BEFORE THE NATIONAL GREEN TRIBUNAL

SOUTHERN ZONE, CHENNAI

Original Application No. 146 of 2024 (SZ)

In the matter of:

R Pratima. ... Applicant(s)

Versus

The Tamil Nadu Coastal Zone Management Authority
and ors.

...Respondent(s)

REPORT FILED BY 1ST RESPONDENT – THE TAMIL NADU COASTAL ZONE MANAGEMENT AUTHORITY.

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Through

Dr. D. Shanmuganathan

Standing Counsel of Govt. of Tamil Nadu

National Green Tribunal

Southern Zone, Chennai

DATE: 22.02.2025

BEFORE THE NATIONAL GREEN TRIBUNAL (SOUTHERN ZONE)

AT CHENNAI

Original Application No. 146 of 2024

R. Pratima

W/o. (Late) V. Ram Mohan

No.399, Kathivakkam High Road,

Ennore, Tamil Nadu 600057

Residing at

1B, Dewside Manor,

58, Mc Nichols Road, Chetpet, Chennai - 600031

Ph.: 9566254546

Email :yogeshwaranadv@gmail.com

.....Applicant

Versus

1. The Tamil Nadu Coastal Zone Management Authority
   Rep by its Member Secretary
   No.1, Jeenis Road, Panagal Building,
   Ground Floor, Saidapet, Chennai-600 015
   Email : tndoe@tn.nic.in Phone : 044 – 24336594
2. The Public Works Department
   Government of Tamil Nadu
   Rep by its Secretary, Fort St George, Chennai
   Phone: 25673040 Email: pwdsec@tn.gov.in
3. Tamil Nadu Pollution Control Board,
   Rep. by its Chairperson,
   No.76, Mount Salai,
   Guindy, Chennai-600032
   Ph No. 044 – 22353076, Email: grievance@tnpcb.gov.in
4. The Chennai Petroleum Corporation Limited
   Rep by its Managing Director
   New No:536, Anna Salai,

Deputy Director (Land Use)
Department of Environment & Climate Change
- Chennai

Director,
Department of Environment and Climate Change,
Chennai - 15

Teynampet Chennai 600 018
Phone:044-24349833, email: pro@cpcl.co.in .....Respondents

REPLY AFFIDAVIT FILED BY THE 1st RESPONDENT

I, A.R. Rahul Nadh., I.A.S., S/o Regunadh A.K, aged about 36 years and having office at Panagal Maaligai, Saidapet, Chennai – 600 015 solemnly affirm and sincerely state as follows,

1. I humbly submit that I am the Director, Department of Environment and Climate Change and also the Member Secretary, Tamil Nadu State Coastal Zone Management Authority (TNSCZMA) and I am well acquainted with the facts of the case from the records available and I am filing this reply in my official capacity on behalf of 1st respondent.

2. I humbly submit that I have gone through the averments contained in the affidavit filed by the Applicant and I deny all the averments except those that are specifically admitted herein and the Applicant is put to strict proof of the same.

3. I humbly submit that the applicant has filed the Original Application seeking clean-up and remediation of her lands in S.No. 239/1A2A1, 239/1A2A2, 239/1A2A3, 239/1A2A8A and 16/1B, Kathivakkam Village, Ennore, on either side of the VNC bridge.

4. It is humbly submitted that an oil slick was formed in Ennore Creek in North Chennai following heavy rainfall for 36 hours from 03/12/2023 due to cyclone Michaung, which caused severe flooding in the State capital and neighboring districts.

5. It is further submitted that Coast Guard District No.5 had informed that they found the traces of oil slick mixed with floodwaters near Ernavur in Thiruvottriyur of Chennai District on 05/12/2023 & 06/12/2023.

6. In view of the above, a team of officials from Environment, Climate Change & Forest Department led by the Additional Chief Secretary to Government, Environment, Climate Change and Forests carried out the

Deputy Director (Land Use)
Department of Environment & Change
Chennai

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Department of Environment and Climate Change,
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restoration activities to clean the oil spill in Ennore creek. These activities continued until the last week of December 2023.

