and it is discharged after treatment. The discharge of the treated waste should be as per the municipal waste management criteria.
- The framework shuttering should be securely installed and checked frequency for leaks prior to pouring concrete and the concrete pouring should be monitored carefully.
- The waste generated by the labours should be collected and disposed as per the municipal waste management.
- Solid waste shall be segregated as hazardous waste, municipal waste and disposed as per the municipal solid waste criteria.
- The complaint regarding the waste floating should be addressed immediately.
- The storm water runoff to the sea from the construction site should not be contacted with the waste disposal of the site. So provision should be made



like storm water ditches are constructed to free flow of the runoff. Ensure offsite natural runoff does not wash over site.

- Ensure ground water is not contaminated by the penetration of leaches from the stockpile or waste dump. Geotextile can be used in the waste dumping area to prevent the penetration of leaches.

6.5 Air Quality & Dust Control

- Air pollution is the major cause for many diseases. The proposed structure is in the people gathering place, the air quality should be checked.
- The dust produced due to the construction may cause air pollution.
- The smog from the vehicle can pollute the air.
- During Construction, the transport of the fine materials like, sand, cement may cause air pollution.

6.5.1 Mitigation measures – Dust control

- The vehicle and equipment used for construction should be maintained and pollution emission should check frequently. And equipment should be switched off when it is not in the use.
- The speed of the vehicles can be restricted to 20 kmph to reduce dust emission due to movement of the vehicle.
- Public access area like the memorial place can be regularly inspected for the construction dust sediments. If any it should be cleaned.
- Prolonged storage of the construction material should be avoided.
- Sprinkling of water near the construction area while running the equipment may reduce the dust production.
- Since the site is near the tourist hub, the air quality can be checked frequently.
- Monitoring can be done for PM_{2.5}, PM₁₀, SO₂, Pb and NO_x which are very toxic to the respiration.

- The construction dump and stockpiles should be covered properly.



Figure 9 Stockpile covering

- During transport of the construction materials, the vehicle should be covered to prevent spillage or air pollution.
- Onsite burning of any waste material should not be permitted.
- If the wind of the onshore and offshore site is adverse then, alternative plan should be done to avoid more dust emission. Like usage of the equipment can be reduced, the stockpiles are closely monitored, the vehicle usage can be reduced. For any alteration, the dust production is not reduced then the work can be stopped for the day.
- Air quality should be checked for a certain interval from the construction site.
- The frequent monitoring of the air quality should be done. The concentration of the pollutant should be in the limit. If the concentration exceeds the limit for 2 consecutive days, then mitigation should be done to control it (The values are taken from the National Ambient Air quality Standards, Central Pollution Control Board issued on 18 November, 2009, New Delhi.)



Table 2 Standard Concentration of pollutant in Ambient Air

Pollutant	Standard Concentration in Ambient air for 24 Hours (for Industrial, Residential, Rural and other area)
Sulphur Dioxide (SO ₂)(μg/m ³)	80
Nitrogen Dioxide (NO ₂) (μg/m ³)	80
Particulate matter (less than 1μm) (μg/m ³)	100
Particulate matter (less than 2.5 μm) (μg/m ³)	60

6.6 Coastal and Marine Ecology

- The seismic operation like drilling, Pile driving, can cause noise and vibration which can temporarily affect the fish and marine ecology.
- Due to construction, the disturbance may cause temporary displacement of fishery resources and affect other aquatic fauna and flora.
- The waste from the construction can affect the marine water.
- As per the CRZ notification 2011, the Pen monument pedestal is in the CRZIVA, Pedestrian pathway above sea is in the CRZ IVA, Lattice Bridge comes under CRZ IA, CRZII, CRZIVA, Pedestrian pathway above beach is in CRZ II, Pedestrian Pathway from K K memorial to bridge is in CRZ II.
- So proper Environmental maintenance should be done as per the CRZ notification 2011.
- The proposed construction passes through the CRZ 1A which is ecologically sensitive area, proper care should be taken to avoid disturbance to marine ecology.



6.6.1 Mitigation measures for Marine ecology

- Identify the sensitive area for marine life such as feeding, breeding, calving and spawning area and plan the seismic activity like pile driving, according to that to avoid the damage of the marine life and ecosystem.
- To avoid underwater noise generated by pile driving can be reduced by providing air bubble curtains, temporary noise attenuation piles, air filled fabric barriers.
- If a marine life mammals are sighted within 500m of the proposed construction site, the work can be stopped until it move away.
- The disposal to the marine should be maintained as per the standards.

Table 3 Standard of Disposal

	Parameters	Concentration not to exceed
Onshore Facilities (for marine disposal)	pH	5.5-9.0
	Oil & grease	10 mg/l
	Suspended solids	100 mg/l
	BOD, 27°C for 3 days	30 mg/l

- Prevention of spillage of diesel, oil, lubricants etc.,
- Usage of appropriate system to barges/workboats for collection of liquid/soils waste generated.
- Provide a post piling monitoring program in the site.
- The oceanographic data like Tides, Waves, Storm surges, Current, Salinity, Sea water temperature, Suspended load and seabed bathymetry are to be collected before the construction.
- Tides move the water to high peaks usually twice a day and twice a month to much higher peaks. Study of tidal flow and current velocity can give a idea of dispersion of pollutants.
- The study of wave energy should be done to determine the effects of beach erosion and accretion.



- The meteorological data like wind speed and direction, Rainfall, Relative humidity, Barometric pressures and history of cyclones, tsunamis, and earthquake subsidence should be studied.
- Coastal areas are more subjected to damages during severe cyclones, Tsunamis and storms. During Severe cyclones tsunamis and earthquake, the sea water level near shore gets increases due to storm surge and set up. Higher wind velocities tend to increase higher wave heights. Thus the collection of these data can be useful in the planning of the evacuation process.
- The marine environment is highly corrosive, and suitable coating system are to be used for the protection of the structures. Since maintenance is difficult, coating are to be applied correctly under the right condition.

6.7 Prohibited activities within CRZ

- Discharge of untreated waste and effluents from industries, cites or towns and other human settlements.
- Dumping of city or town wastes including construction debris, industrial solid waste, fly ash for the purpose of construction and land filling.
- Mining of sand, rocks and other sub strata materials.
- Dressing and altering of active sand dunes.
- In order to safeguard the aquatic system and marine life, disposal of plastic in to the coastal water shall be prohibited and adequate measures for management and disposal of plastic materials shall be undertaken in the CRZ.

6.8 Safety and Health Mitigation measures

- All works can be carried out in a safe manner and the workers should be trained to work in a safely manner.



- A barricade or shutter can be provide around the construction to avoid disturbance to the public.
- Should prepare a safety management plan which describes the responsibility and procedures for all safety measures.
- There should be proper protocols for the personal requiring access into and out to the site area.
- The equipment operated, crane drivers and vessel operated should be licensed as per the Indian norms.
- Drills can be done for emergency evacuation, equipment operation, crane driving, vessels and boat operation before starting of work.
- Emergency plans should be done for immediate action to take for any accident by fire, oil spills etc., to avoid injuries, in worst any death.
- Proper evacuation plan should be done for evacuation of workers in construction site during cyclone warning.
- There should be fire extinguisher and first aid box in onshore as well as in the offshore construction.
- Insurance for all workers should done for monitory cover for any accidents.
- All the workers should be well trained before working in the site mainly in the offshore.
- There should be evacuation boats, vehicle available for the labours who work on the offshore site.
- The equipment, vessels should be checked frequently for any damage or leakage.
- The site should be checked on daily basis for any potential hazards.
- If any hazardous material is there, it should be reported and place in a highly secured manner.



- Since it is near to Chennai port, delineated by cautionary buoys would be observed to restrict access of navigation vessels and any fishing boat.
- The protruded end of reinforcement at the site should be shielded or capped.
- The workers should work in 8 hours shift to maintain good health and avoid fatigue thereby preventing any work accident.
- Health check-up camp for the migrant works should be carried out in a regular basis.
- The history of the medical condition of the workers should be maintained and the physical fit person can be allowed to work in the offshore construction.
- The safety audit should be done before work and at a regular basis and report to the governing authorities.
- Safe and secured camping area should be arranged for the migrant labours. The basic needs like food, water supply, sanitation should be arranged during the construction period and proper hygiene measures should be taken care. The waste generated during the stay should be disposed as per the municipal waste management.
- Transportation from the place of camping to the site should be provided.
- The construction site should be fenced, so that the tourist cannot be disturbed.

6.9 Safety improvement measures

Table 4 Safety measures

Description	Safety Measures
Support for safety	<ul style="list-style-type: none"> • Safety management plan to be prepared • Safety officer to be appointed and be always available.



	<ul style="list-style-type: none"> • Safety program should be conducted. • Take time to prepare. • Use proper equipment for the job and keep it well maintained, and know the safety requirement of the equipment.
Communication	<ul style="list-style-type: none"> • Improve communication • Educate the public • Around large equipment the worker should be with someone with radio or should have a radio. • Need to take things slower and communicate and maintain line of sight. • Pay attention to details and small things and anticipate.
Preparation	<ul style="list-style-type: none"> • Safety involvement from beginning. • Know the safety requirement. • Be Proactive on things that may/will happen. • Use proper equipment for the job • Be aware of weather, wind factors. • Make sure equipment is well maintained. • Understand the work ahead and identify the risks.
Training	<ul style="list-style-type: none"> • The workers should have job specific education • Train the employees before allowing them on the field. • The workers should learn from the experienced team.



6.10 Personal protective Equipment (PPE)

- Hard hats: A head injury can impair a worker for life. Wearing a safety helmet or hard hat is one of the easiest way to protect a worker from a head injury. The hard hat should be provided that it should
 1. Resist penetration by object,
 2. Absorb the shock of a blow
 3. Water-resistant and slow burning
 4. Have replacement of the suspension and headband.
 5. Must hats must have hard outer shell and a shock absorbing lining that incorporates a headband and straps that suspend the shell from 2.54cm to 3.18cm away from the head.

Table 5 Permissible Noise exposure

Duration per day, in hours	Sound level in dB
8	90
6	92
4	95
3	97
2	100
1.5	102
1	105
0.5	110

- Eye and face protection: Hazards include flying particles, molten metal, liquid chemical, acids or caustic liquids, chemical gases or vapour can effect eye and face. These can be avoided using spectacles, goggles, welding shield, laser safety goggles, and face shield.



- **Hearing Protection:** The workers should not expose to high noise which lead to hearing loss. According to the noise exposure, the worker should wear single use earplugs, pre-formed or moulded earplugs, earmuffs can be used as hearing protection.
- **Hand and Arm protection:** Potential hazards include skin absorption of harmful substances, chemical or thermal burns, electrical dangers, bruises, cut can happen if it is not protected safely.
 1. Factors that influence selection of Gloves for a work place depends on
 1. Type of chemical handled
 2. Nature of contact
 3. Duration of contact
 4. Area requiring protection
 5. Grip requirement (Dry, Wet, Oily)
 6. Thermal protection
 7. Size and comfort
 8. Abrasion/resistance requirement
 2. Depends on the exposure, the gloves can be selected. Leather gloves, Aluminized gloves, Synthetic gloves, Aramid fibre gloves, fabric and coated fabric gloves, chemical and liquid resistant gloves, chemical and liquid resistant gloves, insulating rubber gloves.
- **Body protection:** Hot splashes from molten metals and other hot liquids, Potential impacts from tools, machinery and materials and hazardous chemicals can affect the body. So, the body of the worker should be protected with laboratory coats, coveralls, vests etc., leather, rubber, rubberized fabrics coats can be used in the site.
- **Foot and Leg Protection:**



1. Leggings: Protect the lower and feet from heat hazards such as molten metal or welding sparks.
 2. Metatarsal guards: Protect the instep area from impact and compression. It is made of Aluminium steel, fibre or plastic. These strapped to the outside
 3. Toe guards: It is fit over the toes of regular shoes to protect the toes from impact and compression hazards they may be made of steel, aluminium or plastic.
 4. Combination foot and shin guards: It protect the lower legs and feet.
 5. Safety Shoes: It have impact-resistant toes and heat resistant soles that protect the feet against hot work surface common in roofing, paving and hot metal industries. The metal insoles of some safety shoes protect against puncture wounds.
- Safety Belts, Lifelines and Lanyards:
 1. These can be used for workers safeguarding.
 2. Lifelines shall be secured above the point of operation to anchorage or structural member capable of supporting a minimum dead weight of 2000kg.
 3. Safety belt lanyard shall be a minimum of ½ inch nylon or equivalent, with a maximum length to provide for a fall of no greater than 6 feet.
 4. All safety belt shall capable of withstanding a tensile loading of 1500kg without cracking, breaking or taking a permanent deformation.
 - Lifejackets/buoyancy aids
 1. Should be provided to and worn by workers who works in the offshore construction to avoid drowning in case the worker falls down.

2. Lifejackets should be thoroughly checked by the user before each use.
3. The lifejacket/buoyancy aid should preferably be provided with a whistle and/or a self-activating light (for night work) in order to aid locating the wearer and facilitating rescue.



Figure 10 Life jacket/buoyancy aid

4. A lifebuoy with sufficient lifeline (not less than 30m) should be provided and the locations of the lifebuoys should be less than 50m intervals along the edges of places where work is being carried out. To avoid any delays to rescue operations, lifebuoys should not be tightly tied to posts.



Figure 11 Lifebuoy

- Training about PPE:
 1. All worker should be given training regarding put on, take off, adjust and wear the PPE.

2. Proper care, maintenance, useful life and disposal of PPE should be taught to the workers.
3. The contractor should document the training.



Figure 12 PPE

6.11 Other Mitigation measures

- Since the proposed site is near the Chennai port, change of route or proper mitigation should be taken for the navigation of the vessels during the construction period.
- Since the site is near the fishing ground, proper fishery management team should be formed and alternative for the fishing ground should be arranged.
- The proposed structure is in the renowned marine beach and in a State memorial area. So the selected area is a tourist hub. So during the construction time proper barrier should be provided and the work should not disturb the tourist.
- Since the pedestrian deck in the offshore has navigation open arrangement, signalling arrangement have to be made, so the tourist can get aware of crossing the pedestrian.

- During the construction time also the navigation of vessel should be alarmed, so that it won't cause any hazards to the workers.
- A Ramp like structures can be provided to avoid the heavy equipment like cranes stuck in to the sea shore sand.

6.12 Precautionary Signage at the construction site

- Proper sign should be used for every activity of the construction.
- There should be caution sign for the people to know about the construction progressing.
- The caution sign should available at interval span.



- A common sign indicates the precautionary instruction for the visitors and site officers
- If crane or any lifting equipment is in progress, a sign indicates Forklifts crossing for the understating of the workers in progress.



- A proper sign should be placed outside the site area for the remainder to wear the PPE.
- To maintain the waste management proper sign for waste secretion should be put.



7 Post-Construction Mitigation

7.1 Site clearance and operations

- There should be a site inspection regarding the waste clearance, any hazardous problem to be rectified after the construction.
- A proper check of the installation of hand drills, fire extinguisher, proper sign and plan for evacuation of the people during sudden calamities has to be done after construction
- A proper check of the deck opening for vessel navigation should be done.
- If there is any obstruction for marine ecology, should be identified and rectified immediately.
- The fishing ground must be checked for the fishing and proper fishery step shroud be taken to restore the fishing activity.
- Proper sign should be put before opening the deck to avoid accidents.



7.2 Solid Waste management

- When the structure is opened to tourism, a proper solid waste management should be maintained by providing Dust bins in required distance.
- A proper screening system can be done for avoiding plastic in to the bridge covering the sea area.
- The waste collected is disposed as per the municipal solid waste management.



8 BRIEF OUTLINE OF CONSTRUCTION REQUIREMENTS & METHODOLOGY:

- Site investigation (surveying), study of Environmental conditions (wind, current, temperatures etc.)
- Environmental clearance.
- General layout of structures as per client requirement (dimensions, area etc.)
- Sub soil investigation (borehole data – onshore, offshore).
- Designing of the structure with required dimensions of the structures.
- Structural detailing & Good for construction drawing.
- Levels of the structure to be checked and maintained.
- Material sourcing - steel, cement, and aggregates.
- Quality check & testing
- Steel quality test as per IS 1786.
- Testing of concrete – slump cone test, compressive strength test (cube test) as per IS 456:2000.
- Positioning plan for driving pile to be predetermined at each piling locations.
- The anchor is spread with anchor boat equipped with hydraulic winch and a frame at front.
- Floating barge mounted piling or sequentially incremented gantry piling.
- Installation of reinforcement and pouring of concrete into driven liner.
- Testing of pile – pile load test static and dynamic as per IS 2911-4
- Installation of formwork, reinforcement, and casting of pile muff
- Installation of pre-cast pre-stressed beams
- Lattice bridge installation
- Commence of Pen memorial monument construction



- Installation of formwork, reinforcement, and casting of deck slab with provisions for glass intermediate frames
- Installation of deck facilities furniture – Fenders, bollards, ladders, glasses, emergency fixtures, etc...
- Laying of wearing coat & surface finishing

9 CONSTRUCTION DETAILING

Following general Construction details have been summarized. It is advised to take these into account for detailed plans to be conceived in future.

1. Site investigation

- Site investigation is carrying out for surveying the location and the bathymetry of the location for the water depth.

2. Site clearance

- The traffic movement to be controlled for easy movement of the equipment for surveying at the location.

3. Bore hole data

- The bore hole data is used to determine the type of soil at each depth at a location for determining the hard strata for rigid support.

4. Materials for Construction

4.1. Aggregates (Coarse & Fine)

- Crushed stone, crushed gravel, natural gravel, or other acceptable inert material must be clean, hard, robust, dense, non-porous, and durable to be used as coarse aggregate in plain and reinforced cement concrete (PCC and RCC).
- Fine aggregate is made up of small pieces of crushed stone or gravel that are free of mica, soft or flaky materials, garbage, lumps, and other potentially dangerous substances.

4.2. Cement



- Cement must be handled, stored, and transported on the site in a way that prevents degradation or contamination. Cement must be kept above ground in sheds that are completely dry and water-tight, and it must be stacked no more than eight bags high.

4.3.TMT Reinforcement

- The TMT reinforcement bars must be stored above the ground on platforms, skids, or other supports with well-drained surfaces when they are brought to the project site. They must also be shielded from exposure to the elements to prevent degradation by exposure.

4.4.Water

- Water must be stored in containers/tanks that are covered at the top and cleaned at regular intervals to prevent foreign matter intrusion or organic matter growth.

4.5.Fly Ash

- Fly ash is a finely crushed residue of the combustion of pulverised coal in boilers. The inclusion of fly ash is meant to improve the pozzolanic grade of the substance. The producer or supplier is responsible for making sure that their fly ash complies with IS: 3812-1981.

5. Tests and Standard of Acceptance

5.1.Cement

- Cement to be used in the Works shall be conforming to the following IS standards codes-
 - 53 Grade Ordinary Portland Cement: IS 8112
 - Portland Pozzolana Cement (fly ash based): IS 1489 (part-I)

5.2.Aggregates

- Test conforming to IS: 2386, Parts I to VIII.

5.3.Water



- Test conforming to IS 3025 to ascertain its suitability.
- The pH value should conform to IS: 456-2000.

5.4.TMT Reinforcement

- The material must undergo the required testing in line with the relevant IS requirements, and test certificates must be provided. Reinforcement must be manufactured, provided, and installed in conformity with specified criteria.

5.5.Mortar Mixing

- The specified characteristic compressive strength is determined using table 2 of IS: 456-2000.
- Mortar mix should be conforming to IS: 4031.

6. Cast-In-Situ Concrete Piles

6.1.General

- Cast-in-situ concrete piles must be built by driving or sinking non-structural tubular steel casings into the ground to the needed or refusal level. Clearing the casings of any materials, inserting reinforcement, and filling them with concrete is part of the permanent works.

6.2.Requirements for Pile Founding Levels

- All bored piles in the works shall be socketed into the hard strata for the minimum length or terminated up to the required level.

6.3.Installation of Permanent Pile Casings

- Pile casings are to be driven from a fixed frame of sufficient rigidity to ensure accuracy of driving under all conditions of tide, stream flow or hammer drop. The pile casings may also be installed from firm ground or from temporary supports or from fixed platform.

6.4.Pile Bore Bottom Cleaning

- Prior to placing concrete, polymeric slurry flushing at high pressure shall be done in the same way as the pre-bore flushing but using tremie



pipes connected to polymer pump. The pile bore shall be cleaned using either by air lift flushing or direct mud circulation (Polymer Flushing).

6.5. Installation of Reinforcement

- Prefabricated reinforcement cages for piles shall be marked and fitted with spacers to ensure that the cage is correctly orientated and positioned within the pile.

6.6. Placement of Concrete

- To prevent segregation, a tube or tremie pipe shall be used to place concrete in all piles. The tremie must be water-tight throughout its length and have a hopper attached at its head.

6.7. Cut-off and Clean-up of Top of Pile

- Pile heads are to be trimmed to the cut-off levels shown in the Drawings within a tolerance of ± 25 mm preferably on the negative side.

6.8. Testing of Piles

- The testing of should be carried out as per following IS standards
 - IS:2911(Part-4)
 - IS 14593
 - IS 14593

7. Formwork

7.1. General

- Formwork includes all staging, centring, scaffolding, and temporary construction needed for their support, as well as all temporary or permanent forms needed to shape the concrete into the shape, proportions, and surface finish indicated on the drawing.

7.2. Materials

- The thickness of the metal utilised for the forms must be such that they maintain their original shape. Forms must be inspected for damage before being re-used.



7.3. Design of Formwork

- The design of the formwork shall conform to provisions of IS 14687.

7.4. Workmanship

- Formwork for stage equipment must be robust and strong and leak-proof. To prevent any movement or sagging between supports, forms must be made sufficiently rigid with ties and bracings. It is forbidden to use lubricating (machine) oils as a coating or releasing agent.

7.5. Formed Surface and Finish

- This material shall leave no stain on the concrete and the surface finish of all concrete works shall be assessed in accordance with AS3610.

7.6. Preparation of Formwork Before Concreting

- The inside surfaces of forms must be coated with a release agent provided by an approved manufacturer or of an approved material to prevent concrete from adhering to the formwork.

7.7. Placement, Compaction, Finishing and Curing of Concrete

- Vibrators must adhere to IS: 3558 and IS-7246. The finished job must have all construction and expansion joints precisely tooled, free of mortar and concrete. Fresh concrete cannot be placed against concrete that has been in situ for more than 30 minutes. Surfaces exposed to the elements need to be maintained consistently damp or wet by ponding or by being covered in bags.

7.8. Installation of Precast Concrete Units

- The dimensions must be verified before the precast concrete units are lifted into position. All lifting, handling, and storing methods must be approved before being used. Final structural connections cannot be made until the precast concrete components have been built.

7.9. Sample Testing & Strength

- A random sampling procedure shall be adopted to ensure that each



concrete batch shall have a reasonable chance of being tested that is the sampling should be spread over the entire period of concreting. The test strength of the sample shall be the average of the strength of 3 cubes.

7.10. Removal of Formwork

- Centring must be uniformly and consistently decreased to allow the concrete to absorb pressures from its own weight. In order to avoid damaging the concrete, the formwork must be removed carefully. This will prevent any shock or vibration that could damage the concrete as it warms up.

7.11. Re-Use of Formwork

- When formwork is taken apart, each component must be inspected for damage and any that are must be removed for repair. All components must be free of soil, concrete, and other undesired contaminants before being used again. Parts with threads need to be oiled after cleaning.

8. Steel Reinforcement

8.1. General

- This work shall consist of furnishing and placing uncoated mild steel or high strength deformed reinforcement bars of the shape and dimensions conforming to these Specifications or as approved by the Employer. Reinforcements should be Corrosion Resistant Steel (CRS) high strength deformed TMT bars.

8.2. Protection of Reinforcement

- Steel reinforcing that isn't coated needs to be guarded against corrosion and chloride contamination. There must be no rust, mortar, loose mill scale, grease, oil, or paint on the reinforcements. This may be ensured either by using reinforcement fresh from the factory or thoroughly cleaning all reinforcement.

8.3. Bending & Placing of Reinforcement

- Contractors must submit a Bar Bending schedule to the Employer at



least two weeks before start of work. Bars must be bent cold to the specified shape and dimensions or as directed by the employer. Bars bent during transport or handling shall be straightened before being used on work. The reinforcement cage should generally be fabricated in the yard at ground level and then shifted and placed in position. The diameter of binding wire shall not be less than 1mm. Prolonged time gap between assembling of reinforcements and casting of concrete, may result in rust formation on the surface.

8.4.Lapping & Welding

- Lapping of bars shall be done in accordance with the relevant requirements specified in IS: 456 Code of Practice for Plain and Reinforced Concrete.
- The method of welding should conform to IS: 9417 and to any supplemental specifications. The welders & welding operator should conform to IS: 9417 & the M.S. electrodes used for welding shall conform to IS: 814.

8.5.Mechanical Coupling of Bars

- Bars may be jointed with approved patented mechanical devices conforming to IS: 16172 and as indicated on the drawing.

9. Environmental Management and Risk Assessment

- The impacts during the construction phase on the environment would be basically of transient nature and are expected to reduce gradually on completion of the construction activities.
- Environmental Impact Assessment (EIA) shall be prepared for different stages of project execution such Before, During & After Construction
- Proper Risk assessment shall be carried out prior to initiation of the works and re-visited and ensured on a daily basis throughout the project duration.



10. Project Management

- Quality Control of the Materials, Work executed, Equipment, Safety measures shall be ensured from planning till completion stage
- Project Management plans shall be devised at the start such that to enable timely completion of works
- Proper approvals and Stakeholder management should be sought.

10 SHORELINE MANAGEMENT

10.1 Stability of Shoreline through Satellite Imagery and Beach Profile

The investigation has been carried out through an analysis of historical satellite imageries and beach profile changes. The coastline is digitized for several years with the help of Google Earth at 1:5000 scale. Thereby existing coastal protection structures are located site specifically and demarcated. The instant availability of a wide range of historic images helps to enhance the accuracy and linearity in predicting the shoreline changes over the years.

10.2 Shoreline Assessment

- The Digital Shoreline Analysis System (DSAS) is computer software that computes rate-of-change statistics from multiple historic shoreline positions residing in a GIS.
- The shoreline change rate was calculated by dividing the distance of shoreline movement by the time difference between the oldest and the most recent shoreline over last 5 decades.

10.3 Shoreline Analysis

Demarcating and assessing the shoreline for a given study area before going into the field has advantages that includes.

- Promoting effective hypothesis for locating the vulnerable sites



- Aiding the selection and evaluating of the critically vulnerable sites
- Providing a baseline data on historic changes on shorelines

10.4 Mapping the shoreline

4 different mapping each portraying a significant data, which is used in this Comprehensive Shoreline Management study are as below.

- I. Present status of the shoreline including the physical features and man-made structures
- II. One decadal oscillation of shoreline profile
- III. Rate of shoreline change during last one decade.
- IV. Identification of vulnerability in terms of rate of shoreline erosion

Oscillations of the berm crest has been analyzed using beach profile changes.

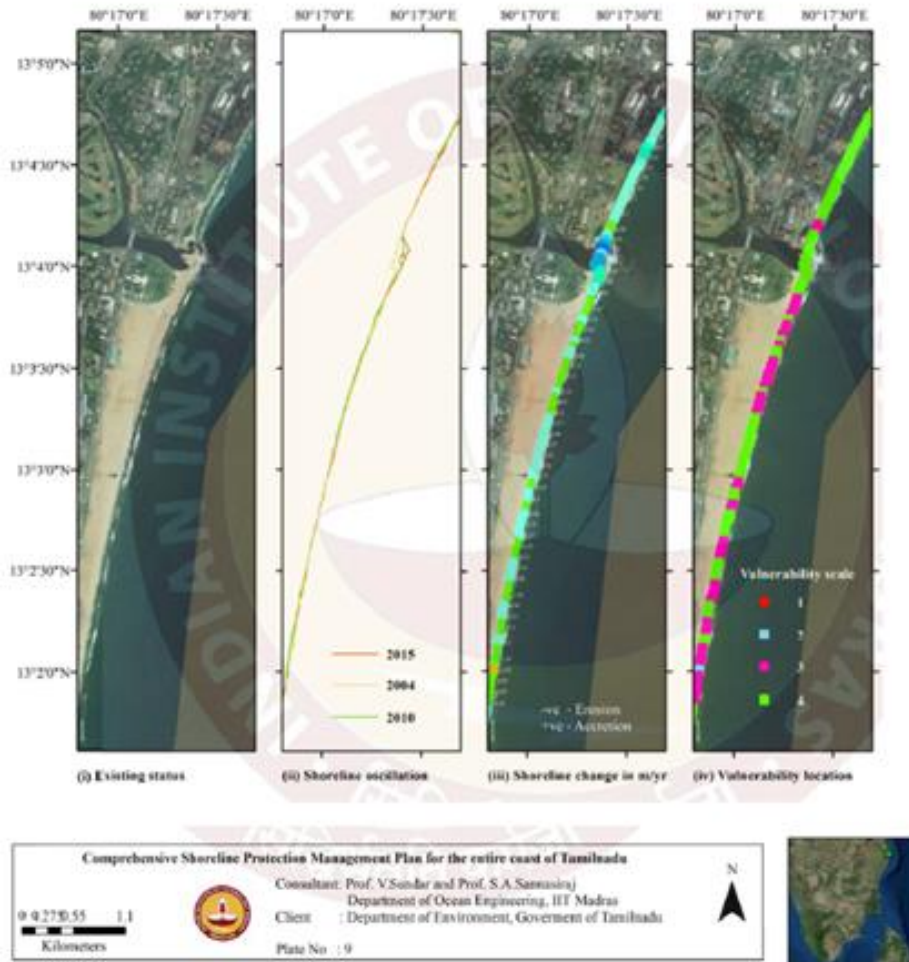


Figure 13 SMP at Marina

It can be inferred from the SMP that the current location is a Stable/Accretion zone, which may not involve further impact on adjacent regions.

11 Dredging requirements

- No active dredging is required at the chosen site location during construction & execution of offshore memorial works.

12 Visualisation of Key Stages during Execution of Construction activities - Sample

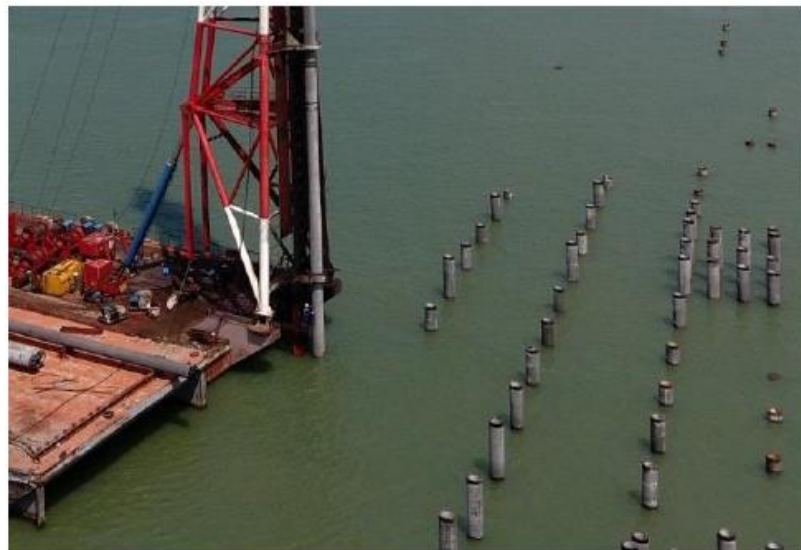


Figure 14 Piling work



Figure 15 Pile cap concreting

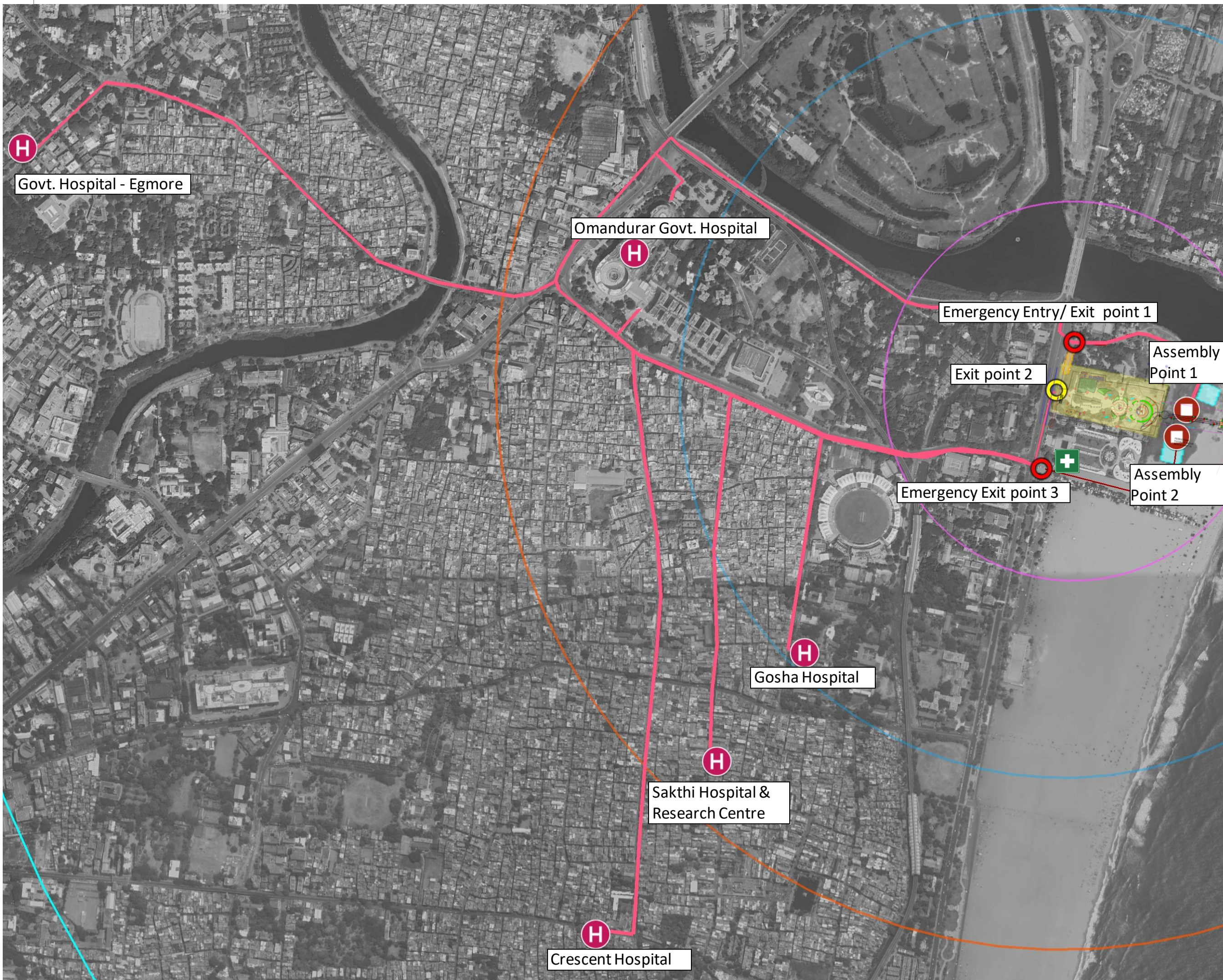


Figure 16 Installation of pre-cast beams



Figure 17 Deck slab construction

Access routes to Medical services at 3km Radius



Access routes to Medical services at at 1Km Radius



Sno	Hospital	Distance from/to Exit point 1 (Km)
Government		
1	Government Kasturba Gandhi (Gosha) Hospital	1
2	Omandurar Govt. Hospital	1.6
3	Govt. Hospital - Egmore	3.5
Private		
1	Sakthi Hospital & Research Centre	1.7
2	Crescent Hospital	2.8

PROJECT CONSULTANT:



Center For Urbanization Building and Environment
 Module No. 6C, 6th Floor, Phase II building,
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 Tharamani, Chennai, Tamil Nadu 600113
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- Assembly Point
- Emergency Exit Point
- Exit Point from Memorial Park
- Emergency Evacuation route
- Memorial park
- 500m Radius
- 1.0km Radius
- 1.5km Radius
- 3.0 km Radius

- Hospital Locations
- Medical Camp spots
- Route to Medical services
- Ambulance Stop points
- First Aid Centre

PROJECT TITLE:

Consultancy Services for evolving Crowd Management Plan, Emergency Evacuation Plan, Road Connectivity Studies and Detailed Traffic Management for the proposed construction of Muthamizh Arignar Dr. Kalaigner Pen Monument, Chennai, Tamil Nadu

SUBTITLE:

Road Connectivity & Traffic Management Plan

DRAWING TITLE:

Critical Routes to Medical Services

DRAWING NUMBER:

2022_PENMONUMENT/TMP/RC/01

DATE:

05-04-2023

REV. NO

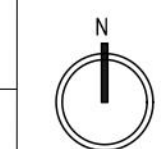
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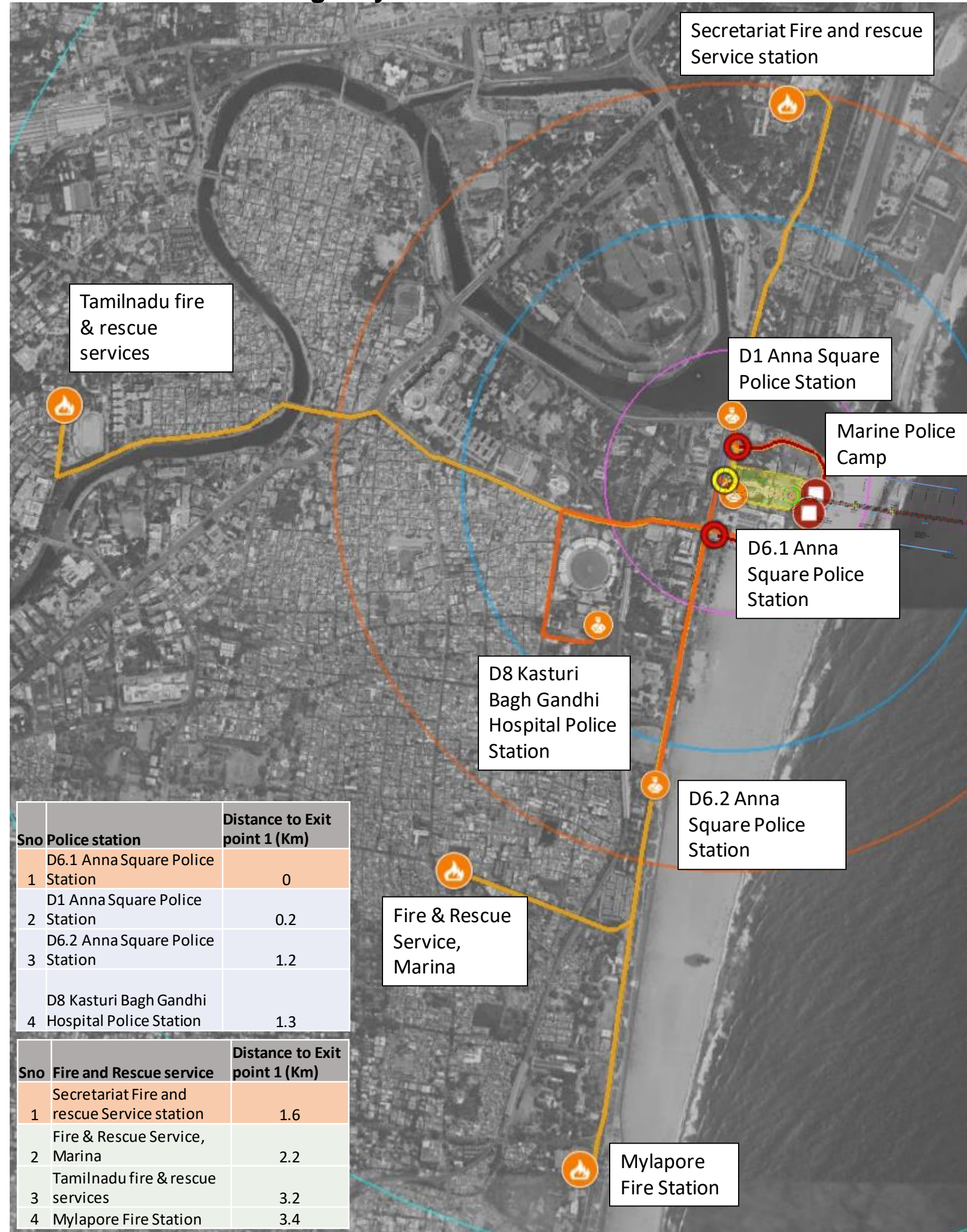
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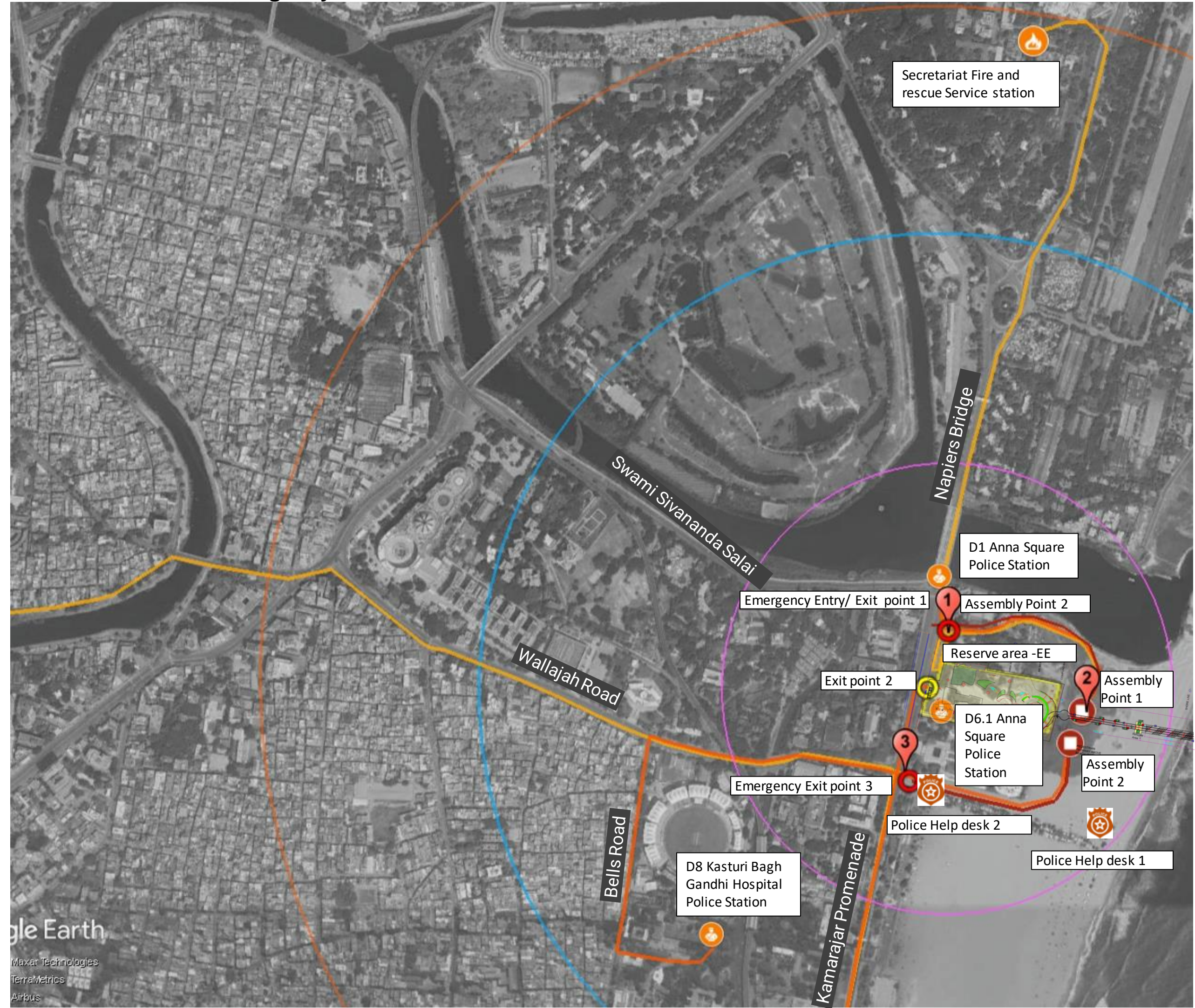
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Access routes to Emergency services at 3km Radius



Access routes to Emergency services 1.5Km Radius



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- Assembly Point
- Emergency Exit Point
- Exit Point from Memorial Park
- Emergency Evacuation route
- Memorial park
- 500m Radius
- 1.0km Radius
- 1.5km Radius
- 3.0 km Radius
- Fire & Rescue services
- Police Station & Police Outposts
- Fire and Rescue route
- Police patrol route
- Fire and rescue vehicle Stop points
- Police Help Desk

PROJECT TITLE:

Consultancy Services for evolving Crowd Management Plan, Emergency Evacuation Plan, Road Connectivity Studies and Detailed Traffic Management for the proposed construction of Muthamizh Arignar Dr. Kalaignar Pen Monument, Chennai, Tamil Nadu

SUBTITLE:

Road Connectivity & Traffic Management Plan

DRAWING TITLE:

Critical Routes to Emergency Services

DRAWING NUMBER:

2022_PENMONUMENT/TMP/RC/02

DATE:

05-04-2023

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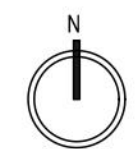
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- TENDER
- CONSTRUCTION
- AS-BUILT

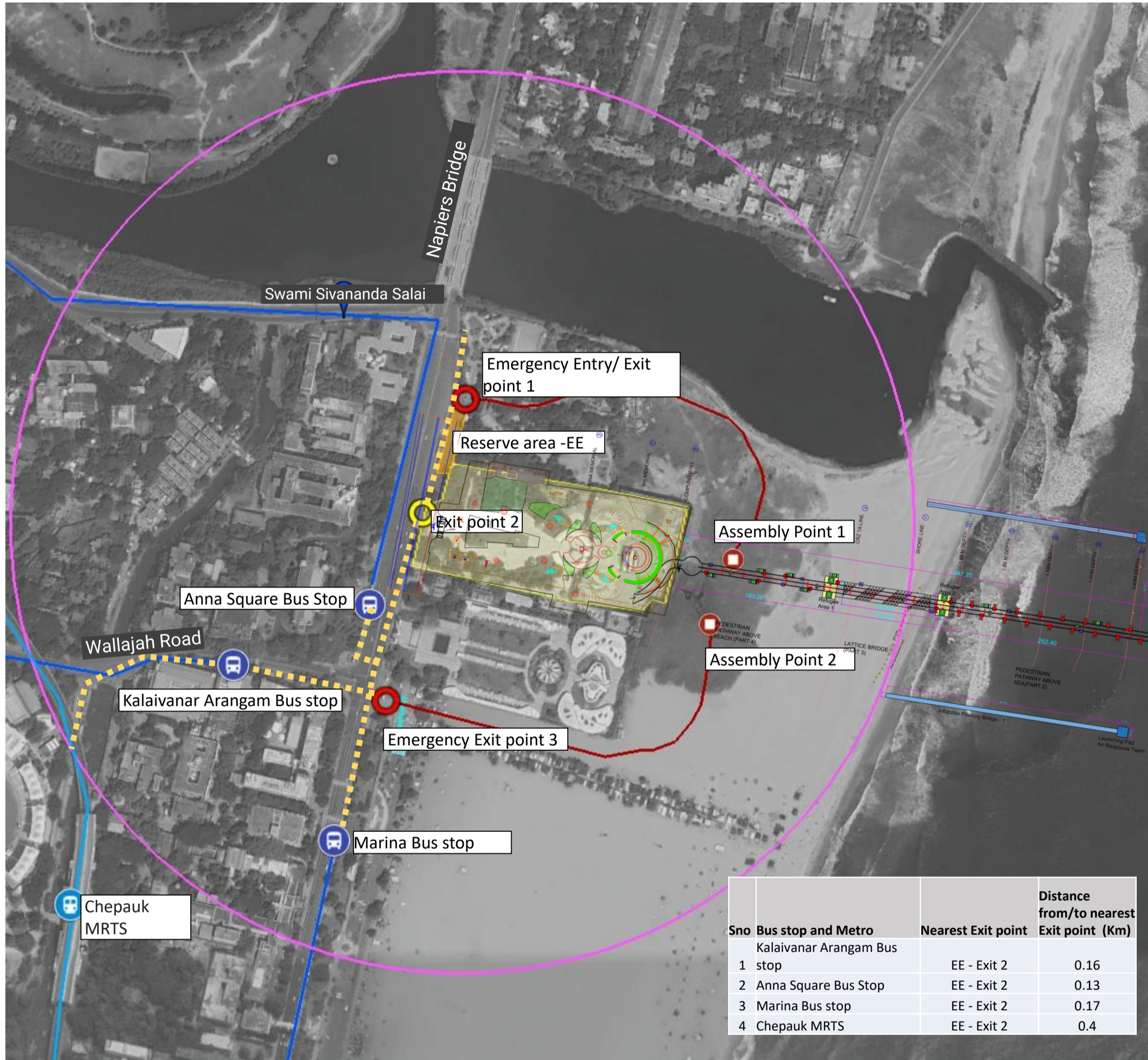
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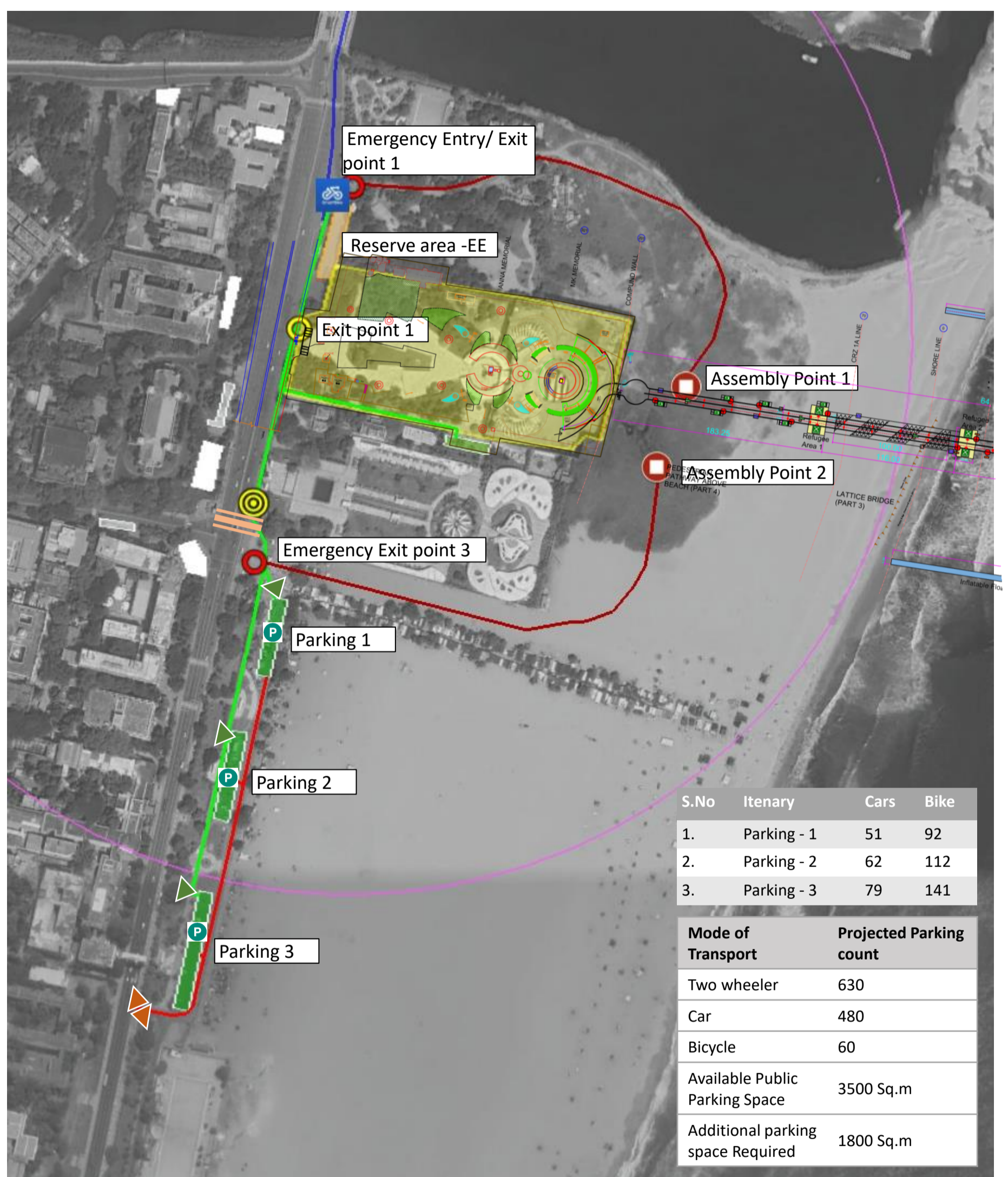
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DISPERSION THROUGH PUBLIC TRANSPORT



DISPERSION THROUGH NMT & INTERMEDIATE PUBLIC TRANSPORT



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- Assembly Point
- Bus stand
- Pedestrian path
- Emergency Exit Point
- MRTS station
- Subway
- Exit Point from Memorial Park
- Bus Route
- Auto stand
- Emergency Evacuation route
- Pedestrian route
- Parking area
- 500m Radius
- Smart Bike
- Memorial park
- Pedestrian entry
- 1.0km Radius
- Vehicle entry
- 1.5km Radius
- Parking Area
- 3.0 km Radius

PROJECT TITLE:
 Consultancy Services for evolving Crowd Management Plan, Emergency Evacuation Plan, Road Connectivity Studies and Detailed Traffic Management for the proposed construction of Muthamizh Arignar Dr. Kalaigern Pen Monument, Chennai, Tamil Nadu

SUBTITLE:
 Road Connectivity & Traffic Management Plan

DRAWING TITLE:
 Dispersion Through Public Transport , NMT and Intermediate transport services map