7. It is respectfully submitted that, following the restoration activities to know the extent of damage and the nature of damage caused due to oil spillage to the creek / Estuarine and marine ecosystem as well as to the adjoining areas especially the mangrove forest and the surroundings, the Department of Environment and Climate Change has engaged the Environmental & Water Resources Engineering, Department of Civil Engineering, IIT Madras for conducting study on "Environmental Impact Assessment of Oil spill affected areas at Ennore Creek".

8. Further, the Department of Environment and Climate Change received a proposal from Dr. Indumathi Nambi, Professor, Environment and Water Resource Division, Department of Civil Engineering, IIT Madras, to conduct Phase I: Assessment of Oil Spill and Suggestion for Remediation and Restoration, and Phase II: Environmental Impact Assessment and Suggestion for Mitigation of Damage and Prevention of Oil Spill in Kosasthalaiyar Basin. The objective of the study is to provide a holistic, unambiguous, and unbiased report on the conditions observed, measured, and analyzed.

9. It is humbly submitted that the Department of Environment and Climate Change received fund from the Tamil Nadu Pollution Control Board (TNPCB) for the above study.

10. It is humbly submitted that most of the Phase I work has already been completed by IIT Madras. Phase II is currently in progress.

11. It is humbly submitted that IIT Madras has scientifically surveyed the impacted area through boat, road, and drone. Field measurements of water depth, oil stains, and flow velocity were conducted, and water quality parameters such as pH and TDS were monitored on-site. Soil samples, water, and oil sludge were analyzed in the laboratory. The samples were tested for Total Petroleum Hydrocarbons (TPH) and

Deputy Director (Land Use)
Department of Environment & Climate Change
Chennai

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Polycyclic Aromatic Hydrocarbons (PAHs). Additionally, Differential GPS (DGT) was used to survey the oil-inundated areas to measure the height and area extent of the oil spread. Apart from physical surveys on land, the spill assessment was conducted using two drone surveys equipped with high-resolution cameras and hyperspectral cameras.

12. It is respectfully submitted that IIT Madras has submitted a report titled "Oil Spill Assessment in the Environment in & Around Ennore Post Flooding 2023" (Annexure - I) and a Preliminary Assessment Report (Annexure - II) on April 24, 2024. The final report, after the restoration work is completed and followed by post-restoration monitoring, is yet to be received from IIT Madras.

13. It is humbly submitted that the oil spill restoration activities in the Ennore Creek were carried out by the Tamil Nadu Pollution Control Board (TNPCB). TNPCB not only undertook extensive restoration efforts but has also established a robust framework for continuous monitoring to ensure that no residual contamination poses a threat to the ecosystem. Furthermore, the clear and detailed recommendations provided by IIT Madras, encompassing strategies for remediation, restoration, and precautionary measures to mitigate environmental damages, will serve as a vital resource for the TNPCB in devising a comprehensive plan of action. These recommendations will be meticulously reviewed and implemented by TNPCB to ensure long-term environmental sustainability and to prevent future incidents of similar nature.

It is therefore humbly prayed that this Hon'ble Tribunal may be pleased to record the above-mentioned facts and pass such further order or orders as this Hon'ble Tribunal may deem fit and proper in the interest of justice.

Solemnly affirmed at Chennai
This the 20th day of December 2024
and signed his name in presence

Deputy Director (Land Use)
Department of Environment & Climate Change
Chennai

BEFORE ME
Director,
Department of Environment and Climate Change,
Chennai - 15

Annexure - I

5

ASSESSMENT OF ENNORE OIL SPILL DURING MICHAUNG CYLCONE

March 2024

Environment Engineering Division

Department of Civil Engineering

Indian Institute of Technology Madras, Chennai – 600036

Executive Summary

The "MICHAUNG" cyclonic storm caused extensive oil spillage from Chennai Petroleum Corporation Limited (M/s CPCL). The resulting contamination adversely affected biodiversity, daily life, and livelihoods in the impacted regions. IIT Madras research team conducted a comprehensive field assessment, mapping oil contamination across 20 zones. Notable hotspots included stormwater outlets of M/s CPCL, residential areas and industrial areas in Ennore. Field surveys, mapping efforts using drones, questionnaire surveys provided deep insights into the extent of oil contamination. Oil pools, sheens, and stains were observed in residential, industrial, and natural areas, threatening biodiversity, and public health.