DRAWING NUMBER:
 2022-PENMONUMENT/TMP/RC/03

DATE:
 05-04-2023

REV. NO
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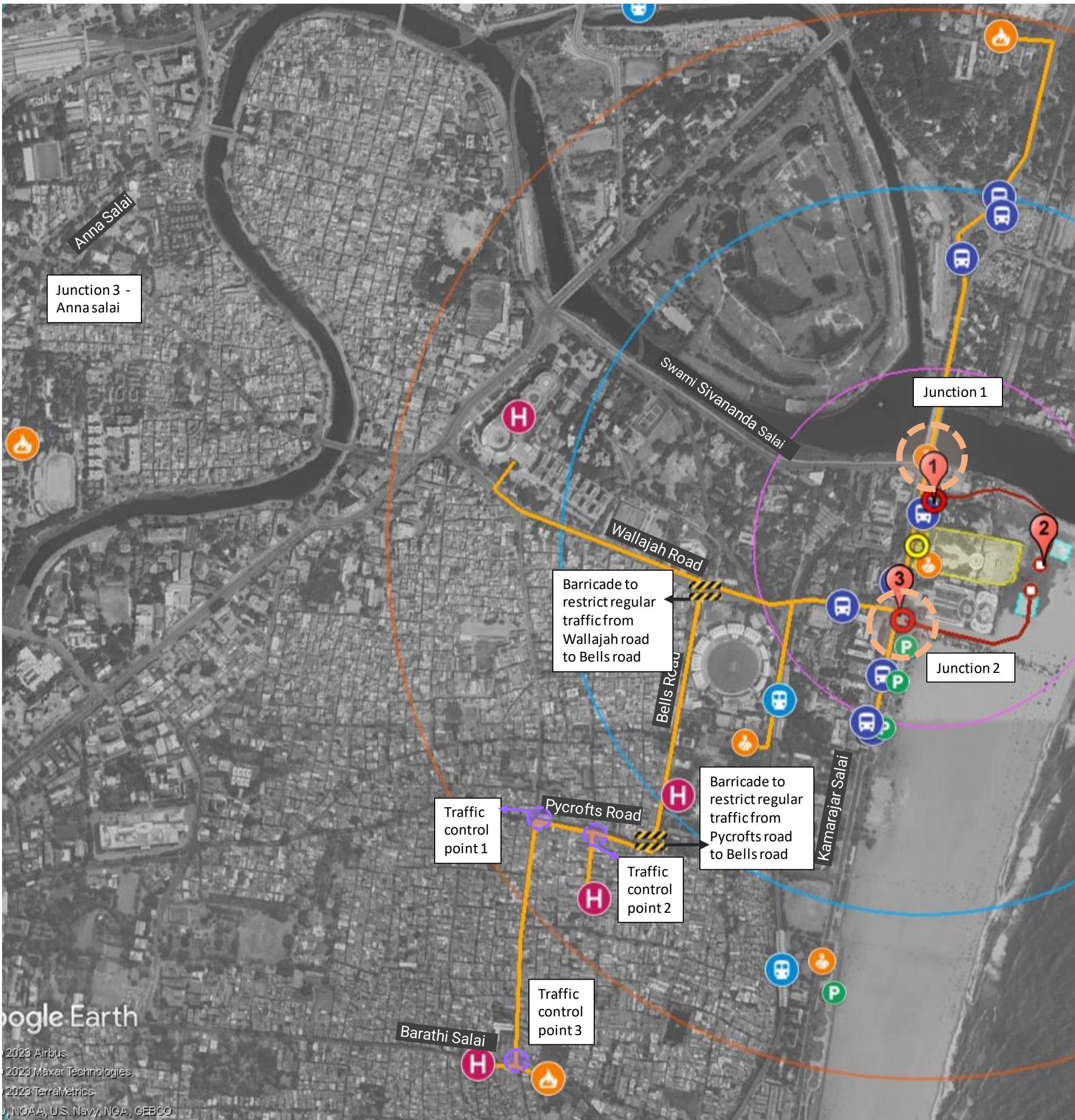
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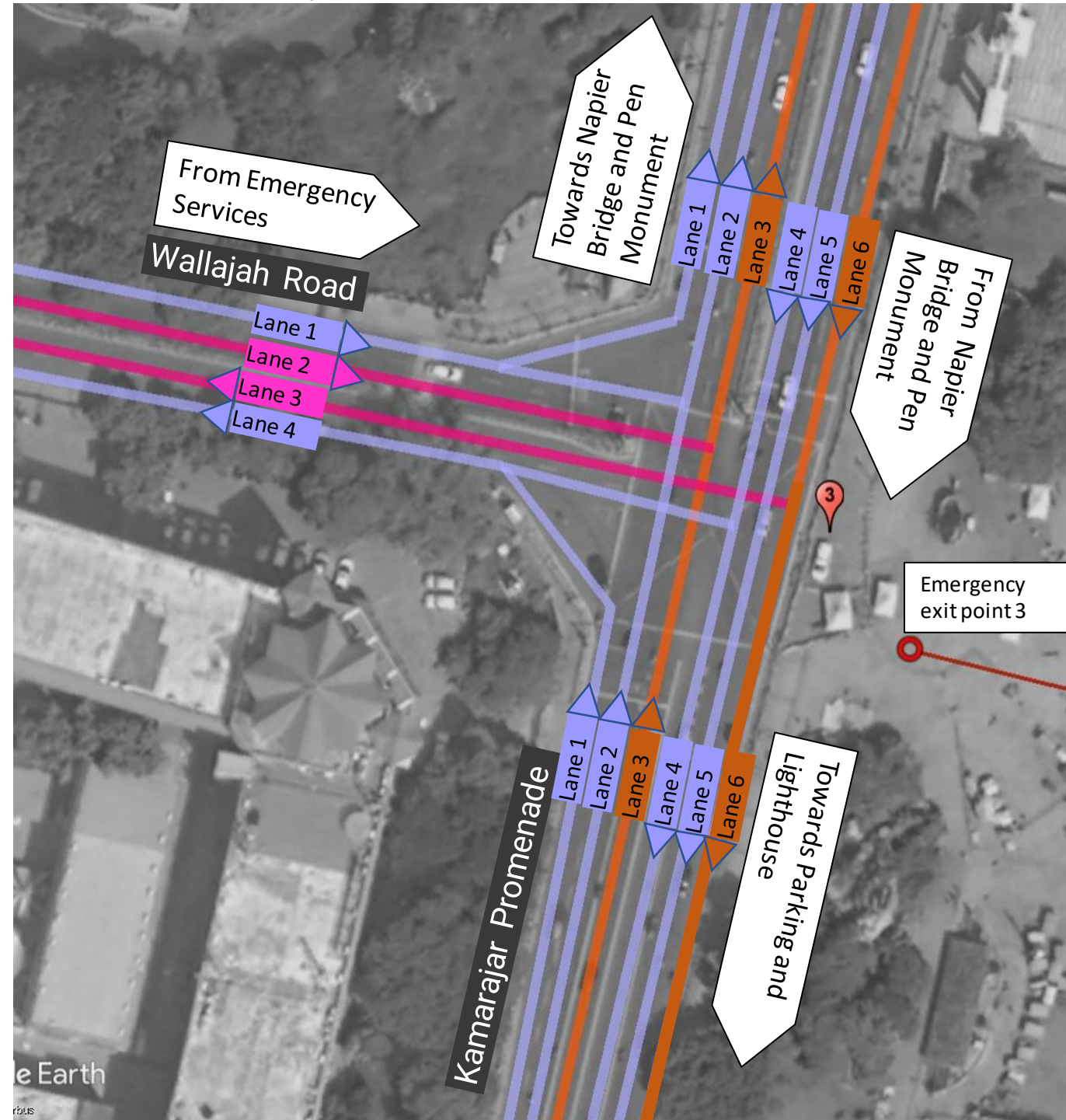
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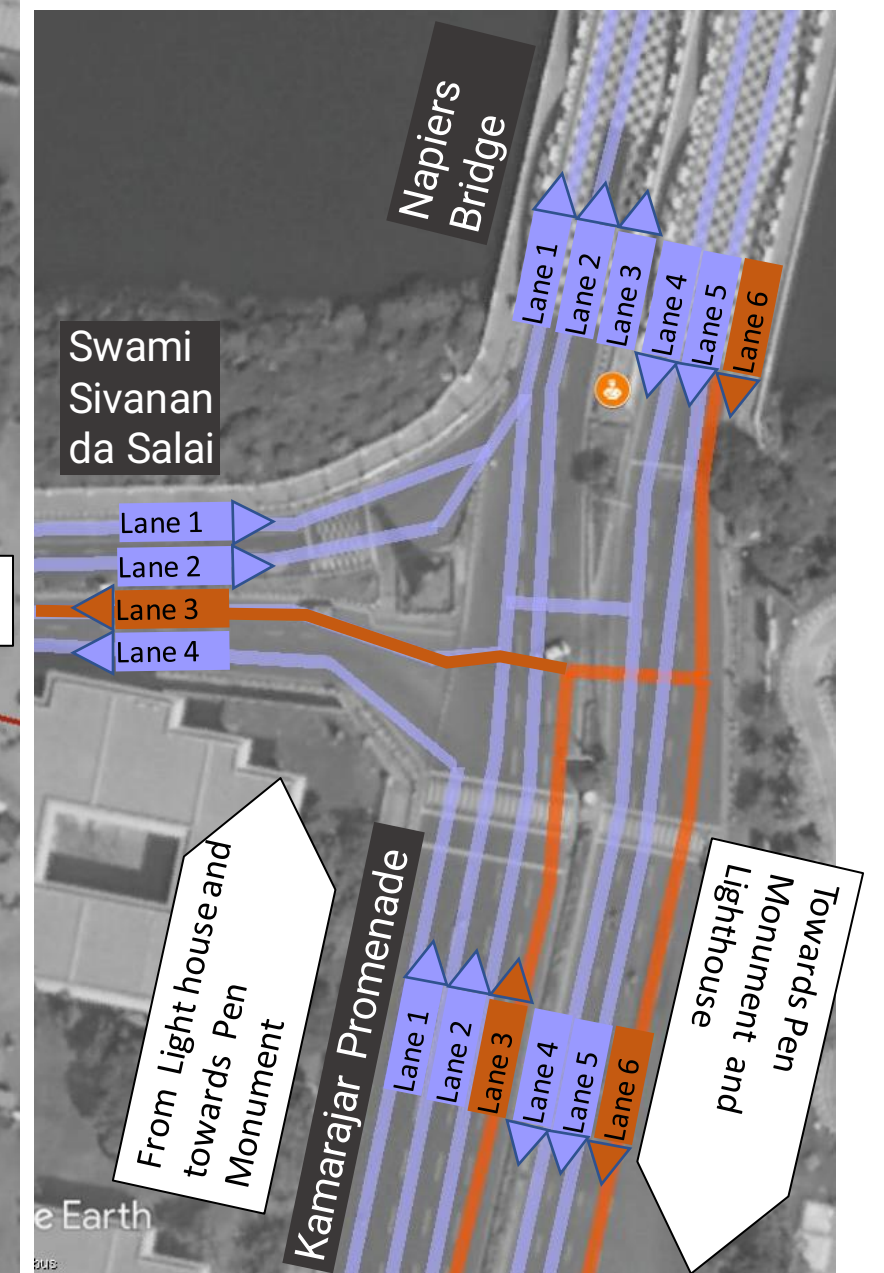
Critical routes during Emergency / Crowd events



Lane separation at Junction 2 – Wallajah Road to Kamarajar Salai



Lane separation at Junction 1 – Napier's Bridge to Kamarajar Salai



S.no	Road	Descriptions
1	Wallajah Road	
	Lane 2	From Emergency services towards Pen Monument
	Lane 3	From Pen Monument towards Emergency services
2	Kamarajar Salai	
	Lane 3	From Lighthouse to Pen Monument during High crowd and Emergency situation
	Lane 6	From Pen Monument towards parking and Public transport

S.no	Road	Descriptions
1	Kamarajar Salai	
	Lane 3	From Lighthouse to Pen Monument during High crowd and Emergency situation
	Lane 6	From Napier's bridge to Pen Monument during High crowd and Emergency situation
2	Napiers Bridge	
	Lane 6	Start of lane separation From Napier's bridge to Pen Monument
3	Sivannanda Salai	
	Lane 3	From Emergency services and public transport to Pen monument

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- Assembly Point
- Emergency Exit Point
- Exit Point from Memorial Park
- Emergency Evacuation route
- Memorial park
- 500m Radius
- 1.0km Radius
- 1.5km Radius
- 3.0 km Radius
- Traffic Control Point
- Barricade to restrict entry for Regular traffic flow
- Critical routes during Emergency / Crowd events
- Emergency and Crowd event - Lane separation to Pen monument
- Medical Emergency services - Lane separation to Pen monument
- Lane separation for Regular traffic flow
- Lane separation at Junction

PROJECT TITLE:

Consultancy Services for evolving Crowd Management Plan, Emergency Evacuation Plan, Road Connectivity Studies and Detailed Traffic Management for the proposed construction of Muthamizh Arignar Dr. Kalaiginner Pen Monument, Chennai, Tamil Nadu

SUBTITLE:

Road Connectivity & Traffic Management Plan

DRAWING TITLE:

Traffic control map

DRAWING NUMBER:

2022-PENMONUMENT/TMP/RC/04

DATE:

05-04-2023

REV. NO

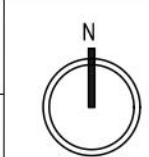
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SCALE:
As per drawing





Tamil Nadu
Public Works
Department



Marina Beach

Consultancy Services for Evolving Crowd Management Plan, Emergency Evacuation Plan, Road Connectivity Studies, and Detailed Traffic Management Report for the Proposed Construction Of Muthamizh Arignar Dr. Kalaig ner Pen Monument, Chennai.

ROAD CONNECTIVITY & TRAFFIC MANAGEMENT PLAN

APRIL 2023 - Updated

Prepared By:

Centre for Urbanization, Buildings & Environment

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CONTENTS

1.1. INTRODUCTION 3

 1.1.1. OBJECTIVES 3

 1.1.2. SCOPE 3

1.2. ESSENTIALS OF ROAD CONNECTIVITY STUDIES AND TRAFFIC MANAGEMENT PLAN..... 4

1.3. ESSENTIAL ROAD CONNECTIVITY 4

 1.3.1. ACCESS TO SERVICES DURING CROWD EVENT / EMERGENCY EVACUATION 4

 1.3.2. ACCESS TO VARIOUS MODES OF TRANSPORT DURING CROWD EVENT / EMERGENCY EVACUATION 7

1.4. TRAFFIC MANAGEMENT PLAN..... 8

 1.4.1. SUMMARY OF TRAFFIC & TRANSPORTATION STUDIES 8

 1.4.1.1. CLASSIFIED TRAFFIC VOLUME COUNT SURVEY AT KAMARAJAR PROMENADE 8

 1.4.1.2. Origin and Destination (OD) SURVEY 9

 1.4.1.3. Speed Survey 10

 1.4.1.4. Level of Service (LOS): 10

 1.4.2. Traffic Management Strategies..... 14

 1.4.2.1. Lane Separation..... 14

 1.4.2.2. Detours at peak hours 15

 1.4.2.3. Traffic control devices 15

 1.4.2.4. Speed limit reductions..... 16

 1.4.2.5. Critical Routes..... 16

 1.4.3. Traffic CONTROL..... 17

 1.4.4. Communication and Coordination..... 18

 1.4.4.1. Communication: 18

 1.4.4.2. Coordination:..... 18

 1.4.4.3. Handling complaints or concerns:..... 19

 1.4.5. WAYFINDING, SIGNAGE & ROAD MARKINGS 19

 1.4.6. TRAFFIC FLOW 20

 1.4.7. pedestrian & NMT Planning & safety..... 21

 1.4.8. Private vehicle parking 22

 1.4.9. Conclusion 23





ROAD CONNECTIVITY & TRAFFIC MANAGEMENT PLAN





1.1. INTRODUCTION

Road connectivity is an integral part of infrastructural development. A well-connected road network stimulates economic and social development by linking different land uses together. The tangible and intangible indicators of a well-connected road network are employment, wages, consumption, savings, investment, and benefits of tourism – which will have an impact on the volume of gross domestic product, the key macroeconomic indicator, which measures the economic output of the respective area. Traffic management is the organization, arrangement, guidance, and control of both stationary and moving traffic, including pedestrians, NMT, IPT, and others. It aims at providing for the safe, orderly, and efficient movement of persons and goods, and to protect and, where possible, enhance the quality of the project site and influence area. In terms of tourism or leisure facilities, this is crucial to enhancing the visitor experience, crowd management, and handling emergency situations. Many people visit these sites, especially on Sundays and during holidays. Natural and recreational values become threatened by increasing traffic congestion and parking problems.

1.1.1. OBJECTIVES

- ❖ To ensure safe and efficient road connectivity for visitors to Memorials and proposed Pen monument.
- ❖ To enhance the overall visitor experience by providing a seamless and hassle-free access to prn monument
- ❖ To improve accessibility to emergency services during emergency situations.
- ❖ To plan an effective dispersion of the public from the Pen Monument through means of public, private, and intermediate mode of transportation.

1.1.2. SCOPE

- ❖ To study the existing road connectivity and traffic scenario in the immediate vicinity of the proposed Pen Monument.
- ❖ Devise a traffic management plan to guide safe and efficient movement of vehicles and pedestrians. This shall include a management plan at the micro level through the identification of critical routes significant for access to medical, and emergency services and dispersion through public, private, and intermediate transport to the Project site.
- ❖ Road network planning involving the assessment of the existing road network, identifying access paths and points to provide better connectivity to the proposed pen monument.





1.2. ESSENTIALS OF ROAD CONNECTIVITY STUDIES AND TRAFFIC MANAGEMENT PLAN

Consideration of available and planned transport facilities, parking as well as an understanding of the traffic patterns shall be developed. Through the collection of primary and secondary data, the current travel and transportation characteristics of the study area shall be studied based on traffic and transportation studies, parking analysis, NMT Infrastructure analysis using both the secondary and primary data. This study shall be used to comprehend the trip patterns, travel demand, transportation infrastructure needs, and mobility issues in the subject study area. The context of the Influence Areas shall be studied in terms of existing situation, road connectivity analysis, observed constraints, upcoming transport infrastructure in the study area as well as demand estimation based on induced impact of the project. Some key tools used for this

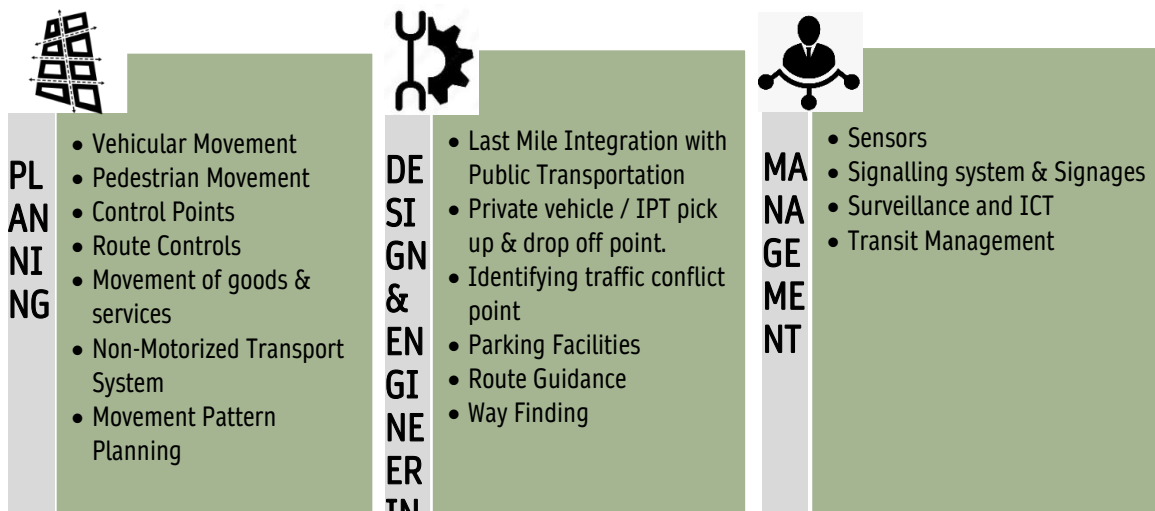


Figure 1.1– Tools for Traffic Management

are mentioned here.

1.3. ESSENTIAL ROAD CONNECTIVITY

1.3.1. ACCESS TO SERVICES DURING CROWD EVENT / EMERGENCY EVACUATION

Access to services during a crowd event or emergency evacuation is critical for ensuring the safety and well-being of individuals in the affected area. In such situations, it is essential to have well-planned and efficient strategies in place to provide access to essential services, such as medical assistance, Police/security assistance, as well as safe evacuation routes.

During a crowd event or emergency evacuation, two assembly points are designated on shore for the proposed pen monument to evacuate the crowd during emergency where individuals/groups can receive medical attention, food, and water and safety & rescue needs. These assembly points are easily accessible and strategically located in areas where large numbers of people are expected to gather. Temporary Medical & Rescue camp shall be put up at the designated assembly points during the emergency evacuation period.





Service providers, such as medical professionals and emergency responders, shall be stationed at these areas to provide assistance as needed.

In addition to service areas, it is important to establish safe evacuation routes for visitors to leave the affected area. These routes shall be clearly marked and well-lit, with regular checkpoints to ensure that individuals are directed towards safety. Ramp and elevator facilities are provided for onshore infrastructure as part of emergency Universal design to ensure that evacuation routes are accessible to individuals with disabilities or other mobility impairments. The proposed access to services during emergency evacuation is given in figure. It is essential to provide clear and concise instructions to individuals in the affected area regarding access to services and safe evacuation routes. This can be done through public address systems, text messaging, and social media updates, among other communication channels.

Finally, well-trained and coordinated response team in place to manage access to services and safe evacuation during a crowd event or emergency. This team shall include representatives from various organizations, including emergency responders, medical professionals, and event organizers, among others.

Services	Assumption	Total
Hospitals	One hospital bed for every 10 evacuees	100 hospital beds
Police	One police officer for every 100 evacuees	100 police officers
Fire & Rescue team	One Fire & Rescue team for every 500 evacuees	20 Fire & Rescue teams

Table 1.1 - Assumption and calculations for services

Table 1.1 describes the requirements of services during emergencies. However, it's important to note that this is a rough estimate, and the actual number required may vary depending on the specific circumstances of the emergency. The below table shows the list of possible emergency responders, medical professionals in closer proximity to the proposed pen monument is given in table:

S No	Hospital	Distance from/to Exit point 1 (Km)
Government		
1	Government Kasturba Gandhi(Gosha) Hospital	1
2	Omandurar Govt. Hospital	1.6
3	Govt. Hospital - Egmore	3.5
Private		
1	Sakthi Hospital & Research Centre	1.7
2	Crescent Hospital	2.8

Table 1.2 – Distance of nearby hospitals from proposed exit point

S No	Police station	Distance to Exit point 1 (Km)
1	D1 Anna Square Police Station	0.2
2	D6.1 Anna Square Police Station	0
3	D6.2 Anna Square Police Station	1.2
4	D8 Kasturi Bagh Gandhi Hospital Police Station	1.3

S No	Fire and Rescue service	Distance to Exit point 1 (Km)
1	Secretariat Fire and rescue Service station	1.6





2	Fire & Rescue Service, Marina	2.2
3	Mylapore Fire Station	3.4
4	Tamilnadu fire & rescueservices	3.2

Table 1.3 – Distance of police stations from the proposed exit point

Table 1.4 – Distance of Fire and Rescue service from the proposed exit point

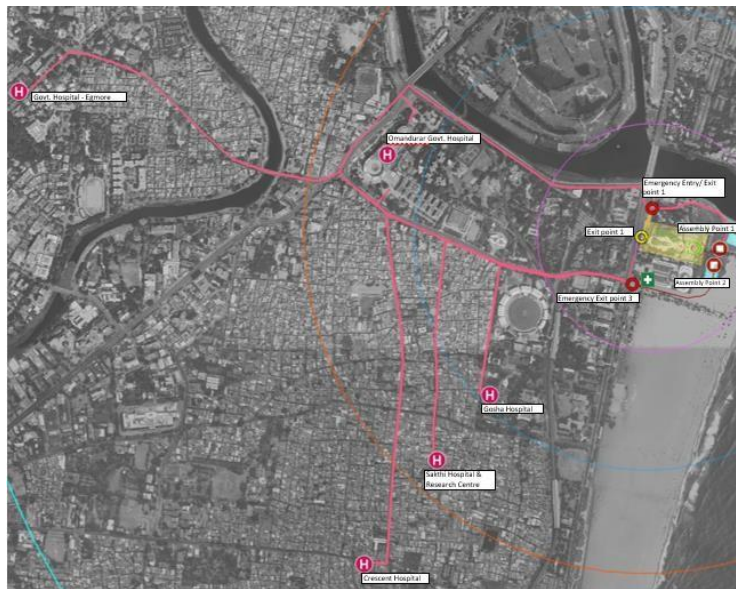


Figure 1.2 - Access to Services During Crowd Event / Emergency Evacuation





1.3.2. ACCESS TO VARIOUS MODES OF TRANSPORT DURING CROWD EVENT / EMERGENCY EVACUATION

Access to various modes of transport during peak hours of crowded events and emergency evacuations is essential for the efficient and safe movement of people. Buses and trains are important modes of transport as they can move large numbers of people quickly and efficiently. They can be used to transport people to designated safe areas or to other transport hubs such as bus terminus or train stations. These modes of transport can also be used to provide shuttle services between different locations, making it easier for people to move around during the event or evacuation.

Private vehicles are another important mode of transport during crowded events and emergency evacuations. People may need to use their vehicles to leave the affected area, particularly if public transport services are not available or are overcrowded. In addition, emergency services such as ambulances and fire trucks may also need access to roads in the area, so it is important to ensure that these vehicles have priority access which has been explained in the previous sub-topic as well.

Paratransit services such as accessible vans or taxis are important for people with disabilities or mobility challenges. These services can provide customized transportation options that meet the specific needs of individuals, ensuring that everyone can safely leave the affected area during a crowded event or emergency evacuation.

Non-motorized transport (NMT) options such as walking, cycling can also be effective transportation options during crowded events or emergency evacuations, particularly in urban areas where traffic congestion can be a problem. Providing safe and accessible walking and cycling paths can help to encourage people to use NMT options, reducing the number of vehicles on the road and making it easier for emergency services to move around. In summary, access to various modes of transport is critical during crowded events and emergency evacuations. A range of transportation options including buses, trains, private vehicles, paratransit, and NMT should be considered and coordinated to ensure the efficient and safe movement of people during these situations. Based on these aspects, access to various modes of transport is illustrated in Figure 1.3.

S No	Bus Stop and Metro	Nearest Exit point	Distance from/to nearest Exit point(Km)
1	Kalaivanar Arangam Bus stop	EE - Exit 2	0.16
2	Anna Square Bus Stop	EE - Exit 2	0.13
3	Proposed Bus stop	EE - Exit 1	0.2
4	Marina Bus stop	EE - Exit 2	0.17
5	Chepauk MRTS	EE - Exit 2	0.4

Table 1.5 – Distance of Fire and Rescue service from the proposed exit point



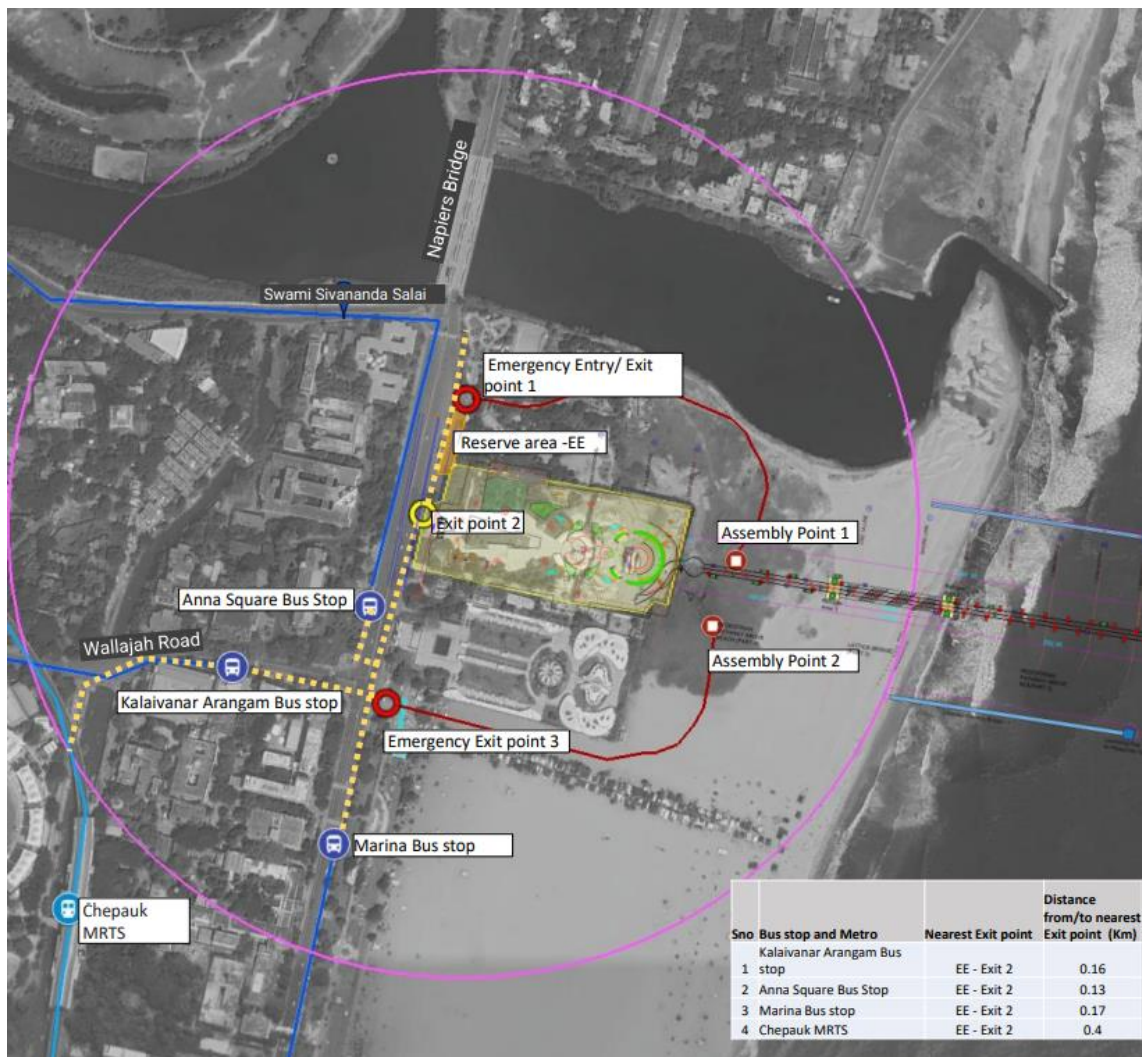


Figure 1.3 – Dispersion through public transport, NMT and Intermediate Transport

1.4. TRAFFIC MANAGEMENT PLAN

1.4.1. SUMMARY OF TRAFFIC & TRANSPORTATION STUDIES

1.4.1.1. CLASSIFIED TRAFFIC VOLUME COUNT SURVEY AT KAMARAJAR PROMENADE

The traffic survey was conducted over a period of two days, Monday (06.03.2023) and Saturday(04.03.2023), from 7:00 AM to 11:00 PM. The survey was carried out at Junction 1(Light house – Wallajah – Napiers bridge), and the results were presented in a table. The table 1.5 displays the volume count % of vehicles as a percentage, segregated by the direction of traffic and type of day (weekend or weekday).

Based on the findings, the highest volume of traffic was observed on Napiers Bridge towards Light House (straight) with 41.9% on weekends and 37.7% on weekdays. The second-highest volume was recorded on Light House towards Napiers Bridge (straight) with 33.5% on weekends and 37.9% on weekdays. The lowest volume of traffic was observed on Wallajah Road towards Napiers Bridge (left turn) with 4.9% on weekdays and 10.8% on weekends. The table also indicates that the percentage of vehicles taking left turns is generally lower than those taking straight or right turns. Overall, the survey provides useful insights into the traffic flow at Junction 1, which could help in





Direction of Traffic	Volume (PCU%)	
	Weekend	Weekday
Junction 1 (Light house - Wallajah - Napier's bridge)		
Light House towards Napier's Bridge (STRAIGHT)	33.5%	37.9%
Light House towards Wallajah Road (LEFT TURN)	13.7%	11.7%
Napier's Bridge towards Light House (STRAIGHT)	41.9%	37.7%
Napier's Bridge towards Wallajah Road (RIGHT TURN)	12.4%	7.7%
Wallajah Road towards Napier's Bridge (LEFT TURN)	10.8%	4.9%
Wallajah Road towards Light House (RIGHT TURN)	11.8%	12.1%

developing strategies to alleviate congestion and improve the overall traffic management in the area.

Table 1.6 - PCU percentage on weekday & weekend at Junction 1: Labour Statue

Direction of traffic	Volume (PCU%)	
	Day 1 (Weekend)	Day 2 (Weekday)
Junction 2 (Light house - Swami Sivananda Salai - Napier's bridge)		
Light House towards Napier's Bridge (STRAIGHT)	34.67%	50.87%
Light House towards Swami Sivananda Salai (LEFT TURN)	8.22%	3.91%
Napier's Bridge towards Light House (STRAIGHT)	45.72%	30.81%
Napier's Bridge towards Swami Sivananda Salai (RIGHT TURN)	4.72%	8.65%
Swami Sivananda Salai towards Napier's Bridge (LEFT TURN)	4.79%	5.99%
Swami Sivananda Salai towards Light House (RIGHT TURN)	Vehicles Not allowed	

Table 1.7 - PCU percentage on weekday & weekend at Junction 2

The above table 1.7 shows the percentage of the volume count of Passenger Car Units (PCU%) for each direction of traffic at Junction 2 (Light house - Swami Sivanda Salai - Napiers bridge) during Day 1 (Weekend). The direction of traffic includes Light House towards Napiers Bridge (STRAIGHT), Light House towards Swami Sivananda Salai (LEFT TURN), Napiers Bridge towards Light House (STRAIGHT), Napiers Bridge towards Swami Sivananda Salai (RIGHT TURN), and Swami Sivananda Salai towards Napiers Bridge (LEFT TURN). It indicates that the highest percentage of traffic is from Napiers Bridge towards Light House (STRAIGHT) with 45.72%, followed by Light House towards Napiers Bridge (STRAIGHT) with 34.67%, and Light House towards Swami Sivananda Salai (LEFT TURN) with 8.22%. The table also shows that vehicles are not allowed to make a right turn from Swami Sivananda Salai towards Light House.

1.4.1.2. Origin and Destination (OD) SURVEY

This shows that out of 1150 surveys, 389 trips (33%) of vehicles are going towards the secretariat followed by 190 trips (16%) towards the beach and other spots. 160 (13%) and 148 (12%) trips are going towards Madras university and Presidency college as their destination. 130 trips (11%) are going toward the temple while 34 trips (2.9%) are going to the government office.





Similarly, 283 (24%) number of trips are made with mode 1 (Two-Wheeler), and 242 (21%) trips are made with mode 5 (Train). Also, very few trips 22 (2%) are made with mode 6 (Bicycle).

Likewise, 500 (43%) trips are made for purpose 1 (Work), 319 (27%) trips are made for purpose 2 (Business). Also, 221 (19%) trips are made for purpose 5 (Social & Recreation) and 110 (9.5%) trips are made for purpose 7 (Tourism). In addition, 526 (45%) trips were made with the vehicle occupying 2 people and 401 (34%) trips were made with vehicle occupying single person. Similarly, 201 (17%) trips were made with vehicle occupying 3 people and 22 (2%) trips were made with vehicles occupying 4 people. Total 1150 trips carried 2150 peoples which shows that average of two people is carried by vehicles for the surveyed vehicles. This data can be used to prediction of number of people traveling through the routes for later use.

1.4.1.3. Speed Survey

The following table shows that the average speed at Wallajah Road towards Anna Salai and toward Wallajah Road from Anna Salai is 30kmph in weekend as well as weekdays. Similarly, the average speed at the Kamarajar Promenade towards Anna Salai and from Anna Salai towards the Kamarajar Promenade is 65-75 kmph on weekends and 48-60 kmph on weekdays. Similarly, the average speed at the Kamarajar Promenade towards Napier’s bridge and to Labour statue is 48-60 kmph on weekends and the average speed on weekdays is 50-60 kmph. The survey was carried out for passenger vehicles like Cars, Autos and Two Wheelers.

Name of the Road	Car	Auto	Two-wheeler
Kamarajar Promenade	max. of 30 secs. to 1 min. delay due to traffic signal @ Anna Salai & traffic jam with an average speed limit of 40 to 60 Km/hr	max. of 30 secs. to 1 min. delay due to traffic signal @ Anna Salai & traffic jam with an average speed limit of 30 to 50 Km/hr	max. of 30 secs. to 1 min. delay due to traffic signal @ Anna Salai & traffic jam with an average speed limit of 40 to 60 Km/hr
Swami Sivan Anna Salai	No delay due to very less vehicle movement.	No delay due to very less vehicle movement.	No delay due to very less vehicle movement.
Wallajah Road	max. of 30 secs. to 1 min. delay due to traffic signal @ Anna Salai & traffic jams with an average speed limit of 40 to 60 Km/hr.	max. of 30 secs. to 1 min. delay due to traffic signal @ Anna Salai & traffic jams with an average speed limit of 30 to 50 Km/hr	max. of 30 secs. to 1 min. delay due to traffic signal @ Anna Salai & traffic jams with an average speed limit of 40 to 60 Km/hr

Table 1.8 – Speed survey findings

1.4.1.4. Level of Service (LOS):

The Level of service (LOS) and Capacity analysis of signalized intersection is carried out based on the Indo-HCM method. All the volumes were converted into passenger car units (PCU) as per the factors mentioned in Indo HCM for different categories of vehicles. We then divided the survey data into two parts:

- i) morning and ii) evening to calculate the Peak Hour Factor (PHF) for morning and evening





to get the adjusted volume. This was done for both conditions: i) weekends and ii) weekdays. Based on the movements happening at both the intersection and the existing signal timings, the phase diagram to calculate the lane group volume has been made. The phase diagram for both the intersection is shown below:

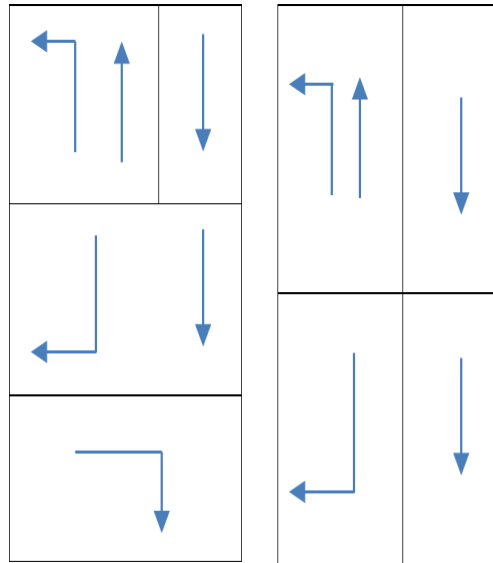


Figure 1.4. a) Phase diagram for Labour statue Junction b) Phase diagram for Napier’s bridge junction

Table 1.9 and 1.10 shows the LOS and delays for each bound for each peak (Morning and evening) on weekend and week days. Also, the overall level of service and total intersection delays for each condition is shown below in Table.

LABOUR STATUE JUNCTION								
Movements			North Bound		South Bound		East Bound	
			T	L	T	R	L	R
Weekdays	Morning Peak	Level of service (LOS)	F		A	C	--	C
	Evening Peak	Level of service (LOS)	F		B	F	--	C
Weekend	Morning Peak	Level of service (LOS)	D		F	F	--	F
	Evening Peak	Level of service (LOS)	F		C	F	--	E
Weekend	Morning Peak	Overall Level of Service	F					
	Evening Peak		F					
Weekdays	Morning Peak	Overall Level of Service	D					
	Evening Peak		F					

Table 1.9 – LOS and delays for each bound

NAPIER'S BRIDGE JUNCTION								
Movements			North Bound		South Bound		East Bound	
			T	L	T	R	L	R
Weekdays	Morning Peak	Level of service (LOS)	B		A	D	--	--





	Evening Peak	Level of service (LOS)	F	A	F	--	--
Weekend	Morning Peak	Level of service (LOS)	A	A	B	--	--
	Evening Peak	Level of service (LOS)	A	A	B	--	--
Weekend	Morning Peak	Overall Level of Service	A				
	Evening Peak		A				
Weekdays	Morning Peak	Overall Level of Service	B				
	Evening Peak		F				

Table 1.10 – LOS and delays for each bound

This shows that at Labour statue junction, the Overall Level of service in the morning peak, evening peak of the weekend, and evening peak of weekdays is "F" and its "D" for the weekdays morning peak. Since the left turn (from the lighthouse towards wallajah road) is free to move.

Similarly, it shows that at Napier's bridge junction, the Overall Level of service in the morning peak and evening peak at weekend is "A" and its "B" for the morning peak and "F" for the evening peak on weekdays. Also, at Napier's Bridge junction, there is no right turn for eastbound (vehicles coming from swami Sivananda salai road towards labour statue junction) and the left turn is free to move.

criteria for signalized intersection in term of control delay per vehicle (s/veh)

LOS	Delay
A	≤ 10
B	10-20
C	20-35
D	35-55
E	55-80
F	>80

The following Table illustrates the expected LOS of the Labour statue and Napier's Bridge Junction post the completion of pen monument (without any intervention). The LOS was calculated based on the assumption of approximately 20% addition to the existing traffic count (PCU).

LABOUR STATUE JUNCTION								
Movements			North Bound		South Bound		East Bound	
			T	L	T	R	L	R
Weekdays	Morning Peak	Level of service (LOS)	F		C	D	--	D
	Evening Peak	Level of service (LOS)	F		D	F	--	E
Weekend	Morning Peak	Level of service (LOS)	F		F	F	--	F
	Evening Peak	Level of service (LOS)	F		F	F	--	F
Weekend	Morning Peak	Overall Level of Service	F					
	Evening Peak		F					



Road Connectivity & Traffic Management Plan **449**

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Weekdays	Morning Peak	Overall Level of Service	F
	Evening Peak		F





NAPIER'S BRIDGE JUNCTION									
Movements			North Bound		South Bound		East Bound		
			T	L	T	R	L	R	
Weekdays	Morning Peak	Level of service (LOS)	D		A	F	--	--	
	Evening Peak	Level of service (LOS)	F		A	F	--	--	
Weekend	Morning Peak	Level of service (LOS)	A		A	B	--	--	
	Evening Peak	Level of service (LOS)	B		A	B	--	--	
Weekend	Morning Peak	Overall Level of Service	A						
	Evening Peak		A						
Weekdays	Morning Peak	Overall Level of Service	D						
	Evening Peak		F						

Table 1.11 – LOS post completion of Pen Monument on Labour Statue and Napiers Bridge Junctions.

The existing LOS calculations indicate that the Labour statue Junction is already in a stressed condition with LoS as “F” during Peak Hours. The Proposed Pen Monument is expected to result in an overall increase of 20% in the existing PCU count. The introduction of Pen Monument will impact the existing LoS for this Junction. However, It is noted that Chennai Comprehensive Mobility Plan 2019 mentions the proposal for junction improvement at the the labour statue junction is required to improve the existing low LOS. This intervention will result in overall improvement of the LOS for this junction. The Napier’s Bridge Junction is mildly impacted during the evening peak hours. It is suggested that a macro level study should be carried out to improve the LOS in context of improving the overall traffic situation of the area. Some strategic interventions which could help with distributing the peak load of visitor movement to Pen Monument could be strategic pricing of tickets during the peak hours and FoC entry for the Non Peak Hours.

1.4.2. TRAFFIC MANAGEMENT STRATEGIES

1.4.2.1. Lane Separation

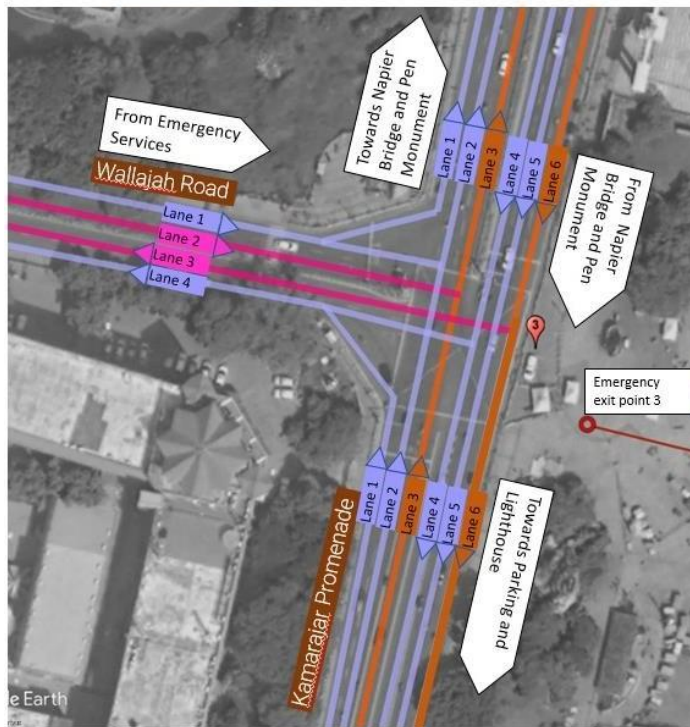
Lane Separations are a useful tool for traffic management as they allow for more efficient use of the available road space, which can help alleviate congestion and reduce travel times during emergency evacuation and peak hours on event/special days. By closing one or more lanes of a road, traffic can be redirected into the remaining lanes, which can increase the capacity of the road and reduce the likelihood of gridlock. This can be especially important during peak traffic periods, such as rush hour, when congestion is more likely to occur. Figure 1.5 illustrates the proposed lane separation at Kamarajar Promenade to avoid conflicts at evacuation routes. At Junction 1, during Emergency/ event days the lighthouse to Napiers road will split into 3 lanes. 2 Lanes shall be allowed for regular vehicular movement, whereas one lane will be dedicated to the



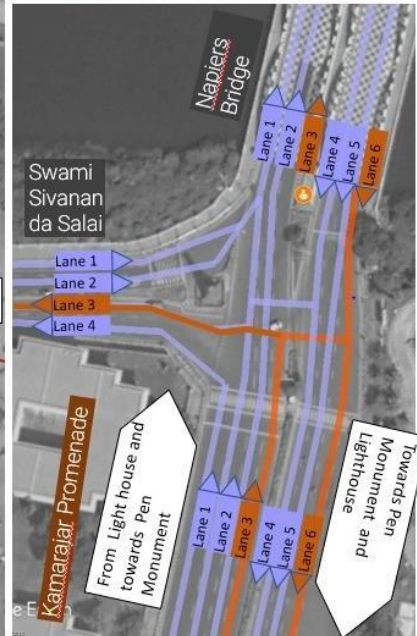


movement of visitors to the beach & tourism. Similar lane separation is followed for junction 2 as well.

Lane separation at Junction 2 – Wallajah Road to Kamarajar Salai



Lane separation at Junction 1 – Napiers Bridge to Kamarajar Salai



- Assembly Point
- Emergency Exit Point
- Exit Point from Memorial Park
- Emergency Evacuation route
- Memorial park
- 500m Radius
- 1.0km Radius
- 1.5km Radius
- 3.0 km Radius
- Critical routes with lane separation during emergency / crowd events
- Barricade to restrict entry for Regular traffic flow
- Critical Routes
- Emergency and Crowd event - Lane separation to Pen monument
- Medical Emergency services - Lane separation to Pen monument
- Lane separation for Regular traffic flow

Figure 1.5 - Proposed Lane Separations

1.4.2.2. Detours at peak hours

Detours shall be introduced for diverting traffic away from a congested area or bottleneck, detours can help reduce the volume of traffic in the affected area, improve traffic flow, and reduce travel times. In addition to reducing congestion and improving travel times, detours can also improve safety by reducing the number of vehicles on the road in congested areas. This can reduce the likelihood of accidents and improve overall road safety.

1.4.2.3. Traffic control devices

Variable Message Signs (VMS) are electronic traffic control devices that display real-time information to drivers and pedestrians. VMS systems are equipped with LED or LCD displays that can change their message instantly, providing up-to-date information to motorists. They are typically controlled by a central system that can remotely update the message displayed on the





sign, making them an efficient way to communicate important information quickly and effectively.

Road flares, also known as fuses, are small handheld or roadside emergency devices for signaling, warning, and controlling traffic. They are usually designed with bright red- or orange-colored lights and emit a high level of heat to attract attention. Road flares are typically used in emergency situations or to mark off hazardous areas. They will be used to direct traffic, signal for help, or provide temporary illumination. Road flares are commonly used by emergency responders, law enforcement agencies, and transportation departments for traffic control and accident management purposes.

Barricades are an important traffic control device that shall be used for various purposes, such as indicating road closures, controlling traffic flow, and directing vehicles and pedestrians in specific directions. Traffic cones shall be used to redirect traffic, create a temporary barrier, or indicate a hazard on the road. They come in various sizes, colors, and materials, but typically have a conical shape with a wider base and a pointed top.

1.4.2.4. Speed limit reductions

Speed limit reductions are proposed as part of the TMP to improve safety and reduce congestion. Lowering the speed limit on roads can help to reduce the number and severity of accidents, particularly in areas with high pedestrian or cyclist traffic.

Reducing speed limits can also help to control traffic flow and reduce congestion. When cars are traveling at a slower speed, there is typically less congestion on the roads, as cars can travel closer together without increasing the risk of accidents. This can be particularly effective in urban areas with high levels of traffic. In addition to improving safety and reducing congestion, speed limit reductions can also have environmental benefits. When cars are traveling at lower speeds, they typically emit less pollution, which can help to improve air quality in urban areas. Overall, speed limit reductions can be an effective tool in traffic management plans, particularly in areas with high levels of pedestrian and cyclist traffic. By reducing speeds, traffic managers can improve safety, reduce congestion, and promote more sustainable transportation.

1.4.2.5. Critical Routes

To create critical routes from and to the proposed Pen monument, the road network was assessed, and the available routes to essential services such as hospitals, police stations, and rescue and fire teams were identified. Factors such as the capacity of each road, distance from key areas, and traffic levels during peak times were considered.

The routes were then prioritized based on their proximity to essential services, capacity, and ease of access. Consideration was given to the needs of people with disabilities or limited mobility when prioritizing routes.

Emergency services were also consulted to ensure that the critical roads plan aligned with their response plans. Alternative routes were identified in case of road closures or congestion,





and arrangements shall be made to ensure that emergency services could easily access the affected areas.

Clear communication of the plan is crucial. Service providers shall be informed of the critical routes using clear signage and digital mapping tools. People were made aware of which roads lead to essential services and how to navigate the route safely.

Regular reviews and updates to the plan are important to reflect changes in the road network, traffic patterns, or service availability. Figure 1.6 illustrates the proposed critical routes from and to the pen monument.

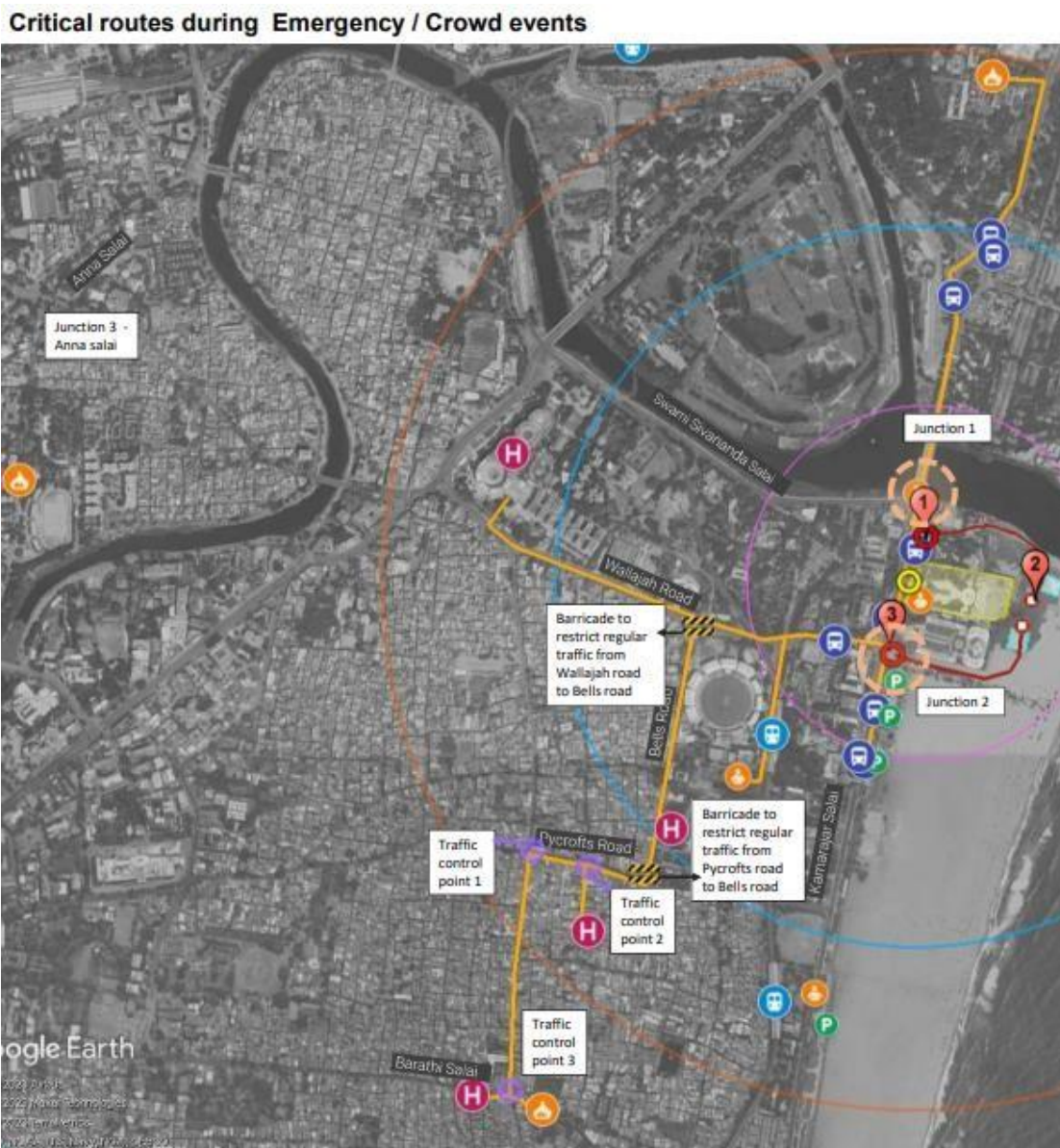


Figure 1.6 - Proposed Critical Routes

1.4.3. TRAFFIC CONTROL





Effective Traffic control Plans are essential for managing traffic flow at the site area. One key element of traffic control strategies is the location of traffic control devices, such as signs, cones, and barriers. These devices are placed in strategic locations to guide motorists and ensure their safety, as well as the safety of the visitors to the proposed pen monument. The location of these devices is carefully considered to ensure that they are placed in areas where they will be most effective in controlling traffic flow.

Another important aspect of traffic control strategies is the deployment and removal of traffic control devices. Workers must follow a specific sequence when deploying and removing devices to ensure that the process is safe and efficient. Instructions for deployment and removal should be included in the traffic control plan, and workers must be adequately trained and qualified to perform these tasks. By following the instructions outlined in the traffic control plan, workers can ensure that devices are deployed and removed in a way that minimizes disruptions to traffic flow.

Finally, traffic control strategies must be adaptable to changing circumstances. Unexpected events, such as accidents or political events, can impact traffic flow and require adjustments to the traffic control plan. Workers must be prepared to respond to these situations by adjusting the location, deployment, or removal of traffic control devices. By being flexible and responsive to changing circumstances, a traffic control plan can effectively manage traffic flow during peak hours or emergencies.

1.4.4. COMMUNICATION AND COORDINATION

1.4.4.1. Communication:

Effective communication is essential in traffic management plans. One key element is the use of Intelligent Transportation Systems (ITS) to share real-time traffic information with the public. ITS technologies include roadside message signs, traffic cameras, and sensors that can detect vehicle speeds and volumes. The data from these devices can be analyzed and used to provide travelers with up-to-date information on traffic conditions, delays, and alternate routes. This information can be distributed through various channels, including social media, email alerts, and mobile applications.

Another important communication strategy is coordinating with stakeholders, including emergency responders and local government officials. Traffic managers should establish regular communication channels with these stakeholders to keep them informed of any changes in traffic patterns or incidents that could impact response times or public safety.

1.4.4.2. Coordination:

Coordination with emergency responders is critical in traffic management plans. Traffic managers should have a clear understanding of emergency response procedures and protocols, and be prepared to adjust traffic flow to accommodate emergency vehicles. This may involve closing certain lanes or routes, or redirecting traffic to alternate routes to allow emergency vehicles to reach their destination quickly and safely.

In addition, traffic managers should be aware of potential emergencies, such as natural





disasters or mass gatherings, and have contingency plans in place. The list of possible stakeholders that will be involved is listed in table 1.1, table 1.2 & table 1.3.

1.4.4.3. Handling complaints or concerns:

Traffic managers should establish a system for handling complaints or concerns from the public. This includes setting up a hotline or online portal where individuals can report issues or submit feedback. Traffic managers should also be prepared to respond to complaints in a timely, and to take appropriate action to address any concerns that are raised.

To effectively handle complaints, traffic managers may need to conduct traffic studies or analyses to identify potential issues and develop solutions. This could involve working with other stakeholders, such as local government officials or law enforcement, to implement changes to traffic flow or to address specific concerns.

Overall, effective communication and coordination are essential elements of a traffic management plan. By leveraging ITS technologies and working closely with stakeholders, traffic managers can ensure that roads are safe and efficient for all users, while also addressing concerns and maintaining public trust.

1.4.5. WAYFINDING, SIGNAGE & ROAD MARKINGS

To effectively communicate traffic management strategies to drivers, it is important to use clear and easily understandable signage and markings. Here are some considerations for the placement, design, and size of such signage and markings:

1. Placement: The signage should be placed in a location that is visible to drivers from a distance, allowing them enough time to react to any changes in traffic flow. The placement should also take into account any obstructions, such as trees or buildings, that may block the view of the sign.
2. Design: The design of the signage should be clear and easy to understand. It should use simple language and graphics to convey the intended message. The color of the sign should be consistent with local and national standards.
3. Size: The size of the signage should be appropriate for the speed of the traffic and the distance at which it will be viewed. Larger signs may be needed for higher-speed roads or longer distances.
4. Special considerations: Safety should be a top priority when designing and placing signage. Signs should be placed in a way that does not obstruct the view of drivers or workers. They should also be designed to be visible at night and in adverse weather conditions.

Some specific signage and markings that may be used to inform drivers of traffic management strategies include:

1. Lane markings: Lane markings can be used to designate specific lanes for certain types of traffic, such as HOV lanes or bus lanes.
2. Speed limit signs: Speed limit signs are used to inform drivers of the maximum speed allowed on a





given road.

3. Road closure signs: Road closure signs are used to inform drivers that a road is closed and to provide alternative routes.
4. Detour signs: Detour signs are used to guide drivers along an alternative route when a road is closed.
5. Temporary traffic signals: Temporary traffic signals can be used to manage traffic flow in areas where construction or other work is taking place.
6. Warning signs: Warning signs can be used to alert drivers to potential hazards, such as uneven pavement or a steep grade.

Overall, clear and effective signage and markings are critical for communicating traffic management strategies to drivers. Proper placement, design, and size, as well as consideration for safety, are important factors to keep in mind when implementing these tools.

1.4.6. TRAFFIC FLOW

Adyar, with a percentage of 23%, has the highest trip origin, followed by Chrompet and T. Nagar with 12% and 9%, respectively. Guindy and Tambaram both have 7% origin, while Ambattur has 5%. All other regions have less than 5% reaching the various destination such as Secretariat, Madras University, Presidency College, Santhome Church, Beach & Others spots, Tourism, etc. at Kamarajar Promenade.

Based on the traffic survey, it can be observed that Adyar has the highest trip origin with 23% of the total trips originating from there. This indicates that Adyar is a major traffic hub in the area. The second and third highest trip origins are from Chrompet and T.Nagar, respectively, with 12% and 9% of total trips originating from those areas.

Guindy, Tambaram, and Ambattur also have a significant percentage of trip origins with 7% and 5% each. This shows that these regions are also important traffic hubs in the area.

The survey also notes that the trips were headed towards various destinations such as Secretariat, Madras University, Presidency College, Santhome Church, Beach & Other spots, and Tourism at Kamarajar Promenade. These are popular destinations in the area, and the traffic flow to these destinations could impact the overall traffic flow in the region.

Overall, the survey highlights the importance of these regions in the traffic flow of the area and emphasizes the need for effective traffic management strategies to ensure a smooth flow of traffic to various destinations. Based on the survey findings of the traffic flow, the detour routes during emergency/ special events/peak hours are proposed.



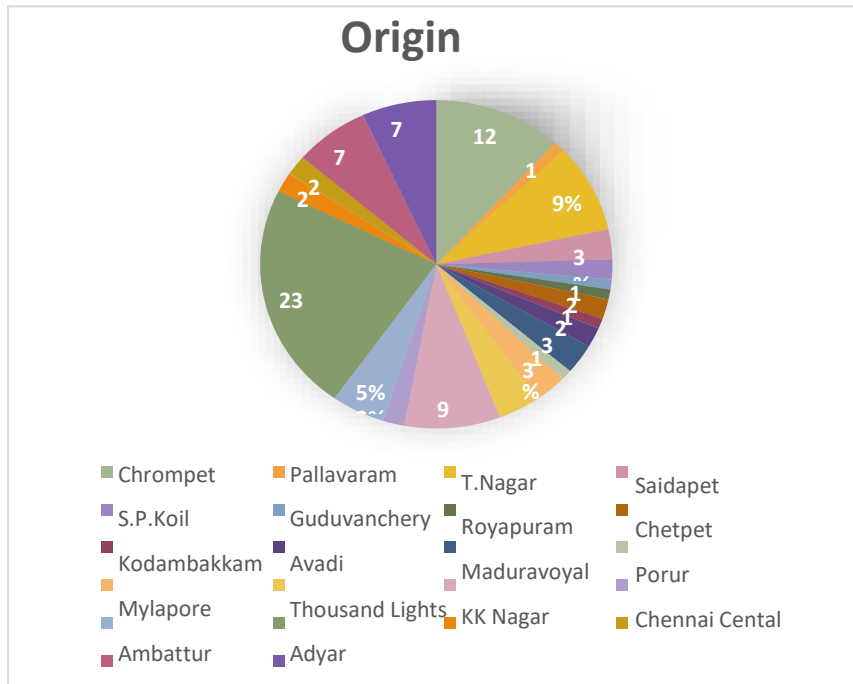


Figure 1.7 – Origin Distribution

1.4.7. PEDESTRIAN & NMT PLANNING & SAFETY

The following strategies shall be incorporated as part of enhancing the NMT & Safe pedestrian movement at Kamarajar Promenade. To enhance pedestrian and NMT safety, measures such as traffic calming, speed reduction, and improving visibility at intersections shall be implemented. This shall be done as part of the wayfinding design and traffic flow strategies.

Smart technologies such as Intelligent Transport Systems (ITS) and real-time traffic management systems can be used to improve pedestrian and NMT safety. These systems can provide real-time information about traffic flow and can help in the efficient management of pedestrian and NMT traffic. Encouraging and promoting active transport modes such as walking, cycling, and public transport can help to reduce the number of vehicles on the road, which in turn reduces the risk of accidents involving pedestrians and NMT users.





Stakeholders such as local communities, businesses, and transport providers should be involved in the planning and implementation of pedestrian and NMT-friendly infrastructure. This can help to ensure that the infrastructure is designed to meet the needs of all road users. Figure 1.8 illustrates the pedestrian & NMT



Plan at Kamarajar Promenade.



Figure 1.8 – Pedestrian & NMT Plan at Kamarajar Promenade.

1.4.8. PRIVATE VEHICLE PARKING

Table 1.9 displays the projected parking count for different modes of transport, along with the available public parking space and the additional parking space required at the Marina post the construction of the proposed pen monument. According to the Existing Travel And Transport Characteristics of Chennai city, Modal Share 2018, two-wheeler mode of transport shall have the 29.6% of the projected parking count,





followed by 7.1% of the projected car parking for the proposed pen monument. Additional parking can be proposed behind the anna memorial bus stand or as found suitable.

The available public parking space in the area is 3500 square meters. However, the projected parking count for the various modes of transport exceeds the available parking space, and there is a requirement for an additional parking space of 6800 square meters. This indicates a significant shortage of parking space in the area.

The shortage of parking space can result in various problems such as illegal parking, congestion, and traffic issues. It can also impact the overall economic growth and development of the area by discouraging visitors and businesses from entering the area due to a lack of parking facilities.

Therefore, it is essential to develop effective strategies to address the parking issues in the area. Some of the solutions may include building new parking structures, promoting alternative modes of transport, encouraging carpooling and ride-sharing, and implementing smart parking management systems. By addressing the parking issues, it will be possible to improve the traffic flow in the area and ensure the

Mode of Transport	Projected Parking count
Two wheeler	740
Car	110
Bicycle	150
Available Public Parking Space	3500 Sq.m
Additional parking space Required	1900 Sq.m

sustainable growth and development of the region.

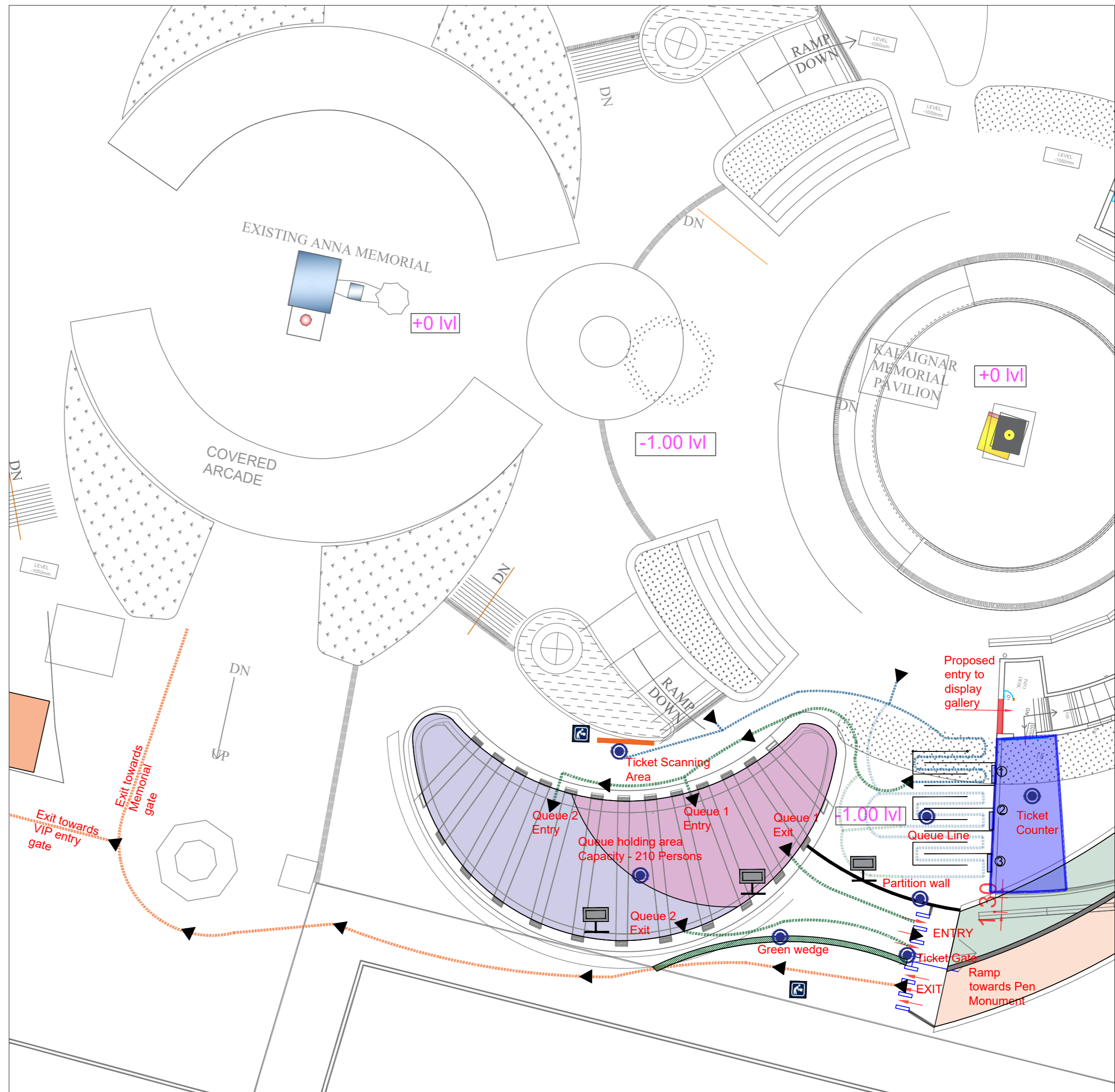
Table 1.12 – Projected Parking Count

1.4.9. CONCLUSION

The traffic Management proposal discusses the access to essential medical, fire, and rescue services and based on which the critical routes to the project site were identified that can be managed at the micro level. This micro-level intervention includes strategies such as lane separation and traffic control points during the times of evacuation will be effective in safe and secured access to emergency services.

Improving the LOS during both the existing and post-development of the proposed monument scenario will require a city/micro-level approach. To improve the LOS rating Macro level traffic management approach is essential, through detours of traffic flow which has various trip destinations except for the Beach/recreation purpose.





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GENERAL NOTES:

- All dimensions are in "mm" unless otherwise specified
- Site conditions shall be studied carefully in conjunction with this drawing. Any clarification in this regard shall be raised with this office.
- The specifications and details shall be followed as per the drawing and written instructions
- The drawings shall not be scaled. The written dimensions prevail

Legend :

- Plaza Area
- Queuing Area
- Ticket Booth Office
- Seating Benches
- Toilet Block
- Comand Centre
- Green wedge
- Memorial circulation
- Ticket Queue circulation
- Waiting area to Ticket Gate
- Exit from Pen Monument
- Display Boards
- Partial wall

PROJECT TITLE:

Consultancy Services for evolving Crowd Management Plan, Emergency Evacuation Plan, Road Connectivity Studies and Detailed Traffic Management for the proposed construction of Muthamizh Arignar Dr. Kalaignar Pen Monument, Chennai, Tamil Nadu

SUBTITLE:

Crowd Management Plan

DRAWING TITLE:

Detail drawing for Crowd Management Plan

DRAWING NUMBER:

2022_PENMONUMENT/CMPI/01

DATE:

04-04-2023

REV. NO

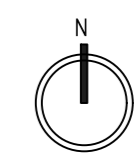
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- CONSTRUCTION
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SCALE:
As per drawing





Tamil Nadu
Public Works
Department



Consultancy Services for Evolving
Crowd Management Plan, Emergency
Evacuation Plan, Road Connectivity
Studies, and Detailed Traffic
Management Report for the
Proposed Construction Of
Muthamizh Arignar Dr. Kalaig
ner Pen Monument, Chennai.

Crowd Management Plan Report

APRIL 2023

Prepared By:

Centre for Urbanization, Buildings & Environment

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CONTENTS

1.1	INTRODUCTION	2
1.2	SIGNIFICANCE OF CROWD MANAGEMENT IN THE CONTEXT OF THE SITE	2
1.3	REVIEW OF RELEVANT CROWD DISASTERS IN PAST	3
1.4	CAUSES AND TRIGGERS FOR CROWD DISASTERS	4
1.4.1.	Structural Failures.....	4
1.4.2.	Fire/Electricity.....	4
1.4.3.	Crowd Control.....	4
1.4.4.	Crowd Behaviour	5
1.4.5.	Security	5
1.4.6.	Lack of PLANNED Coordination between Stakeholders	5
1.5	ESSENTIALS OF CROWD MANAGEMENT PLAN.....	6
1.6	DEMAND ASSESSMENT.....	6
1.6.1.	User Profile	7
1.6.2.	User classification:.....	7
1.6.3.	Peak hour.....	8
1.6.4.	Possible high crowding Event	8
1.7	SUPPLY ASSESSMENT.....	9
1.7.1.	Crowd control measure map	9
1.8	CROWD MANAGEMENT STRATEGIES.....	10
	Ticketing system	11
	Queue Control system	11
	Command and control Centre	11
	Facilities and Amenities.....	11
1.9	CROWD MANAGEMENT EQUIPMENTS.....	12
1.9.1.	CROWD MONITORING EQUIPMENT.....	12
	Crowd Sensors	12
	Wireless communications	12
	Public Address System.....	13
	Crowd Monitoring through CCTV	13
	RFID Bands.....	14
1.9.2.	COMMAND CENTRE EQUIPMENTS.....	14
	Emergency Communication Systems	14





Video Surveillance Systems 14

Alarm Systems 15





CROWD MANAGEMENT PLAN





1.1 INTRODUCTION

Crowd management is a systemic measure for controlling and monitoring individuals and groups to operate for safe and balanced use of resources. Crowd management is defined as the systematic planning for, and supervision of, the orderly movement and assembly of people.¹ The situation of crowding occurs when an excessively large number of people gathering in a constrained space on a daily or an event basis, at places such as tourist spots, sporting events, concerts, religious festivals, public protests, etc. The events/triggers that can lead to crowd disasters are natural calamities, manmade acts of violence, structural defects, fire/ electrical issues, unplanned crowd control, lack of understanding of crowd behaviour, security lapses, physical space attributes, and improper coordination between various stakeholders. The aspects to consider also include “frequent” scenarios as well as “infrequent” scenarios while taking into consideration an expected daily flow.

1.2 SIGNIFICANCE OF CROWD MANAGEMENT IN THE CONTEXT OF THE SITE

In recent times, major crowd-related disasters have been recurring throughout the country at places of mass gathering. According to the National Crime Records Bureau figures, from 2000 to 2013, almost 2,000 people died in stampedes². This has led to the development of management planning techniques and technologies to cater to multi-hazard situations by context-appropriate mitigation and response management systems.

Marina is a significantly large-scale landmark in the city attracting large gatherings on a daily and as well as on an event basis. In absence of adequate crowd management systems, such places are highly prone to crowd disasters. One recent incident is the stampede in 2018 during the political leader Karunanidhi’s funeral procession at the burial ground³. Often, natural calamities like flooding and cyclones also necessitate that an efficient system is devised to tackle crowding situations. A major natural disaster that caused significant damage is the 2004 Tsunami.

A high visibility tourism destination depends on effective management of crowd flows at and through various site features giving the visitor time and opportunity to appreciate and enjoy the culture and values of the place being visited and to acquire knowledge and understanding of the site’s significance. An overcrowded destination also affects the quality of the visitor experience. This in turn means that the crowds should be managed well both daily as well as on an event basis. This is especially crucial in the context of the site since it lies close to major existing crowd congregation areas.

The Proposed Pen Monument has a projected occupancy of about 10,000 visitors per day, which may lead to an increase in traffic congestion as well as an increased possibility of crowding-related incidents. Due to its prime location and proximity to other crowd pullers like the university, Marina Beach, and other memorials and tourist spaces, it is imperative to plan for a comprehensive crowd management strategy.

¹ <https://www.gkstill.com/Support/crowd-flow/fruin/Fruin2.html>

² <https://blog.forumias.com/crowd-disasters-and-management-in-india/>

³ <https://www.thehindubusinessline.com/info-tech/Chennai%E2%80%99s-Marina-crowds-to-be-part-of-communication-experiment/article20828228.ece>





1.3 REVIEW OF RELEVANT CROWD DISASTERS IN PAST

This section presents a quick review of some of the past crowd disasters in India to understand the causes and triggers to understand the underlying patterns and then synthesize them into a generic crowd disaster process.

S. NO	PLACE AND DATE OF DISASTER	CASUALTIES
1	Uphaar Cinema, Delhi, 13 June 1997. Movie goers trying to come out of a smoky cinema hall.	59
	<p>Description</p> <p>On Friday, 13th June, 1997, during the matinee show at Uphaar cinema, located in Green Park area of south Delhi, a transformer, of Delhi Vidyut Board installed in the ground floor parking, caught fire. The entire balcony area and the stairs leading to the balcony in the cinema were so full of smoke that it had become impossible for many of the patrons to go out of the building and as a result thereof 59 people, which included infants and children, lost their lives because of asphyxiation and about 103 other persons sustained injuries in trying to get out. The Delhi High Court was of view that the Licensee of the Uphaar Cinema, the licensing branch of the Delhi Police, the Delhi Vidyut Board (DVB) and the Municipal Corporation of Delhi (MCD) were all responsible for having contributed to the spreading of fire and smoke by their acts of omission and commission; and they are all jointly and severally liable for payment of compensation to the victims of the unfortunate incident. The negligence on the part of DVB in maintaining the transformers and the repairs were the root cause of the incident, i.e. the starting of the fire. Cinema owners violated municipal by-laws by making several unauthorised alterations in the structure (in particular raising a parapet wall so as to use the area between the wall and the transformer room for commercial purposes) contributing to the incident. Closing one of the exits in the balcony and reducing the width of gangways, contrary to a Cinema Hall rules, impeded the free and quick exit of the patrons. Illegal, overcrowded, haphazard parking in a stilt floor increased the fire hazard and also blocked the said area to be used as an exit in emergency. MCD failed to point out the alterations in the structure. The licensing authority also failed to note violations and take remedial action. It went on issuing temporary permits for a period of more than 13 years, when rules clearly contemplated that the temporary permits could not be renewed for a period of more than six month.</p>	
2	Sabarimala Stampede , Kerala, 14 January 2011	102
	<p>Description</p> <p>On January 14, 1999, 52 pilgrims were killed and several injured in a tragedy at Pampa hill top. Cause: The tragedy happened because of uncontrolled crowding of pilgrims at the Hill Top in Pamba and the rushing down by pilgrims, immediately after seeing the Makarjyothi, towards parking places and bus stand. Some people stumbled upon and others fell over them near Kerala State Electricity Board's building. Some Observations made by the commission: • Strict liability is on the State, to see that the right to life of a citizen is properly safeguarded. Breach of duty of care by the State, the Devaswom Board, and the Electricity</p>	





Board. • A large number of pilgrims crowding at Hill Top, Nilakkal and Sannidhanam, much above the capacity of those places for holding people. It is surprising to see that no steps have been taken. Possible steps to avoid disasters — Setting up a high coordination committee — Developing alternate roads, widening existing ones — Restriction of entry of vehicles (and type) beyond parking lot — Regulating and arranging parking of vehicles — Introduction of shuttle bus services — High parking fee — Shelters on the route — Banning unnecessary shops — Discourage overstay (high halting fee) — Restricting entry to Sannidhanam — Ticketing and numbering system at gateways to limit no. of pilgrims — Constructing barricades, lighting system, waiting hall — Drawing up a Master-Plan

Table 1.1 – Crowd Disaster Case studies

1.4 CAUSES AND TRIGGERS FOR CROWD DISASTERS

Broadly, the causes and triggers for Crowd Disaster Events can be categorised into 5 categories, namely Structural, Fire/Electricity, Crowd Control, Crowd Behaviour, Security and lack of planned coordination between stakeholders. These are enumerated below:

1.4.1. STRUCTURAL FAILURES

- Barricades/ Railings/fences/ Metal / Non Metal barriers.
- Collapse of Makeshift and Temporary Structures.
- Poor Lighting / Access.
- Difficult terrain / walkways.
- Slippery/muddy areas.
- Narrow streets with illegal vendors; sloped gradient.
- Windowless structures, narrow staircases.
- Narrow and few entry/exits.
- Absence of emergency exits.
- Unauthorised construction.
- Hindrances / obstructions to exits

1.4.2. FIRE/ELECTRICITY

- Fire.
- Fast spreading fire in wooden structures/ quick burning acrylic and other such materials.
- Non-availability of fire extinguisher/fire extinguishers not in working condition
- Unauthorized fireworks in enclosed places
- Building and fire code violations
- Lack of adequate lighting of entry/ exits, assembly areas / emergency exits and the path ways used by the crowd.
- Electricity supply failure creating panic and triggering a sudden exodus.
- Short circuit from electrical generator leading to fire.
- Elevators catching fire, steep stair designs.

1.4.3. CROWD CONTROL

- More than anticipated crowd at gatherings/ public celebrations.
- Underestimation of audience, staffing, services.





- People allowed in excess of holding capacity.
- Limited holding area before the entrance.
- Lack of access control.
- Closed/locked entries and exits.
- Reliance on one major exit route. Lack of alternative exit routes.
- Uncontrolled parking and movement of vehicles.
- Vehicular and pedestrian conflicts.
- Unmanaged and unregulated traffic.
- Lack of adequate and strong railings to marshal the queue.
- Lack of sectoral partitions to segregate assembled crowd.
- Lack of proper public address system to control crowd.

1.4.4. CROWD BEHAVIOUR

- A wild rush to force the way towards entrance/exits.
- Crowds attempting to enter a venue after the start/closing time.
- A collision between large inward flows and outward flows.
- Rush during distribution of disaster relief supplies.
- large number of people trying to board a ferry.
- Crowds trying to re-enter the venue (flows inward/outward flows mixed).
- Unruly and irresponsible crowd behaviour.
- Mad rush to exit/parking space.
- Sudden flow of people in reverse direction.
- Sudden mass evacuation because of a natural disaster.
- Rumours leading to rush down a narrow stairway.

1.4.5. SECURITY

- Under-deployment of security personnel to regulate to control crowd.
- Lack of adequate scientific planning in making police arrangement / emergency services..
- Lack of adequate dress rehearsals / drills before actual deployment.
- Lack of adequate observation towers with PA system and back up force.
- Lack of adequate CCTV surveillance of the crowd with PA system to control monitor and guide as and when required.
- Lack of adequate anti sabotage check of the entire area and sanitizing the same against terrorist, extremist and separatist attack
- Security agency firing/teargas/using force leading to panic and stampede.
- Crowd forced against sharp metal fencing.

1.4.6. LACK OF PLANNED COORDINATION BETWEEN STAKEHOLDERS

- Coordination gap between various agencies (e.g. Police, Corporation, PWD, Fire Services and other emergency services)
- Poor implementation of crowd management plan.
- Inadequate water, amenities, medical assistance, public transport/parking facilities.
- Lack of understanding of the range of duties entrusted to various stakeholders.
- Communication delays.
- Vacant/late/delayed posting of key personnel.





1.5 ESSENTIALS OF CROWD MANAGEMENT PLAN

The significant aspects to consider for an efficient crowd management strategy may include an understanding of crowd characteristics & behaviour, capacity planning, facility design and layout, movement planning, risk assessment, hazard identification, risk preparedness, safety and security measures, surveillance system, streamlined evacuation protocols, emergency response systems, crowd control system and so on. The Study proposes a comprehensive approach for the preparation of the Crowd Management Plan which will concentrate on providing solutions from Planning, Design, and Engineering perspectives as well as Management perspectives.

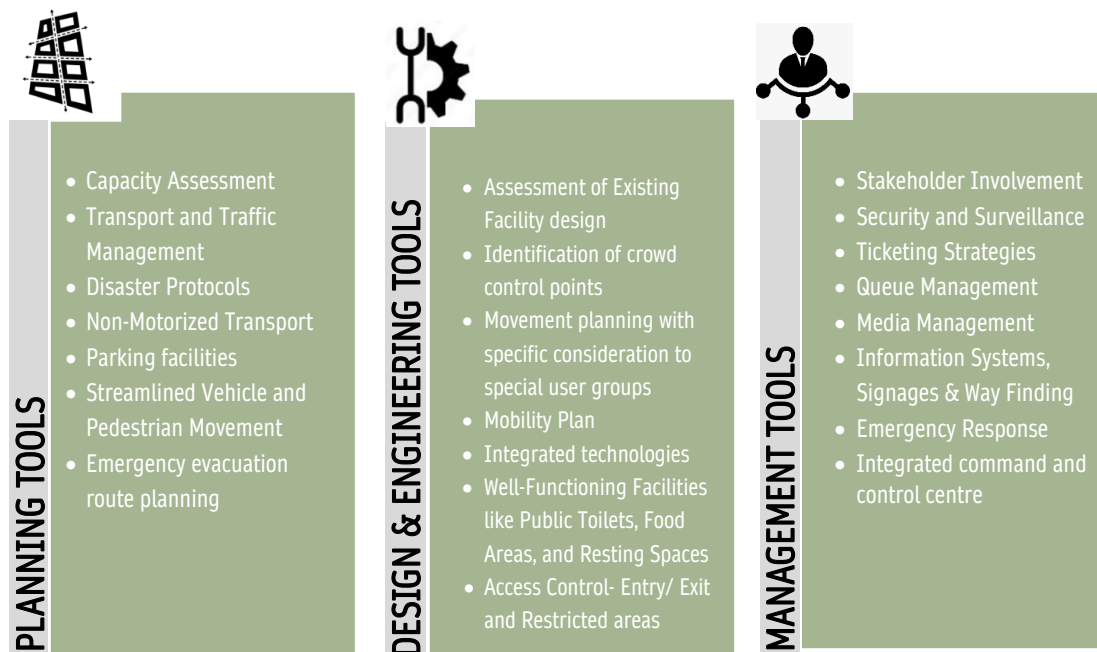


Figure 1.1 - Tools for Crowd Management

1.6 DEMAND ASSESSMENT

The demand assessment is carried out by studying the characteristics of the user such as the approximate user profile, classification and possible high crowding event at the closer vicinity to the proposed pen monument.

On a regular day, the memorial may experience a steady flow of people throughout the day, with peak hours during Morning hours or after work/school hours. However, on holiday/event days, the population in and around the memorial as well as the proposed pen monument can increase significantly.

During holidays/events, people gather in memorial to celebrate, socialize, or participate in activities or events. This can result in large numbers of people concentrated in certain areas.

The following table illustrates the expected carrying capacity of the memorial and pen monument calculated as per the safe space area required per person.





Total No. of visitors per day

Scenario 1 (Optimal Capacity on Regular Days)	Scenario 2 (Maximum Capacity on Event/special Days)
10,000	30,000

Table 1.2 –Carrying capacity of the memorial and pen monument

1.6.1. USER PROFILE

The user profile is significantly higher on weekends than weekdays for all categories of users. The data shows that on weekdays, the female visitors are higher than males. However, on weekends, the number of visitors is much higher, indicating that weekends experience much more significant crowds. The children count is also much higher on weekends, indicating that families visit the area more on weekends.

User Profile	Female	Male	Children
Weekdays	46%	40%	14%
Weekends	42%	43%	15%

Table 1.3 –User Profile

1.6.2. USER CLASSIFICATION:

The below table presents the percentage of different user types on weekdays and weekends. According to the primary survey, tourists account for 12% of users on weekdays, while on weekends they make up a much larger proportion of 69%. Homeless people and police are comparatively less common, comprising only 0.5% and 0.8% of weekday users, respectively. On weekends, the proportion of police decreases to 0.3%, whereas the percentage of homeless people remains the same. Students are the most frequent users during the weekdays, accounting for 22.2% of the users. On weekends, however, they make up only 0.4% of users, while the majority of visitors are non-local users at 64.5%. This table provides useful insights into the different types of users who frequent the Anna & MK memorial place and how their composition may vary depending on the day of the week.

User Classification	Weekday	Weekends
Tourists	12%	69%
Homeless people	0.5%	0.5%
Visitors	64.5%	29.8%
Police	0.8%	0.3%
Students	22.2%	0.4%

Legend: High no of users





Table 1.4 –User Classification

1.6.3. PEAK HOUR

The peak hours on weekdays are from 9:00 am to 12:00 noon and from 6:00 pm to 9:00 pm. During these hours, the visitor count is higher for females in the morning and for males in the evening. The visitor count for children is relatively low, indicating that they are either in school or not present during these hours. The visitor count is significantly higher on weekends than on weekdays, with both males, females and children having a high user density during these hours, indicating that families visit the area more on weekends.

As per the primary survey & Investigation, the user density during peak hours on weekdays and weekends can lead to overcrowding, which can compromise visitors' safety and comfort.

Time	Weekdays	Weekends
9:00am - 12:00 noon	34%	4%
12:00 - 3:00 pm	22%	25%
3:00 - 6:00 pm	24%	34%
6:00 - 9:00 pm	20%	37%

Peak Hours

Table 1.5 –Peak Hour

1.6.4. POSSIBLE HIGH CROWDING EVENT

Types	Frequency	User Density (Approximate)	Users
Perarignar Anna's birth anniversary	Yearly Once	24,000	General Public, Political Party Members, Police, Media
Perarignar Anna's death anniversary	Yearly Once	24,000	General Public, Political Party Members, Police, Media
Kalaignar Dr. M. Karunanidhi birth anniversary	Yearly Once	28,000	General Public, Political Party Members, Police, Media
Kalaignar Dr. M. Karunanidhi death anniversary	Yearly Once	28,000	General Public, Political Party Members, Police, Media
Political Events	On average, thrice a year	24,000	Political Party Members, Police, Media

Table 1.6 –Possible high crowding event

The table 1.6 shows that the birth and death anniversaries of Perarignar Anna and Kalaignar Dr. M. Karunanidhi attract a similar number of users, with an approximate user density of 28,000 and 32,000, respectively. These





events are held yearly, once a year. On the other hand, political events take place on average thrice a year, attracting a user density of 24,000, primarily comprising political party members, police, and media.

This data is used as part of crowd management plan to determine the resources required for each event such as security personnel, parking, and crowd control measures. Additionally, understanding the type and frequency of events helps to plan crowd management during peak periods.

1.7 SUPPLY ASSESSMENT

1.7.1. CROWD CONTROL MEASURE MAP

As part of the crowd control measure ticketing the proposed monument is essential in order to organise the visitor movement at the site. The input capacity of the visitors is considered as 10000 visitors per day which will aid in identifying the holding area capacity for designating the holding areas post the ticketing process. In order to optimize and control the entry queuing system is essential to control and monitor the entrance and exit to the monument. The crowd is streamlined through provisions of design and infrastructure tools such as median or partitions, pause points or seating areas along with the provision of facilities and amenities.

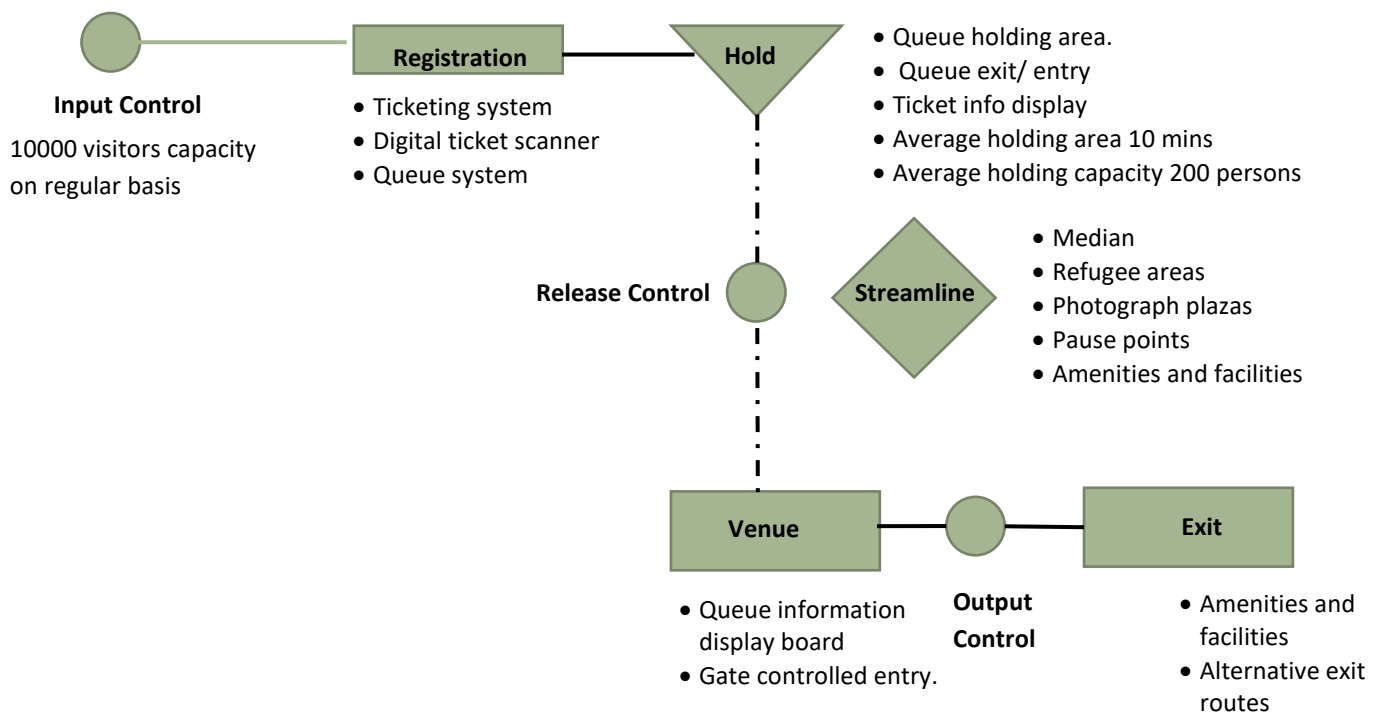


Figure 1.2 – Crowd Control Map





1.8 CROWD MANAGEMENT STRATEGIES

The Crowd control plan outlines the effective process of controlling and monitoring the visitors predominantly at the entry/exit to the monument and memorial. The challenging part for crowd management is to control the visitor capacity for both the proposed Pen monument and Memorial Park. The entrance to the pen monument creates a bottle neck at the southeast corner of the site. A plaza is proposed at the entrance area to the pen monument which will act as a major crowd control zone.

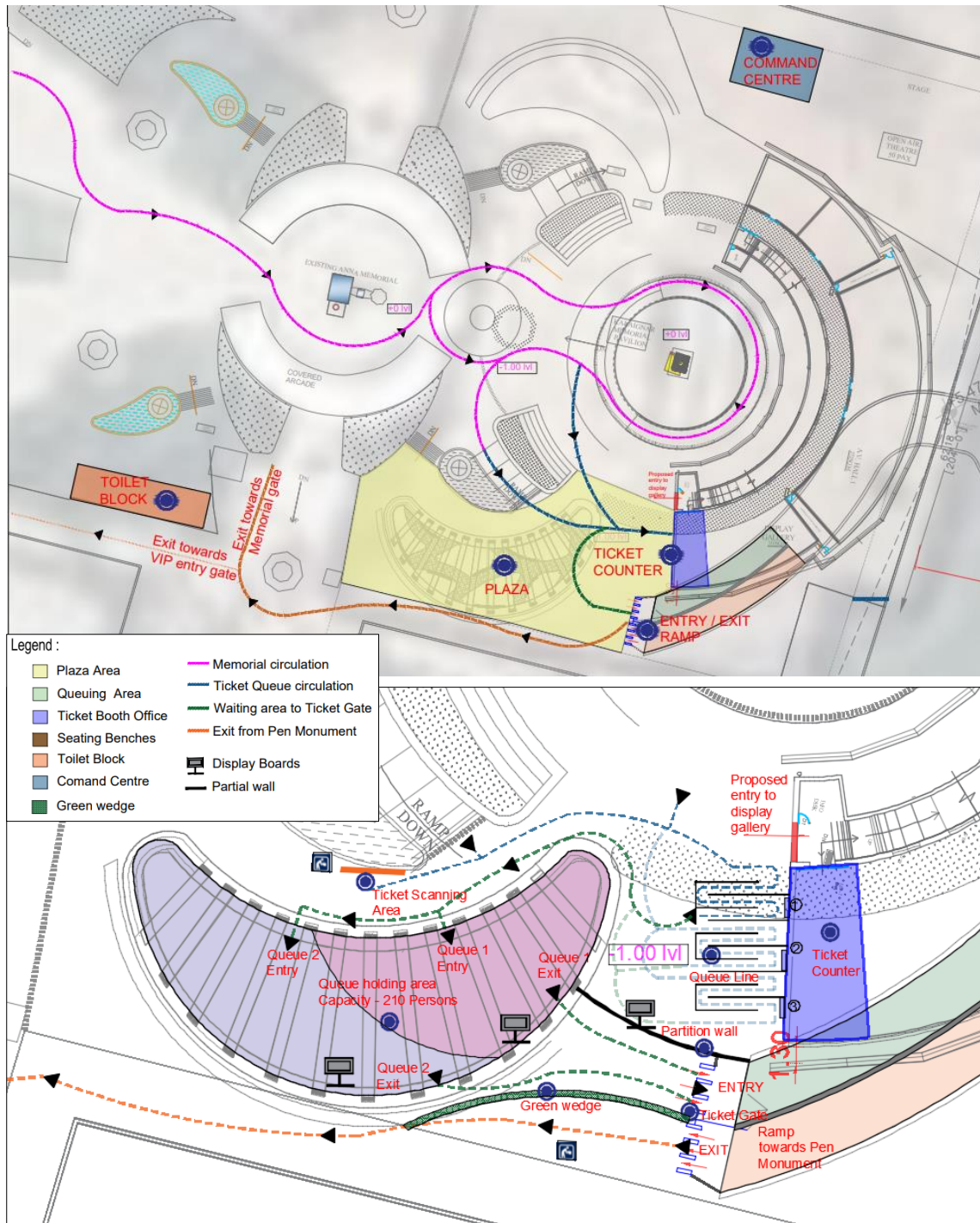


Figure 1.3 - Proposed Crowd Management Plan





Crowd management strategies are:

Ticketing system

In order to track and manage the crowd ticketing is essential which will aid in controlling and monitoring the crowd as well as organising the visitor movement. The following are the elements as part of the ticketing system:

- Ticket office
- Queue line
- Digital ticket scanner
- Ticket gate scanner

Queue Control system

Queue control system is a tool for managing and optimizing the flow of visitors for registration for tickets through a queue. The following are the elements as part of the Queue system:

- Queue holding area – waiting and seating spaces
- Ticket Identification number
- Queue information Display board

Command and control Centre

A command and control center is facility that will aid to centralize the control and management of the public space. The centre will take over the overall operations like monitoring, controlling and commanding. The information related to crowding, services and emergency situations will be incorporated from multiple sources. This will aid in providing critical resources as part of emergency response operations.

Facilities and Amenities

The visitor amenities are proposed at refugee areas, entrance/ exits to ensure clear movement and ease of movement at the site. Based on the capacity the space quantities and space required were determined for the following amenities:

- Toilets
- Drinking water fountains
- Signage display
- Waiting and seating spaces

The dispersal plan for Crowd management plan and Emergency evacuation plan will be linked with the Traffic management plan for developing better link to the services such as parking, fire and medical services. In case of high crowd scenarios the emergency evacuation exits shall be used for dispersion of crowd towards Kamarajar Salai.





1.9 CROWD MANAGEMENT EQUIPMENTS

1.9.1. CROWD MONITORING EQUIPMENT

Crowd Sensors

Crowd sensors are an essential component of any evacuation plan, especially for a monument located near the sea shore. These sensors are designed to detect and measure the movement of people in real-time, which can help emergency responders understand the flow of crowds during an evacuation and make informed decisions. By providing real-time data, the sensors can help to prevent overcrowding, monitor congestion, and ensure the safety of those involved in the evacuation process.

Technical Specifications for crowd sensors

- **Detection range:** The range of the sensor to detect people in its surroundings.
- **Accuracy:** The accuracy of the sensor to measure the movement and count of people.
- **Sensitivity:** The sensitivity of the sensor to detect the movement of people in different weather conditions, such as rain or fog.
- **Data collection:** The sensor should be capable of collecting data and transmitting it in real-time to a central location.
- **Power supply:** The sensor should be powered by a reliable power source, such as batteries or a power grid.
- **Communication:** The sensor should be capable of communicating with other sensors and a central control system, allowing for real-time monitoring and data analysis.
- **Durability:** The sensor should be durable and able to withstand harsh weather conditions and other external factors that may affect its performance.

Wireless communications

Wireless communication is an essential component of any evacuation plan, particularly in situations where there may be a large number of people involved. One option for wireless communication is a mesh network, which uses a series of interconnected devices to create a network that can transmit data over long distances. This type of network can be particularly useful in situations where traditional cellular or Wi-Fi networks may not be available, such as in remote areas or during natural disasters.

Technical Specifications for Wireless Mesh Networks

- **Range:** Mesh networks can transmit data over a range of several miles, depending on the number of devices in the network and the strength of the signal.
- **Bandwidth:** The bandwidth of a mesh network will depend on the number of devices in the network and the type of data being transmitted. In general, mesh networks can support high-bandwidth applications such as video streaming and VoIP.
- **Security:** Mesh networks can be secured using a variety of encryption methods to prevent unauthorized access.





- Redundancy: Mesh networks are designed to be self-healing, meaning that if one device in the network fails, the network will automatically reroute data through another device to ensure continuity of service.
- Power consumption: Mesh networks can be designed to be energy-efficient, allowing devices to run on batteries for extended periods of time.
- Scalability: Mesh networks can be scaled up or down depending on the number of devices and the amount of data being transmitted.

Public Address System

A Public Address (PA) system is an electronic amplification system that can be used to distribute sound to a large group of people. It is an essential component of any evacuation plan as it can be used to make announcements and provide instructions to people during an emergency. The PA system typically consists of a microphone or other input device, an amplifier, and a set of speakers that can be placed in various locations throughout the area. The PA system is an effective way to communicate with a large number of people simultaneously, making it a critical tool for ensuring the safety of individuals during an emergency situation.

Technical Specifications for Public Address System

- Power output: 100 watts
- Frequency response: 50 Hz to 15 kHz
- Amplifier type: Class D
- Input channels: 4 microphone/line inputs, 2 stereo line inputs
- Output channels: 2 speaker outputs
- Speaker type: 2-way, full-range speakers
- Maximum sound pressure level: 115 dB
- Power supply: 100-240 V AC, 50/60 Hz

Crowd Monitoring through CCTV

Crowd monitoring through CCTV is an essential component of any evacuation plan for a monument, particularly in high-risk areas such as a sea shore. It involves the installation of strategically placed CCTV cameras that are able to monitor and record crowd movement and behavior in real-time. This allows for a timely response to any issues that may arise during an evacuation, such as overcrowding or congestion.

Technical Specifications for Crowd Monitoring through CCTV

- High-definition resolution: 1080p or higher
- Wide-angle lens: 120 degrees or greater
- Infrared night vision: up to 50 meters or more
- Motion detection: able to detect movement in designated areas
- Live streaming capabilities: able to stream footage in real-time to a central monitoring station
- Storage capacity: able to store footage for a minimum of 30 days





- Weatherproof and durable design: able to withstand harsh weather conditions and vandalism

RFID Bands

RFID (Radio-Frequency Identification) bands are a useful tool for crowd management in the event of an emergency. These bands can be worn by visitors to the monument and can be used to track their movements and locations in real-time. This can help authorities to manage crowds effectively and respond to emergencies quickly. The RFID bands can be linked to a central monitoring system that can provide real-time data on the number of visitors, their location, and movements within the monument.

Technical specifications for RFID bands:

- Frequency: UHF (Ultra High Frequency) 860-960MHz
- Reading distance: Up to 10 meters
- Data storage capacity: 512 bytes
- Battery life: Up to 5 years
- Material: PVC or silicone
- Operating temperature: -20 to 60 °C
- Waterproof and dustproof
- Can be easily deactivated once the event is over.

1.9.2. COMMAND CENTRE EQUIPMENTS

Emergency Communication Systems

Emergency Communication Systems are an essential component of any emergency evacuation plan. They allow for quick and efficient communication between the emergency responders and the people in need of assistance. Some common types of emergency communication systems include

- a) Two-Way Radios: These are portable devices that allow for communication between different individuals or groups during an emergency. They are particularly useful for emergency responders who need to stay in constant communication with each other.
- b) Public Address Systems: These are used to broadcast important messages or instructions to a large group of people. They are particularly useful in emergency situations where people need to be quickly and efficiently directed to safety.
- c) Emergency Notification Systems: These are automated systems that can quickly notify large groups of people of an emergency situation. They can send messages via text message, email, or even automated phone calls.
- d) Satellite Phones: These phones are particularly useful in areas where traditional communication systems may not be available. They allow for communication with emergency responders or other individuals who may be able to provide assistance.

Video Surveillance Systems





Video Surveillance Systems play a crucial role in ensuring safety and security during an emergency evacuation. They help in monitoring the crowd and identifying any potential security threats. These systems consist of cameras, video recorders, monitors, and other related equipment.

Technical specifications for Video Surveillance Systems:

- Camera resolution: HD (720p, 1080p), Full HD (1080p, 1440p, 2160p)
- Camera type: Fixed, Pan-tilt-zoom (PTZ), 360-degree, bullet, dome
- Video recording format: MP4, AVI, H.264, H.265
- Storage capacity: 1TB, 2TB, 4TB, 8TB, 16TB, or more
- Network connectivity: Wired, wireless, PoE (Power over Ethernet)
- Viewing options: Local monitor, remote access, mobile app
- Advanced features: Motion detection, facial recognition, object tracking, night vision, weather-resistant casing.

Alarm Systems

Alarm systems are an important part of any evacuation plan. They are designed to alert people in the event of an emergency, and can be used to warn people of potential dangers such as fires, gas leaks, or intruders. The alarm system typically includes a control panel, sensors, and a siren or other audible alarm device. When a sensor is triggered, the control panel activates the alarm, which alerts people in the area to evacuate or take other appropriate action.

Technical specifications for Alarm Systems:

- Control panel: This is the brain of the system that communicates with the sensors and triggers the alarm.
- Sensors: These can include motion detectors, smoke detectors, glass break sensors, and door and window sensors.
- Audible alarm: This is the device that produces a loud noise to alert people in the area of the emergency.
- Visual alarm: This can include strobe lights or other visual cues to alert people who may have difficulty hearing the audible alarm.
- Remote monitoring: Some alarm systems can be monitored remotely by security company or other authorized personnel.
- Backup power supply: In case of power outages, some alarm systems have a backup power supply that allows them to continue functioning.
- Integration with other systems: Alarm systems can often be integrated with other security systems such as access control systems or video surveillance systems.





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GENERAL NOTES:
 1. All dimensions are in "mm" unless otherwise specified
 2. Site conditions shall be studied carefully in conjunction with this drawing. Any clarification in this regard shall be raised with this office.
 3. The specifications and details shall be followed as per the drawing and written instructions
 4. The drawings shall not be scaled. The written dimensions prevail

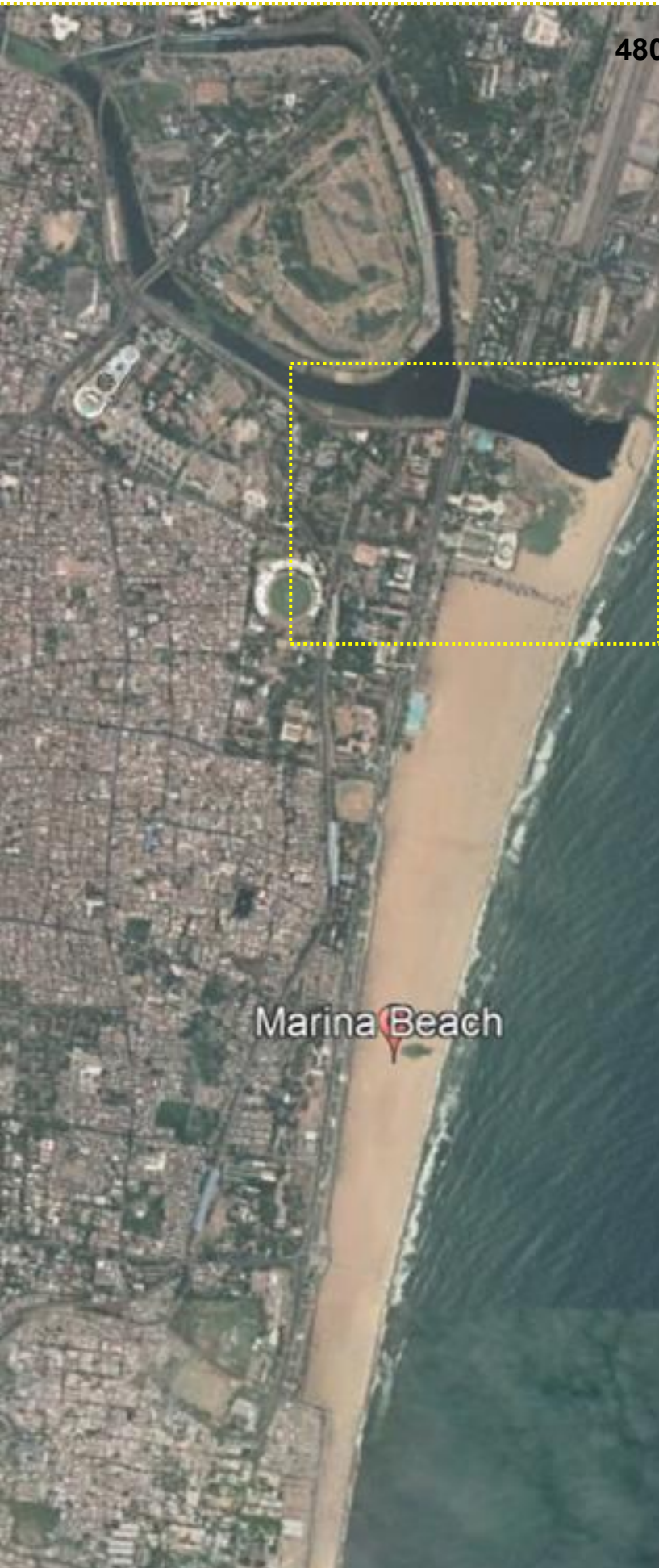
Emergency Evacuation Plan

PROJECT TITLE:
 Consultancy Services for evolving Crowd Management Plan, Emergency Evacuation Plan,
 Road Connectivity Studies and Detailed Traffic Management for the proposed construction of
 Muthamizh Arignar Dr. Kalaingar Pen Monument, Chennai, Tamil Nadu
 SUBTITLE:
 Emergency Evacuation Plan
 DRAWING TITLE:
 Detail drawing for Emergency Evacuation Plan
 Macro Level

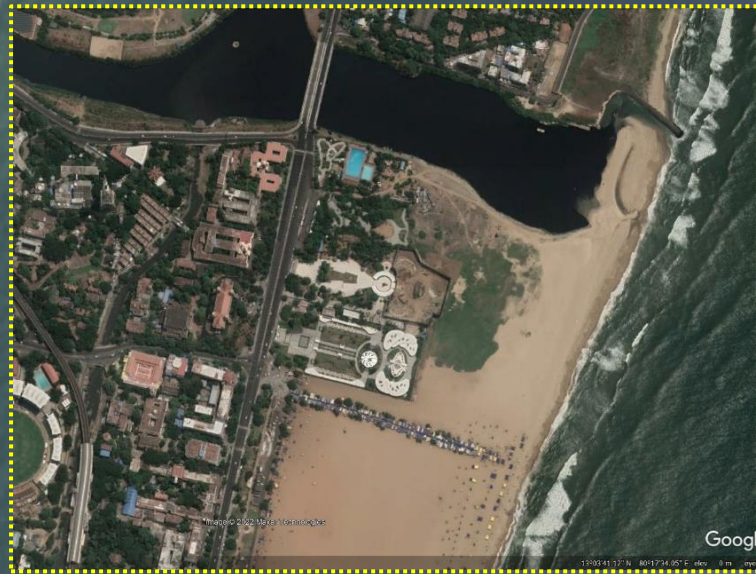
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		AS-BUILT	<input type="checkbox"/>



Tamil Nadu
Public Works
Department



Marina Beach



Consultancy Services for Evolving
Crowd Management Plan, Emergency
Evacuation Plan, Road Connectivity
Studies, and Detailed Traffic
Management Report for the
Proposed Construction Of
Muthamizh Arignar Dr. Kalaignar
Pen Monument, Chennai.

Emergency Evacuation Plan

APRIL 2023 - Updated

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EMERGENCY EVACUATION PLAN





1.1. Contents

1.1. Introduction	3
1.1.1. Site Zoning	3
1.1.2. Offshore Structure (Zone 1):	4
1.1.3. Onshore Structure (Zone 2):	5
1.2. DESIGN BASIS	6
1.2.1. Design Constraints	6
1.2.2. Visitor Density	6
1.2.3. Carrying Capacity.....	6
1.2.4. Streamlining the pedestrian movement.....	7
1.2.5. Off Shore Evacuation Plan (Zone 1A &1B)	9
1.2.1. On Shore Evacuation Plan (Zone 2A &2B)	11
1.2.2. Capacity Building and Training Program.....	11
1.2.3. Proposed Emergency Evacuation Plan	13
1.3. EQUIPMENT	14
1.3.1. Lighting and power equipment.....	14
1.3.2. Communication equipment.....	17
1.3.3. Sea rescue equipment.....	30





1.1. INTRODUCTION

The Emergency Evacuation Plan is designed based on the thorough assessment of the layout of existing memorials and proposed pen monument. The nature of the hazards, risks and occupants can vary widely as per the type and location of the infrastructure. As the proposed monument includes both on & offshore Infrastructure, potential hazards and risks for both infrastructural types were considered while forming the emergency evacuation plan. The total length of the proposed pen monument is 647.25M from the compound wall of the MK Memorial.

This stretch includes pedestrian pathway above beach, Lattice bridge, pedestrian pathway above sea and the pen pedestal. For the purpose of assessment and strategy framing, the stretch is divided into two major zones and four sub zones as shown in figure 1.1.



Figure 1.1 - Base map

1.1.1. Site Zoning

For the purpose of preparation of and Emergency Evacuation Plans, the site is divided into zones as explained in this section. The zones are summarised in the table below and represented in Figure 1.2.

S No	Zones	Description
1	1	Offshore Structure Zone 1A: Pen Pedestal. Zone 1B: Pedestrian Bridge above Sea.
2	2	Onshore Structure Zone 2A: Lattice Bridge over land and beach. Zone 2B: Pedestrian Above Grade Pathway from Muthamizh Arignar Dr. Kalaingar Memorial to Pedestrian Bridge above Sea.





3

3	3	<p>Memorials</p> <p>Zone 3A: Under Construction Muthamizh Arignar Dr. Kalaignar Memorial [Former CM Thiru M. Karunannidhi's Memorial].</p> <p>Zone 3B: Existing Anna Memorial [Former CM Thiru C. N. Annaudurai's Memorial].</p>
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Table 1.1 – Site Zoning Descriptions

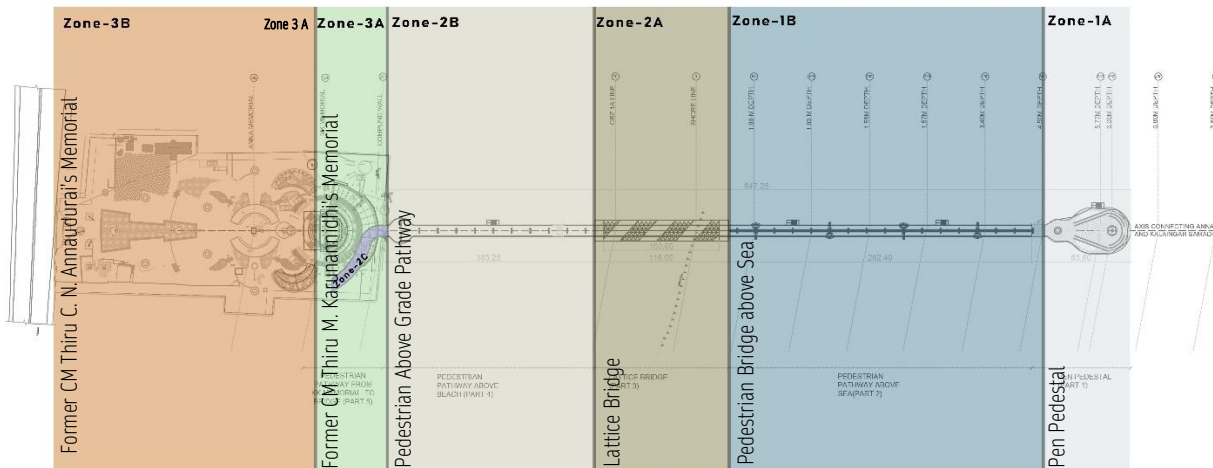


Figure 1.2 – Site Zoning Map

Description	Length (in mts)	Area (in sq. mts.)
1) Zone 1A Pen Pedestal	74	450.0
2) Zone 1B Pedestrian Pathway above Sea	273	1,911.0
3) Zone 1C Lattice Bridge above Beach & Land	116	812.0
4) Zone 2A Pedestrian Pathway above Beach	183	1350.0
5) Zone 2B Pedestrian Pathway from Muthamizh Arignar Dr. Kalaignar Memorial to Bridge	66	462.0
Total Area		4,985.0

Source: (HUBERT ENVIRO CARE SYSTEMS (P) LTD, CHENNAI, 2022)

1.1.2. Offshore Structure (Zone 1):

Off shore bridge (Zone 1) has the main tourist attraction that comprises of pen pedestal as zone 1A and the pedestrian pathway above the sea as zone 1B. The physical attribute of both sub zones is studied before strategizing the emergency evacuation plan. Zone 1B has a width of 7m, this two-way pedestrian path leads to the tear shape pen pedestal of 2290sq.m located 561M from the shore line.



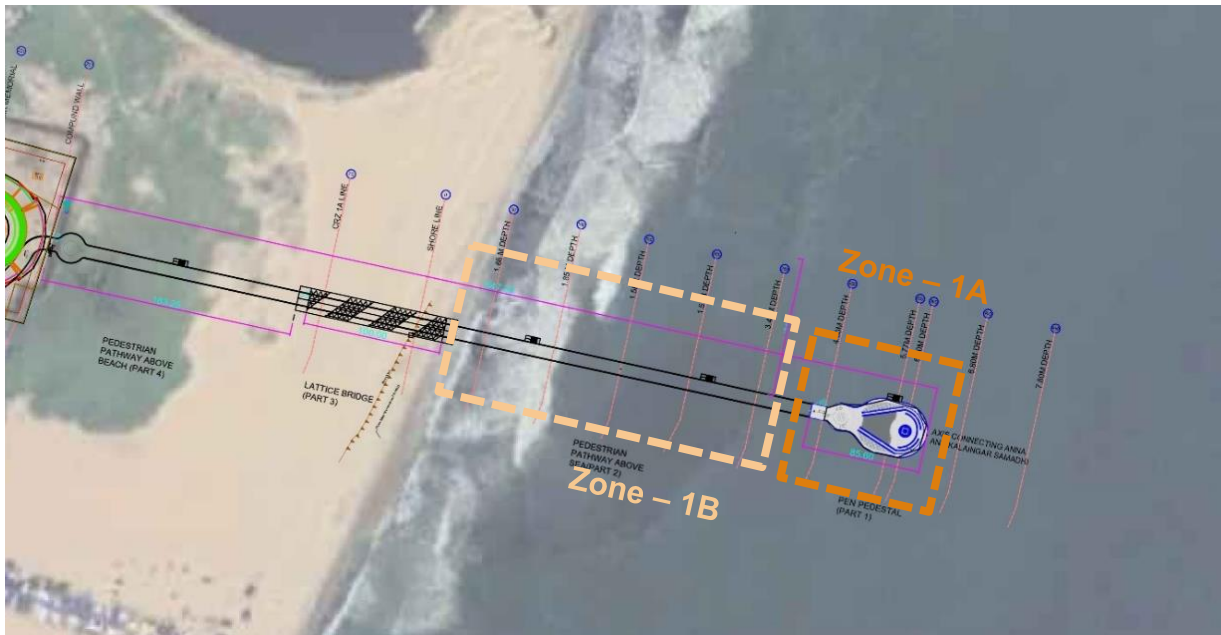


Figure:1.3 – Zone 1 Offshore Structure

1.1.3. Onshore Structure (Zone 2):

Zone 2 onshore development comprises two types of infrastructures, lattice bridge as zone 2A and pedestrian pathway as zone 2B. The lattice bridge of 116m long and 7m wide at bottom (Refer Figure1.3) acts as a connecting element between the Onshore and Offshore bride. Zone 2B has the pedestrian pathway above the beach that connects the pen monument with the MK Memorial.



Figure:1.4 – Zone 2 Offshore Structure



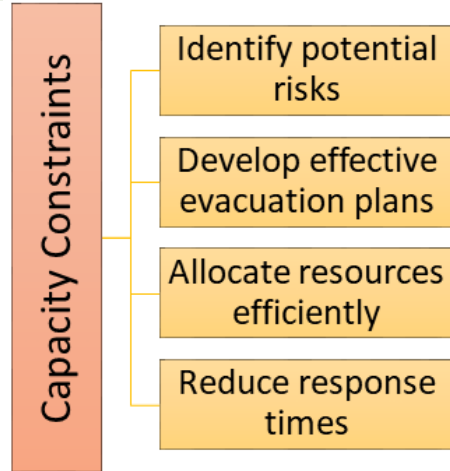


1.2. DESIGN BASIS

1.2.1. Design Constraints

Deriving an effective emergency evacuation plan requires a careful consideration of physical nature of the site and surroundings along with standards as studied to deliver a comprehensive emergency evacuation plan that addresses the unique needs of each zone.

The potential limitations and bottlenecks of the structure that can affect the efficiency and safety of an emergency response are identified by studying the capacity constraints of the given site. Understanding capacity constraints can help to anticipate and prepare for various scenarios, develop effective evacuation plans, and allocate resources appropriately. Figure 1.4 illustrates the necessity of the capacity constraints for the proposed pen monument.



1.2.2. Visitor Density

As per the primary survey & Investigation conducted on the Immediate influence area around the Perarignar Anna Memorial & Dr. M. Karunanidhi Memorial, it is observed that the visitor density is higher in morning from 9:00 to 12:00 AM during the due to the presence of the Institutional and office buildings. Whereas, the visitor density is higher in evening and night during the weekends compared to other times of the day during the weekends, as most people come to visit the beach, the memorial, and the commercial street in the holidays.

1.2.3. Carrying Capacity

To derive the carrying capacity, the total circulation area of the bridge is divided by safe space area per person. The maximum carrying capacity of the proposed bridge at any given time should not exceed 2600 visitors.

$$\text{Max Carrying Capacity} = \frac{\text{Total Circulation Area (Sq. Mts.)}}{\text{Safe Space Per Person (Sq. Mts.)}}$$

	Two Way Movement	One Way Movement
Total Circulation Area (Sq. Mts.)	5766	2883
Safe Space Per Person (Sq. Mts.)	2	2
Mean Time needed to walk the Site (min)	30.8	10.2
Max Carrying Capacity per cycle	2883	1440

Table 2.2 Carrying capacity calculation

On a regular day, the pen monument may experience a steady flow of people throughout the day, with peak hours during Morning hours or after work/school hours. However, on holiday/event days, the population in and around the pen monument can increase significantly.

During holidays/events, people gather in Anna or MK memorial to celebrate, socialize, or participate in activities or events. This can result in large numbers of people concentrated in certain areas. The emergency





evacuation is planned for optimal crowd on regular days. However, the pen monument has maximum capacity of 30000 that can be accommodated during the event/special days.

Total No.of visitors per day	10000
Total No.of visitor Group	44
Total No.of visitor cycle	15
Total No.of visitors per cycle (Max)	760
Safe Space Per Person (Sq. Mts.)	2

Table 2.3 - Scenario 1 – Optimal Capacity on Regular Days

Total No.of visitors per day	30000
Total No.of visitor Group	44.0
Total No.of visitor cycle	15.0
Total No.of visitors per cycle	2883
Safe Space Per Person (Sq. Mts.)	2.0

Table 2.4 - Scenario 2 –Maximum Capacity on Event/special Days

1.2.4. Streamlining the pedestrian movement

Lack of streamlining the crowd during an emergency evacuation, may make visitors panic and rush in different directions, causing confusion and chaos. This can lead to people becoming trapped or injured, hindering the evacuation process, and putting themselves and others at risk. In order to create a comprehensive evacuation movement, the following methods are followed:

- Ticketing
- Pause points
- Medians
- Standardized entry/exit times

This division of visiting capacity will help to manage the flow of visitors to the Pen Monument, ensuring that the number of visitors in the monument at any given time is within the carrying capacity of the site. The entry time, stay duration, and exit time will be standardized to ensure that visitors have sufficient time to explore the monument while allowing for the smooth entry and exit of visitors.

By dividing the visiting capacity into 44 groups, it will be easier to manage the flow of visitors, reducing overcrowding and the risk of accidents. Each cycle will consist of three groups, ensuring that the number of visitors in each group is manageable and does not exceed the carrying capacity of the site.

Overall, standardizing the visiting capacity to the Pen Monument is essential to ensure the safety and enjoyment of visitors while protecting the site and visitors from Hazards. Table 2.2 depicts the sample standardization of entry, exit, cycle details.

Additionally, openable median shall be used throughout the bridge to streamline the entry and exit movement of the crowd.





Visitor group	Peak Hours	Entry	Destination	Stay	Exit	Max No of Entries / 20 mins	Cycle number	
1		06:00	06:20	06:40	07:00	200	1	
2		06:20	06:40	07:00	07:20	200		
3		06:40	07:00	07:20	07:40	200		
4		07:00	07:20	07:40	08:00	200	2	
5	Peak Hours During Weekdays	07:20	07:40	08:00	08:20	255		
6		07:40	08:00	08:20	08:40	255		
7		08:00	08:20	08:40	09:00	255	3	
8		08:20	08:40	09:00	09:20	255		
9		08:40	09:00	09:20	09:40	255		
10		09:00	09:20	09:40	10:00	255	4	
11		09:20	09:40	10:00	10:20	255		
12		09:40	10:00	10:20	10:40	255		
13			10:00	10:20	10:40	11:00	255	5
14			10:20	10:40	11:00	11:20	255	
15		10:40	11:00	11:20	11:40	255		
16		11:00	11:20	11:40	12:00	200	6	
17		11:20	11:40	12:00	12:20	200		
18		11:40	12:00	12:20	12:40	200		
19		12:00	12:20	12:40	13:00	200	7	
20		12:20	12:40	13:00	13:20	200		
21		12:40	13:00	13:20	13:40	200		
22		13:00	13:20	13:40	14:00	200	8	
23		13:20	13:40	14:00	14:20	200		
24		13:40	14:00	14:20	14:40	200		
25		14:00	14:20	14:40	15:00	200	9	
26		14:20	14:40	15:00	15:20	200		
27		14:40	15:00	15:20	15:40	200		
28		15:00	15:20	15:40	16:00	200	10	
29		15:20	15:40	16:00	16:20	200		
30		15:40	16:00	16:20	16:40	200		
31		16:00	16:20	16:40	17:00	200	11	
32		16:20	16:40	17:00	17:20	200		
33		16:40	17:00	17:20	17:40	200		
34		17:00	17:20	17:40	18:00	200	12	
35		17:20	17:40	18:00	18:20	200		
36		17:40	18:00	18:20	18:40	200		
37		18:00	18:20	18:40	19:00	200	13	
38		18:20	18:40	19:00	19:20	200		
39	Peak Hours During Weekends	18:40	19:00	19:20	19:40	255	14	
40		19:00	19:20	19:40	20:00	255		
41		19:20	19:40	20:00	20:20	255		





42		19:40	20:00	20:20	20:40	355	15
43		20:00	20:20	20:40	21:00	355	
44		20:20	20:40	21:00	21:20	355	

Table 2.2 – Standardized Entry and Exits and Peak Hours

Note:

1. The operational hour at the proposed Pen Monument is around 15.3hours , the shift hour for evacuation reponse team shall be organised accordingly.
2. In case of Emergency evacuation during the evening time, temporary flood lights shall be installed at access routes 1 and 2.

1.2.5. Off Shore Evacuation Plan (Zone 1A &1B)

Evacuation Strategy	Quantity	Details									
Number of Exits	28	As per NBC, an exit has to be provided every 25 meters.									
Inflatable Slides	34	Location: On bridge deployment The slides shall be used to reach the inflated raft at the water level.									
Inflatable Rafts Location: On bridge deployment	34	<p>Single trips</p> <p>Each raft has a carrying capacity of 25.</p> <table border="1" style="width: 100%;"> <thead> <tr> <th>S.no</th> <th>Parameter</th> <th>Value</th> </tr> </thead> <tbody> <tr> <td>01</td> <td>Speed of the Raft</td> <td>3.5Knots (1 Nautical mile per hour)</td> </tr> <tr> <td>02</td> <td>Distance covered</td> <td>50M(0.03mile)</td> </tr> </tbody> </table> <p>Formula to find the Time taken for the Raft to reach 50m at the speed of 3.5Knots is -</p> <p>Time = Distance x 60 divided by Speed</p> <p>$T = \frac{D \times 60}{S}$</p> <p>$T = \frac{0.03 \times 60}{3.5}$</p> <p>$T = 0.51 \text{ Minutes}$</p> <p>$T = 30 \text{ Seconds.}$</p> <p>Time takes for the Raft to reach 50m in 3.5knots speed is 30 Seconds.</p> <p>The rafts shall be inflated and accessed at the water level through the slides.</p>	S.no	Parameter	Value	01	Speed of the Raft	3.5Knots (1 Nautical mile per hour)	02	Distance covered	50M(0.03mile)
S.no	Parameter	Value									
01	Speed of the Raft	3.5Knots (1 Nautical mile per hour)									
02	Distance covered	50M(0.03mile)									





		The storage of the rafts shall be kept in uninflated position under the handrail area.										
Inflatable Rafts Location: Off bridge deployment	34	The rafts will be kept at the storage unit at the memorial park and shall be deployed when on bridge equipment failure occurs.										
Launching Pad (two on either side of the bridge)	4	Launching pad of area 144 sq.m each shall be provided at the end of each floating bridge. The launching pad provides operating area for the response team and landing area of rescue boats/rafts during emergency evacuation period. Launching pad shall be deployed during emergency situations and stored at the onshore storage unit.										
Inflatable Floating Bridges	2	Inflatable floating bridges shall be deployed during emergency situations and stored at the onshore storage unit. <table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th colspan="2" style="text-align: left;">Floating Bridge</th> </tr> </thead> <tbody> <tr> <td>Capacity/ floating bridge at any given time</td> <td style="text-align: right;">1175</td> </tr> <tr> <td>Width</td> <td style="text-align: right;">5</td> </tr> <tr> <td></td> <td style="text-align: right;">230</td> </tr> <tr> <td>Floating bridge length</td> <td style="text-align: right;">240</td> </tr> </tbody> </table>	Floating Bridge		Capacity/ floating bridge at any given time	1175	Width	5		230	Floating bridge length	240
Floating Bridge												
Capacity/ floating bridge at any given time	1175											
Width	5											
	230											
Floating bridge length	240											
Rescue Life Boats	15	The rescue boats shall be used to attend or rescue the visitor in distress. The rescue boats will be parked on the refugee area at the sea level and only to be used during emergency situation.										
Life Jackets and Life buoys	20 per Raft and 20 additional at the refuge area.	In every raft and additionally at every refuge location.										
Refugee Area	2	As per National building code, 5 % of the built area has to be given as refugee area. Total of 1576 sq.m with carrying capacity of 788 visitors off shore.										
Staircase	3	Provided as per the drawings shared by the PWD and as per NBC standards at every 25m.										
Stretcher Lift	2	Provided at each refuge area. Size as per standards.										
Fire extinguisher	3	As per standards 1 extinguisher per 150 visitors are provided.										
Dry riser	6	Connection box provided at every 100m. The Inlet is provided at the shoreline.										
Emergency Medical Kit	5	One emergency medical kit provided at every 100m.										
Inflatable Lighting Tower	2	Shall be stored at the onshore storage unit.										
Portable Generators	2	Shall be stored at the onshore storage unit.										





Diving Equipment	<p>The following diving equipment shall be stored at the onshore storage unit.</p> <ol style="list-style-type: none"> 1) Personnel Diving kit 2) Portable Air compressor Machine 3) High Pressure Breathing Compressor 4) Underwater Communication set 5) Under water torch
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1.2.1. On Shore Evacuation Plan (Zone 2A &2B)

Evacuation Strategy	Quantity	Details
Number of Exits	7	As per NBC, an exit has to be provided every 25 meters.
Staircase	6	Provided as per standards.
Ramp	1	
Stretcher Lift	2	
Refugee Area	1	Total of 1210 sq.m with carrying capacity of 605 visitors on shore.
Emergency Medical Kit	4	One emergency equipment provided at every 100m.
Fire extinguisher	2	As per standards 1 extinguisher per 150 visitors are provided.
Dry Riser	3	Connection box provided at every 100m. The Inlet is provided at the shoreline.
Communication Equipment		<p>The following communication equipment shall be used for crowd management and during evacuation.</p> <ol style="list-style-type: none"> 1) Digital Hand-Held VHF Set (5 Watt) 2) Digital Mobile / Base Station (25 WATT) 3) Statellite Phone 4) Digital VHF Repeater set 5) Strecher/Spine Board with Accessories

1.2.2. Capacity Building and Training Program

Capacity building and training programs are critical components of crowd management and emergency evacuation planning. Such programs are designed to prepare individuals and organizations better for handling large crowds and the related challenges. The Capacity Building Program shall be built along the following tenets:





1. **Stakeholder Mapping and Identification of Target Training Groups:** This is essential to carry out the training needs assessment for the respective stakeholders. The stakeholders comprise of local traffic police, police department, local body, public works department, crowd management team deployed at site including crowd managers, marshals, security staff, queue management staff and so on, emergency responders including look out staff, medical responders, fire safety staff, command center staff and so on. The local community should also be involved in the process.
2. **Training Need Assessment:** Post the mapping of stakeholders, a rapid training needs assessment may be carried out to identify the training requirements and gaps. Different groups of people may require different types of training. For example, crowd management protocols, evacuation routes and procedures, rescue techniques, basic medical procedures and so on. Training for local community (like fishermen folk, adjacent vendors, business owners can also be involved.
3. **Develop a comprehensive training plan and follow through action plan:** A comprehensive training plan should be developed, including training objectives, content, delivery methods, and evaluation metrics. The training plan should also include regular refresher training to ensure that the skills and knowledge remain up-to-date. For the local community leaflets with general instructions can be circulated on a periodic frequency to keep their involvement as well as inform them of protocols and procedures of Crowd management Plan, Emergency Evacuation Plan and Traffic Management Plan so as to engage them when a situation arises. Various stakeholders thus can be familiarized with the protocols, alleviating anxiety amongst the community and ensure preparedness. Regular drills shall be conducted to update the plan as required and keep stakeholders better prepared.
4. **Test and evaluate the training program:** The training program should be tested and evaluated regularly to ensure that it is effective and up-to-date. This may involve conducting drills and exercises to simulate emergency situations and identify areas for improvement.





1.2.3. Proposed Emergency Evacuation Plan



Figure:2.1 – Proposed Emergency Evacuation Plan

PROPOSED EVACUATION PLAN	
Scenario 1	Individual/ VIP emergency rescue
The entry and exit route are through the same path the leads to the ticketed control point located at the memorial park. Refer figure 2.1	
Scenario 2	Mass evacuation
OFF SHORE EVACUATION	
The offshore evacuation is through Inflatable bridges, ramps, rafts and rescue boats which will lead to the assembly points proposed on the shore.	
ON SHORE EVACUATION	





The on shore evacuation is planned through staircase and ramps which will lead to the assembly points 1&2 where the emergency vehicles and temporary medical camps will be stationed during evacuation times.

Note: The two assembly points 1&2 are connected to the Kamarajar salai through two paths leading to Kamarajar salai as mentioned in figure 2.1

The Plan includes various elements such as exits, inflatable rafts, floating bridges, floating jetties, rescue boats, refugee areas, staircases, fire extinguishers, dry risers, and emergency medical kits.

The number of exits is provided as per the National Building Code, which requires an exit to be provided every 25 meters. A total of 28 exits are to be provided for the evacuation strategy. The number of inflatable rafts provided is 34, and they can make double trips to ensure that all visitors can be evacuated safely.

Two floating bridges are to be provided along with two floating jetties at the end of each bridge. The floating jetties have an area of 144 square meters and act as launching pads for the response team and landing areas for rescue boats/rafts during emergency evacuations.

The strategy also includes providing three fire extinguishers for every 150 visitors, and six dry risers with connection boxes provided at every 100 meters. The inlet for the dry riser is provided at the shoreline. Five emergency medical kits are also provided, with one emergency equipment provided at every 100 meters.

As part of the plan two assembly points were provided on the shore which ensures a safe and secure place for evacuees to gather, away from any potential hazards. The visitors will be rerouted to the Kamarajar Salai as shown in the map.

In conclusion, the emergency evacuation strategy involves a comprehensive approach to ensure the safety of all visitors during an emergency situation. The provision of exits, inflatable rafts, floating bridges, rescue boats, and other elements helps to ensure that visitors can be evacuated safely and efficiently. The strategy also includes provisions for fire safety and emergency medical care. Overall, the implementation of such a strategy can help to minimize the risk to visitors and reduce the impact of emergencies on the facility.

1.3. EQUIPMENT

1.3.1. LIGHTING AND POWER EQUIPMENT

1.3.1.1. INFLATABLE LIGHTING TOWER

An inflatable lighting tower is a portable lighting system that consists of a collapsible, inflatable tower and a set of LED lights. The tower is made of durable, high-strength materials, such as PVC-coated polyester fabric or nylon, and is designed to be quickly inflated using an electric or manual pump. Once inflated, the tower can reach heights of up to 30 feet, providing ample illumination for a wide area. Inflatable lighting towers can be a valuable asset in creating an effective evacuation plan for a monument or historic site. In an emergency situation, such as a natural disaster, it may be necessary to evacuate the area quickly and safely. However, low light conditions can make it difficult for people to navigate their way out of the monument or site. Inflatable lighting towers can be strategically placed to provide a well-lit pathway for evacuation, reducing the risk of injuries or accidents.





Figure:3.1 –Inflatable Lighting Tower

Technical Specifications

Material: The inflatable tower should be made of PVC-coated polyester fabric or nylon with a minimum thickness of 0.6mm. The material should have a high tensile strength and be resistant to abrasion, UV rays, saltwater corrosion, and other harsh environmental conditions.

Height: The tower should have a maximum height of 30 feet and a minimum height of 20 feet, adjustable in increments of 5 feet. The tower should have an inflatable base diameter of at least 6 feet and a minimum wind resistance rating of 40 mph.

Lighting: The tower should have at least four LED lights with a minimum brightness of 15,000 lumens each, providing a total brightness of at least 60,000 lumens. The lights should be adjustable to different angles and should have a minimum color rendering index (CRI) of 80. The lights should have a rated lifespan of at least 50,000 hours and be rated to operate in temperatures of -40°C to 50°C.

Stability: The tower should have a minimum wind resistance rating of 40 mph and a minimum gust resistance rating of 50 mph. The base should be made of durable, non-slip material, and should be weighted down with sandbags or other anchoring devices to prevent tipping.





Portability: The tower should be lightweight and compact when deflated, with a weight of no more than 200 pounds and a deflated size of no more than 5 feet x 5 feet x 5 feet. The tower should be easy to transport in a standard vehicle and should include a carrying case or backpack for easy storage.

Power source: The tower should be compatible with standard power outlets (110-240V AC) and should have a battery backup system with a minimum runtime of 8 hours. The battery system should be able to be charged using solar panels or other renewable energy sources.

Weatherproofing: The tower should be waterproof, with a minimum IP rating of 65, and should be able to withstand exposure to rain, wind, and saltwater spray. All electrical components should be rated to operate in temperatures of -40°C to 50°C and should be sealed to prevent water ingress.

1.3.1.2. Portable Generators

Two sets of portable generators with different power capacities should be provided to ensure backup power supply for the inflatable lighting tower in case of power outages or emergencies.

The larger generator with a capacity of 10.5 KVA may be used to power the inflatable lighting tower and provide a backup power supply in case the primary power source fails. This generator may be suitable for use in situations where the tower needs to be operational for an extended period or requires a higher power supply due to additional equipment, such as sound systems or other electrical devices. The smaller generator with a capacity of 2.5 KVA and 5 KVA may be used as a backup power supply for the inflatable lighting tower in case the larger generator fails. This generator may be suitable for shorter periods of operation or in situations where the power demand is lower.

Technical Specification for portable generators

S.No.	Technical Specifications	Portable Generators – 10.5 KVA	Portable Generators - 5 KVA	Portable Generators – 2.5 KVA
1.	Power output	10.5 KVA or 8.4 KW	5 KVA or 4 KW	2.5 KVA or 2 KW
2.	Engine	Four-stroke diesel engine with a minimum displacement of 400cc. Minimum horsepower - 16 HP. Maximum RPM - 3000	Four-stroke diesel engine with a minimum displacement of 200cc. Minimum horsepower - 6 HP. Maximum RPM - 3600	Four-stroke diesel engine with a minimum displacement of 100cc. Minimum horsepower - 3 HP. Maximum RPM - 3600
3.	Fuel Tank	Minimum capacity of 10 liters made of corrosion-resistant material	Minimum capacity of 5 liters made of corrosion-resistant material	Minimum capacity of 2 liters made of corrosion-resistant material
4.	Noise level	Maximum noise level of 70 dB at a distance of 7 meters	Maximum noise level of 65 dB at a distance of 7 meters	Maximum noise level of 60 dB at a distance of 7 meters





5.	Alternator	Brushless alternator with minimum efficiency rating of 85%, minimum insulation class of H	Brushless alternator with minimum efficiency rating of 80%, minimum insulation class of H	Brushless alternator with minimum efficiency rating of 75%, minimum insulation class of H
6.	Control panel	Digital display for voltage, frequency, and operating hours; switches for starting, stopping, and monitoring the generator; and circuit breakers for overload protection.	Digital display for voltage, frequency, and operating hours; switches for starting, stopping, and monitoring the generator; and circuit breakers for overload protection.	Digital display for voltage, frequency, and operating hours; switches for starting, stopping, and monitoring the generator; and circuit breakers for overload protection.
7.	Enclosure	Weatherproof enclosure made of corrosion-resistant material, with handles for easy mobility.	Weatherproof enclosure made of corrosion-resistant material, with handles for easy mobility.	Weatherproof enclosure made of corrosion-resistant material, with handles for easy mobility.

1.3.2. COMMUNICATION EQUIPMENT

1.3.2.1. Digital Hand-Held VHF Set (5 Watt)

A Digital Hand-Held VHF (Very High Frequency) set is an essential communication equipment for any evacuation plan near the sea shore. This set can provide reliable communication between team members in case of emergency situations, such as natural disasters or security threats. The 5-Watt power output of this set provides strong and clear communication over a significant distance, even in difficult weather conditions. The set should be waterproof, lightweight, and durable to withstand harsh conditions at sea. In addition, it should have a long-lasting battery life and be equipped with features like noise reduction, dual watch, and emergency channels to ensure efficient communication during critical situations.





Figure:3.2 –Digital Hand-Held VHF Set (5 Watt)

Technical Specifications

Material: The inflatable tower should be made of PVC-coated polyester fabric or nylon with a minimum thickness of 0.6mm. The material should have a high tensile strength and be resistant to abrasion, UV rays, saltwater corrosion, and other harsh environmental conditions.

Height: The tower should have a maximum height of 30 feet and a minimum height of 20 feet, adjustable in increments of 5 feet. The tower should have an inflatable base diameter of at least 6 feet and a minimum wind resistance rating of 40 mph.

Lighting: The tower should have at least four LED lights with a minimum brightness of 15,000 lumens each, providing a total brightness of at least 60,000 lumens. The lights should be adjustable to different angles and should have a minimum color rendering index (CRI) of 80. The lights should have a rated lifespan of at least 50,000 hours and be rated to operate in temperatures of -40°C to 50°C.

Stability: The tower should have a minimum wind resistance rating of 40 mph and a minimum gust resistance rating of 50 mph. The base should be made of durable, non-slip material, and should be weighted down with sandbags or other anchoring devices to prevent tipping.

Portability: The tower should be lightweight and compact when deflated, with a weight of no more than 200 pounds and a deflated size of no more than 5 feet x 5 feet x 5 feet. The tower should be easy to transport in a standard vehicle and should include a carrying case or backpack for easy storage.

Power source: The tower should be compatible with standard power outlets (110-240V AC) and should have a battery backup system with a minimum runtime of 8 hours. The battery system should be able to be charged using solar panels or other renewable energy sources.

Weatherproofing: The tower should be waterproof, with a minimum IP rating of 65, and should be able to withstand exposure to rain, wind, and saltwater spray. All electrical components should be rated to operate in temperatures of -40°C to 50°C and should be sealed to prevent water ingress.

Technical specifications for Digital Hand-Held VHF set (5 Watt)





- a) **Frequency range:** 156.025 MHz to 163.275 MHz (Marine Band)
- b) **Power output:** 5 Watts (adjustable to 1 Watt for battery conservation)
- c) **Battery life:** Minimum 8 hours with a Lithium-Ion battery
- d) **Channel capacity:** At least 16 channels, including emergency channels (16 and 9)
- e) **Waterproof rating:** At least IPX7, meaning it can be submerged in water up to 1 meter for 30 minutes
- f) **Antenna:** Removable and flexible, with a gain of at least 3dB
- g) **Display:** Backlit LCD screen for displaying channel, battery life, and signal strength
- h) **Keypad:** Waterproof and backlit for easy use in low light conditions
- i) **Audio features:** Noise reduction, voice activation, dual watch, and speaker/microphone jacks for external audio accessories
- j) **Size and weight:** Compact and lightweight design, weighing no more than 500 grams with battery and antenna
- k) **Durability:** Built to withstand exposure to saltwater, shock, and vibration in marine environments
- l) **Accessories:** Charger, belt clip, and lanyard included. Optional accessories may include external microphones, speakers, or GPS units.
- m) **Modulation:** 16K0G3E (for voice) and 16K0F3E (for data)
- n) **Receiver sensitivity:** Better than 0.25 microvolts for 12 dB SINAD (Signal-to-Noise and Distortion Ratio)
- o) **Squelch sensitivity:** Adjustable between 0.2 microvolts and 1 microvolt
- p) **Frequency stability:** +/- 5 parts per million (ppm)
- q) Maximum deviation: +/- 5 kHz
- r) **Audio output:** At least 500 mW (for built-in speaker) and 1000 mW (for external speaker)
- s) **Microphone input:** Electret condenser type, with sensitivity of at least -40 dB
- t) **Water resistance:** Capable of withstanding high pressure water jets (at least IPX5 rating)
- u) **Shock resistance:** Capable of withstanding a drop of at least 1.5 meters onto a concrete surface
- v) **Vibration resistance:** Capable of withstanding vibration up to 8G
- w) **Approvals:** Compliant with relevant standards such as IEC, CE, and FCC regulations.
- x) **User interface:** Intuitive menu system and ergonomic design for ease of use
- y) **Operating temperature:** -20 degrees Celsius to +55 degrees Celsius
- z) **Storage temperature:** -30 degrees Celsius to +85 degrees Celsius

1.3.2.2. Satellite Phone

A satellite phone is a critical communication device for any emergency evacuation plan, especially in areas with limited or no cellular coverage. These phones use satellites orbiting the Earth to establish communication between two points, making them ideal for use in remote locations or during natural disasters. They are





capable of providing reliable voice and data communication, even in extreme conditions. In addition, they can be equipped with GPS capabilities to provide location information in emergency situations. Satellite phones should be rugged and durable, with long battery life and easy-to-use controls.



Figure:3.3 –Satellite Phone

Technical specifications for Satellite Phone

- a) **Network:** Supports one or more of the following satellite networks: Iridium, Inmarsat, Globalstar, Thuraya
- b) **Frequency range:** Dependent on the satellite network and phone model, but typically includes a range of frequencies from 1616 MHz to 1626.5 MHz for Iridium, 1616 MHz to 1626.5 MHz for Inmarsat, 1616 MHz to 1626.5 MHz for Globalstar, and 1525 MHz to 1559 MHz for Thuraya
- c) **Data transfer rates:** Dependent on the satellite network and phone model, but typically range from 2.4 Kbps to 10.5 Kbps for voice communication and up to 60 Kbps for data communication
- d) **Battery life:** Minimum of 8 hours of talk time and 24 hours of standby time, with the option to extend battery life through the use of solar chargers or other external power sources
- e) **Operating temperature:** -10 degrees Celsius to +55 degrees Celsius
- f) **Storage temperature:** -20 degrees Celsius to +70 degrees Celsius
- g) **Durability:** Built to withstand exposure to harsh weather conditions and extreme temperatures, with shock resistance and water resistance features
- h) **Size and weight:** Typically, compact and lightweight, weighing no more than 500 grams with battery
- i) **GPS capability:** Some models include GPS capability for location tracking and emergency response purposes
- j) **Display:** Backlit LCD screen for displaying call information and status messages





- k) **User interface:** Intuitive menu system and easy-to-use controls, with features like speed dial, call logs, and messaging capabilities
- l) **Antenna:** Removable and external antenna for improved signal strength

1.3.2.3. Digital Mobile / Base Station (25 WATT)

A Digital Mobile/Base Station is an important component of any communication system in an emergency evacuation plan, especially for areas where mobile coverage is limited or unavailable. A Digital Mobile/Base Station is designed to provide high-quality voice and data communication over a wide area, making it an ideal choice for emergency situations. It can be installed in a mobile vehicle or as a fixed base station, making it flexible and adaptable to a variety of scenarios. A Digital Mobile/Base Station with a 25-watt output power is capable of transmitting signals over a distance of 5-10 miles, making it an ideal choice for an evacuation plan for a monument located near the sea shore.



Figure:3.4 – Digital Mobile / Base Station (25 WATT)

Technical specifications for Digital Mobile / Base Station (25 WATT)

- a) **Frequency range:** Dependent on the radio system used, but typically includes a range of frequencies from 136 MHz to 174 MHz or 400 MHz to 520 MHz
- b) **Output power:** 25 watts, capable of transmitting signals over several miles
- c) **Channel capacity:** Dependent on the radio system used, but typically includes multiple channels for voice and data communication
- d) **Modulation:** Dependent on the radio system used, but typically includes options for both analog and digital modulation
- e) **Operating temperature:** -30 degrees Celsius to +60 degrees Celsius
- f) **Storage temperature:** -40 degrees Celsius to +70 degrees Celsius
- g) **Durability:** Built to withstand exposure to harsh weather conditions and extreme temperatures, with shock resistance and water resistance features
- h) **Size and weight:** Typically, compact and lightweight, with dimensions of around 200mm x 140mm x 35mm and weighing no more than 2 kilograms
- i) **Power supply:** 12-volt DC power supply, with options for backup power sources such as batteries or solar panels





- j) **Antenna:** Removable and external antenna for improved signal strength
- k) **Data transmission:** Capable of supporting digital data transmission at speeds of up to 9.6 kbps
- l) **User interface:** Intuitive menu system and easy-to-use controls, with features like speed dial, call logs, and messaging capabilities
- m) **Accessories:** Microphone, speaker, mounting bracket, and power cable included. Optional accessories may include external antennas, battery backup systems, and data transfer cables.

1.3.2.4. Digital VHF Repeater Set

A Digital VHF Repeater Set is an essential component of a robust communication system for an evacuation plan of a monument located on a seashore. In such environments, communication can be challenging due to the distance between parties, physical obstructions, and the presence of saltwater, which can interfere with radio signals.

A Digital VHF Repeater Set is designed to overcome these challenges by acting as a relay station for two-way radios, effectively extending their range and allowing clear communication over longer distances. The device receives incoming radio signals and then rebroadcasts them on a different frequency, allowing for greater coverage and improved signal quality. The use of a repeater set ensures that everyone in the communication network can stay connected and updated, which is critical during an evacuation or emergency situation.



Figure:3.5 – Digital VHF Repeater Set

Technical specifications for Digital VHF Repeater Set

- a) Frequency range: 136-174 MHz
- b) Output power: 25 watts
- c) Operating modes: analog FM and digital P25
- d) Channel capacity: up to 16 channels
- e) Duplex spacing: 5 MHz or 6.25 kHz
- f) Channel spacing: 12.5 kHz or 25 kHz
- g) Dimensions: approximately 19 x 8 x 4 inches (48.3 x 20.3 x 10.2 cm)
- h) Weight: approximately 16 pounds (7.3 kg)
- i) Environmental rating: IP54 or higher (dust and water resistant)
- j) Power source: 12V DC power supply
- k) MFR & AMBULANCE EQUIPMENT

1.3.2.5. Stretcher / Spine Board with Accessories





A Stretcher/Spine Board with accessories is an essential component of any medical response system, especially in a seashore environment where accidents and injuries can occur frequently. The stretcher/spine board is designed to transport injured persons safely and comfortably to the ambulance or medical facility. When selecting a stretcher/spine board for a seashore environment, it is essential to consider the potential challenges posed by sand, water, and uneven terrain. The stretcher/spine board must be designed with durable and waterproof materials to withstand exposure to saltwater and other harsh elements. It should also have large wheels or tracks that allow it to navigate through sand and uneven surfaces. The number of stretchers required for an evacuation plan depends on various factors such as the size of the monument, the number of visitors or employees, and the level of risk involved. As a general rule of thumb, it is recommended to have at least one stretcher available for every 50-100 people present at the monument.

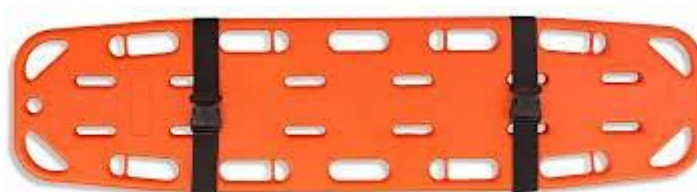


Figure:3.6 – Stretcher / Spine Board with Accessories

A few technical specifications should be considered are given below

- a) Sturdy frame made from lightweight materials such as aluminum or carbon fiber
- b) Designed to support up to 500 pounds of weight
- c) Non-slip surface to prevent injury to the patient during transport
- d) Full set of accessories, including straps, buckles, and padding, to secure the patient in place and prevent further injury during transport
- e) Large wheels or tracks to navigate through sand and uneven surfaces
- f) Built-in flotation device to keep the board and patient afloat in case of an emergency in the water (optional)
- g) Built-in canopy or shade to protect the patient from the sun and heat (optional)

1.3.2.6. Diving Equipment

Diving equipment is an essential component of any evacuation plan for a monument present near the sea shore. This equipment is used in case of emergencies where people might fall into the water or require assistance underwater. This equipment helps the rescue team to carry out safe and efficient underwater search and rescue operations, enabling them to reach individuals who might be in distress. Having a well-equipped diving team with the necessary diving equipment can make a significant difference in the success of an evacuation plan for a monument present near the sea shore.

A few technical specifications on different types of diving equipment discussed are given below

(a) Scuba Diving Tanks:





Figure:3.7 – Scuba Diving Tanks

- I. Made of high-quality, durable materials such as aluminum or steel.
- II. Come in various sizes and capacities, typically ranging from 6 to 100 liters.
- III. Include a valve for controlling the flow of air in and out of the tank.
- IV. May be equipped with a pressure gauge to monitor the amount of air remaining.

(b) Diving Regulator:



Figure:3.8 – Diving Regulator

- I. Used to control the flow of air from the scuba tank to the diver's mouth.
- II. Made of high-quality materials to withstand the harsh conditions of the sea.
- III. Includes a first-stage regulator to reduce the pressure of the air from the tank, a second-stage regulator for breathing, and a pressure gauge to monitor air supply.

(c) Buoyancy Compensator:





Figure:3.9 –Buoyancy Compensator

- I. Used to control buoyancy underwater by adding or releasing air from the vest.
- II. Made of durable materials such as neoprene or nylon.
- III. Includes a bladder for holding air, an inflator hose to add air, and a dump valve to release air.

1.3.2.7. Personnel Diving Kit

(a) Diving Mask:



Figure:3.10 –Diving Mask

- I. Material: High-quality silicone
- II. Lens: Tempered glass
- III. Skirt size: Regular, Large
- IV. Strap: Adjustable, secure buckle system

(b) Fins:





Figure:3.11 –Fins

- I. Material: High-quality rubber
- II. Type: Open-heel or full-foot design
- III. Size: Small, Medium, Large, Extra Large
- IV. Blade length: 15-20 inches
- V. Diving Tanks:
- VI. Capacity: 10-20 liters
- VII. Material: High-pressure aluminum
- VIII. Maximum pressure: 200 bar
- IX. Valve: DIN or Yoke

(c) Wet Suit:

- I. Material: Neoprene or compressed foam
- II. Thickness: 3mm to 7mm
- III. Type: Full suit or shorty
- IV. Size: Small, Medium, Large, Extra Large

1.3.2.8. Portable Air compressor Machine

A portable air compressor machine can be an essential piece of equipment for an evacuation plan near the sea shore, especially in situations where rapid deployment of inflatable boats or life rafts is required. This machine is capable of providing high-pressure air for inflating these boats, as well as for other purposes such as filling air tanks for diving equipment. In emergency situations, having a reliable air compressor that can be easily transported to the site of the evacuation can be critical for ensuring the safety of those involved.





Figure:3.12 –Portable Air compressor Machine

Technical specifications for Portable Air Compressor Machine

- (a) Power source: Gasoline engine or electric motor
- (b) Max pressure: 3000-5000 PSI
- (c) Output flow rate: 10-25 CFM (cubic feet per minute)
- (d) Air tank capacity: 10-30 gallons
- (e) Weight: 50-150 pounds (depending on the model and type of power source)
- (f) Noise level: 70-90 dB (decibels)
- (g) Portability: Wheels and handle for easy transport
- (h) Safety features: Overpressure protection, automatic shutdown in case of overheating or low oil level

1.3.2.9. High Pressure Breathing Compressor

A high-pressure breathing compressor is a crucial piece of equipment for any evacuation plan near the sea shore. It is specifically designed to refill air tanks that are used for diving and emergency breathing apparatus. During an evacuation or rescue operation, the availability of compressed air can mean the difference between life and death. A high-pressure breathing compressor can rapidly refill tanks and provide a continuous supply of fresh air to divers and rescue personnel.



Figure:3.13 – High Pressure Breathing Compressor

Technical specifications for High Pressure Breathing Compressor

- a) Output pressure: 200-300 bar





- b) Output flow rate: 100-300 liters per minute
- c) Power source: Electric motor or gasoline engine
- d) Operating noise level: 70-80 decibels
- e) Cooling system: Air-cooled or water-cooled
- f) Filtration system: Four-stage filtration for removing moisture, oil, and other impurities
- g) Dimensions: Varies based on the model and manufacturer
- h) Weight: Typically, between 100-200 kilograms
- i) Additional features: Automatic shut-off, overheat protection, and pressure relief valve.

1.3.2.10. Under Water Communication Set

Underwater communication sets are crucial equipment for effective communication between divers during an emergency situation or in underwater construction projects. These sets help divers to stay in touch with each other and their surface team, providing a means to communicate vital information and instructions, ensuring safety and improving overall efficiency. In the case of an evacuation plan for a monument located near the sea shore, an underwater communication set is a necessary addition to the safety equipment.



Figure:3.14 – Under Water Communication Set

Technical specifications for Under Water Communication Set

- a) Frequency range: 27.995 - 31.000 MHz
- b) Operating range: Up to 1000 meters underwater
- c) Maximum depth rating: 60 meters
- d) Audio power output: 2 Watts
- e) Power supply: 12V DC rechargeable battery





- f) Operating temperature: -10°C to +50°C
- g) Microphone sensitivity: -60 dB +/- 2 dB
- h) Headphone sensitivity: 105 dB +/- 5 dB
- i) Weight: 2.5 kg
- j) Dimensions: 320mm x 260mm x 200mm

1.3.2.11. Under Water Torch

An underwater torch is an essential piece of equipment for any diving operation, particularly in low light conditions or during night dives. It allows divers to see clearly and navigate effectively in the dark underwater environment. Additionally, in emergency situations, an underwater torch can be used to signal for help or to search for missing equipment or personnel. For the evacuation plan of a monument located near a sea shore, having one or more underwater torches available can ensure that divers can perform their tasks safely and effectively.

Technical specifications for Under Water Torch

- a) Light Output: A minimum of 500 lumens is recommended for effective underwater use
- b) Beam Distance: The torch should be able to project a beam of light at least 50 meters in clear water conditions
- c) Battery Life: The battery life should be sufficient to last for the entire dive or emergency situation, with a minimum of 2-3 hours of continuous use
- d) Waterproof Rating: The torch should have a minimum waterproof rating of IPX8, meaning it is fully submersible and can withstand depths of at least 30 meters
- e) Material: The body of the torch should be made of a durable, corrosion-resistant material such as anodized aluminum or stainless steel to withstand the harsh underwater environment
- f) Switch Type: A reliable, easy-to-use switch is important for quick and accurate operation of the torch in emergency situations
- g) Size and Weight: The torch should be compact and lightweight enough to be easily carried by divers without interfering with their movements or buoyancy control. A weight of less than 500 grams is recommended.





1.3.3. SEA RESCUE EQUIPMENT

1.3.3.1. Inflatable Rafts

Offshore inflatable rafts, also known as life rafts, are critical safety equipment used on offshore platforms to provide a means of emergency evacuation in case of emergency situations.



Figure:3.16 – Inflatable Rafts

Technical specifications

- Capacity: The capacity of the life raft shall be for 25 number of passengers which shall accommodate the intended number of occupants comfortably and safely.
- Construction: The life raft should be constructed from durable materials that are resistant to punctures, abrasion, and degradation from environmental factors such as saltwater and UV radiation. It may have multiple air chambers to provide redundancy in case of puncture or damage to one chamber.
- Inflation System: The life raft should be equipped with a reliable inflation system that can be activated manually or automatically, depending on the type of emergency. This may include CO₂ cylinders, compressed air, or other inflation methods, and it should be designed to inflate the raft rapidly and efficiently.
- Stability and Buoyancy: The life raft should provide sufficient buoyancy and stability to remain afloat and upright in the water, even in rough sea conditions. It should be designed to prevent capsizing and provide a stable platform for occupants to board and remain in while awaiting rescue.
- Ballast System: The life raft may have a ballast system to provide stability and prevent drifting, especially in windy or current-prone conditions. This may include water ballast bags or other mechanisms to anchor the life raft in place.
- Canopy or Cover: The life raft may be equipped with a canopy or cover to provide protection from the elements such as sun, wind, rain, and spray, to help prevent hypothermia and dehydration.
- Boarding and Exiting: The life raft should have boarding and exiting features such as boarding ramps, ladders, or other means to facilitate safe entry and exit for occupants, including injured or disabled persons.





- h) Visibility and Signaling: The life raft should have high-visibility markings, such as bright colors, reflective tape, or signaling devices, to aid in locating the raft in the water and attracting attention from rescuers.
- i) Equipment and Supplies: The life raft should be equipped with essential survival equipment and supplies, such as emergency rations, drinking water, first aid kits, signaling devices (such as flares and whistles), and other necessary items to sustain occupants during an extended evacuation period.
- j) Training and Instructions: The life raft should be accompanied by clear and easy-to-follow instructions for inflation, deployment, and use. Crew members should receive appropriate training on how to operate the life raft in emergency situations.
- k) Serviceability: The life raft should be serviceable, with provisions for regular inspection, maintenance, and replacement of components as needed to ensure its continued reliability and functionality.
- l) Visibility and Signaling: The raft should have high-visibility markings, such as bright colors, reflective tape, or signaling devices, to aid in locating the raft in the water and attracting attention from rescuers.
- m) Self-Draining: The raft may be designed to be self-draining to allow any water that enters the raft to drain out automatically, keeping the interior dry and reducing the risk of swamping

1.3.3.2. Inflatable Motor Rescue Boat with OBM

Inflatable Motor Rescue Boat with OBM is an essential equipment for any evacuation plan in a sea shore. It is designed to provide swift and safe transportation in case of emergencies like natural calamities, accidents, or any other unforeseen events. The boat is designed with high-quality materials, making it lightweight, durable, and easy to maneuver in rough waters. The inflatable nature of the boat allows for quick deployment and easy storage when not in use. With the outboard motor, it can swiftly move through water and rescue people in distress.



Figure:3.17 – Inflatable Motor Rescue Boat with OBM

Technical specifications for Inflatable Motor Rescue Boat with OBM

S.No.	Specifications	Motor Rescue Boar 10 seated	Motor Rescue Boar 20 seated
1.	Seating Capacity	10 people	20 people
2.	Material	High-quality PVC or Hypalon	High-quality PVC or Hypalon
3.	Length	4.5 – 5.5 Meters	7 – 8 meters





4.	Engine	Outboard Motor with 40 – 50 HP	Outboard Motor with 40 HP
5.	Fuel Capacity	Sufficient for a minimum of 4-5 hours of operation	Minimum 80 liters
6.	Inflation time	Less than 10 min	
7.	Maximum Speed	20 – 25 knots	25-30 knots
8.	Features	Navigation lights, rescue equipment storage, and carrying handles	
9.	Accessories	Paddles, air pump, and repair kit	

1.3.3.3. Life Buoys

Life buoys are an important safety equipment to have in any emergency situation, especially near water bodies like the sea. They are designed to keep a person afloat and visible until help arrives. The life buoys used in the evacuation plan for a monument near the sea shore must comply with the relevant safety standards and regulations. They should be made of durable and buoyant material with a bright color for easy visibility. The size and weight of the life buoy should be suitable for easy handling by both swimmers and rescuers. The life buoy should also have appropriate markings such as the name of the monument and its location.



Figure:3.18 – Life Buoys

Technical Specifications

- a) Material: Buoyant and durable material such as polyethylene foam, polyurethane foam, or cork.
- b) Shape: Circular shape with a diameter of 24 inches or as per regulations.
- c) Weight: Approximately 2.5 to 3.5 kg, depending on the material used.
- d) Color: Bright orange, yellow or red for high visibility.
- e) Markings: Clearly visible markings indicating the name and location of the monument.
- f) Accessories: A rope of minimum 30 meters length and a minimum diameter of 8mm, attached to the life buoy for easy retrieval.





- g) Standards: Compliance with relevant safety standards and regulations.

1.3.3.4. Synthetic Life Jackets

Synthetic life jackets are an important safety equipment for any evacuation plan near the sea shore. They are designed to provide buoyancy and keep a person afloat in the water, providing vital time for rescue operations.



Figure:3.19 –Synthetic Life Jackets

Technical specifications for synthetic life jackets include:

- Material: Synthetic life jackets are typically made from materials such as nylon, neoprene, or polyester.
- Buoyancy: The buoyancy of the life jacket is measured in Newtons (N) and should be chosen according to the weight and body size of the person wearing it.
- Size: Life jackets come in different sizes to fit different body types, and it is important to select the correct size to ensure proper fit and buoyancy.
- Closure: Most life jackets have a zip or buckle closure for a secure fit, and some also have adjustable straps for a customizable fit.
- Reflective material: Many life jackets have reflective material on the front and back to aid visibility in low-light conditions.
- Whistle: Some life jackets come with a whistle attached, allowing the wearer to attract attention in case of an emergency.
- Maintenance: Synthetic life jackets should be maintained and serviced regularly to ensure that they are in good working condition when needed.





1.3.3.5. Inflatable Bridges and Launching Pad

Inflatable bridges are a type of temporary or emergency bridge that utilize inflatable elements for buoyancy and support. They are designed to be quickly deployed and provide a temporary solution for bridging gaps, such as rivers, creeks, or other obstacles, where a permanent bridge may not be available or feasible. Here are some general technical specifications that may be considered for inflatable.



Figure:3.20 –Inflatable bridges and Launching pad

- a) **Inflatable Elements:** The bridge consists of inflatable elements, typically made of durable materials such as high-strength fabric or reinforced rubber, that are inflated to provide buoyancy and support. The inflatable elements should be designed to withstand the expected loads and stresses associated with the bridge, including the weight of vehicles, pedestrians, and other loads.
- b) **Modular Design:** Inflatable bridges are often designed in modular sections that can be easily assembled and disassembled. Modular design allows for flexibility in adapting the length and width of the bridge to suit different requirements and locations. The modular sections should be securely interconnected to provide a stable and reliable bridge.
- c) **Anchoring and Stability:** The inflatable bridge should be anchored securely to the ground or other stable structures to prevent drift or movement. Anchoring systems, such as stakes, anchors, or other suitable means, should be provided to ensure stability and prevent the bridge from being carried away by currents or other environmental forces.
- d) **Load Capacity:** The inflatable bridge should be designed to withstand the expected loads and stresses associated with its intended use, such as the weight of vehicles, pedestrians, and other loads. Load capacity should be clearly specified and adhered to in order to ensure safe and efficient operations.
- e) **Decking and Surface Treatment:** The deck or surface of the inflatable bridge should be designed to provide a safe and non-slip surface for users, including pedestrians and vehicles. It should be resistant to wear and tear, and may include features such as handrails or fendering to enhance safety and functionality.
- f) **Inflation System:** The inflatable bridge should be equipped with a reliable and efficient inflation system that allows for quick and easy inflation of the inflatable elements. The inflation system should be designed to provide sufficient pressure and stability to the inflatable elements to ensure proper buoyancy and support.





- g) **Transportation and Storage:** The inflatable bridge should be designed for ease of transportation and storage, as it may need to be deployed in remote or emergency situations. Portable and lightweight design, as well as provisions for transportation and storage, such as carrying cases or containers, may be considered.
- h) **Environmental Considerations:** The inflatable bridge should be designed with consideration for the local environment, including factors such as water quality, wildlife habitat, and other ecological considerations. Measures may be incorporated, such as low-impact anchoring systems or eco-friendly materials, to minimize environmental impacts.
- i) **Compliance and Regulations:** The inflatable bridge should comply with relevant regulations, guidelines, and standards for safety, construction, and environmental protection, as applicable in the specific location and industry in which it is being used. It's important to consult with relevant authorities and adhere to applicable regulations during the design, deployment, and operation of the inflatable bridge.
- j) **Maintenance and Serviceability:** The inflatable bridge should be designed for ease of maintenance and serviceability, including provisions for inspection, cleaning, and repair. Replaceable components and spare parts should be readily available and easily accessible.