Two sources of the oil spill into the environment were identified. One being the storm water discharge outlet at the south-eastern wall of CPCL into the Buckingham Canal and the other being the storm water canal discharging into surplus canal of Kosasthalaiyar River. The flood levels of the Kosasthalaiyar River rose to 5 to 6 ft above the Buckingham Canal bund level causing the entry of oil and water into the adjoining residential areas of Ernavoor and Sathyamoorthy Nagar. The mangroves along the banks and the islands in Kosasthalaiyar River were impacted up to a height of 10 ft near the surplus canal and 3 ft in other areas with complete loss of mangrove saplings. The team observed several dead fish and crabs and oil coated birds.

Laboratory analysis of water, soil and sediment samples revealed Total Petroleum Hydrocarbon (TPH) concentrations ranging from 0.28 to 7.21 g/L in water and 13.6 to 46.55 g/kg in sediments. The estimated volume of oil contamination in the environment ranged from 517 tonnes to 2097 tonnes without including oily sludge collected by CPCL and oil in inaccessible islands and sediments of Kosasthalaiyar River. The oil estimates from our assessment (517 tonnes) and the oily sludge removed by CPCL (395 tonnes) together sums up to 912 tonnes without including the inaccessible areas and bottom sediments of B Canal and K river. Fingerprinting analysis using GC-MS suggests that it could be slop oil or furnace oil or mix of both.

The Tamil Nadu Pollution Control Board's survey of M/s CPCL premises has suspected breaches in stormwater drainage systems and potential risks associated with oil storage and handling practices. An assessment of the open tanks in M/s CPCL premises indicated that 417 tonnes of oil could have been stored before flooding which is much less than 912 tonnes of oil estimated. This mismatch suggests that the flood induced release from the open tanks

may not have been the sole reason of the oil spill. Other possibilities could be breach of oil from enclosed storage tanks of CPCL premises. Urgent remedial actions are imperative to mitigate the environmental and socio-economic consequences of this oil spillage. Efforts should focus on environmental restoration, alongside regulatory measures to enhance industrial safety.

Contents

1. Introduction

A severe cyclonic storm named "MICHAUNG" which formed over the Bay of Bengal, resulted in exceptionally heavy rainfall in the coastal districts of North Tamil Nadu and South Andhra Pradesh states (IMD, 2023). Chennai city experienced significant rainfall, with the Nungambakkam Meteorological Station recording a maximum of 530 mm between December 2 and 4, 2023. This extreme weather event had detrimental effects on the daily lives, livelihoods, and biodiversity of the affected regions.

Chennai Petroleum Corporation Limited, also known as CPCL, which stands as one of the foremost public sector refining companies in India, found itself at the centre of another crisis. Cyclone Michaung led to the leakage of oil deposits from M/s CPCL's guard ponds and stormwater drain ponds. These deposits were released on the flood plains of Kosasthalaiyar River and into the Buckingham Canal. The oil was carried along with the flood water through these waterways ultimately reaching the Ennore Creek and contaminating the Bay of Bengal.

The IIT Madras research team started their field campaign to assess the oil spill contaminations in water and sediments for a 12 km stretch in Buckingham Canal. The field campaign encompassed various activities, including flow measurements in Buckingham Canal, the collection of water and sediment samples, and mapping the spread of oil contamination in the affected area. This preliminary assessment report provides in-depth findings from both field investigations and laboratory analysis, offering insights into the severity of the oil spill contamination. Additionally, it provides a summary of the coast guard's estimation of the oil spill, along with insights gathered from the Tamil Nadu Pollution Control Board (TNPCB) Committee Report.

Figure 1: Oil spread near Ennore railway bridge

Figure 2: Oil contamination in Buckingham Canal

2. Mapping the Extent of Oil Contamination

IITM started their on-site investigations after the first response measures undertaken by CPCL. By then, oily sludge of 395 tonnes floating on the river and the banks were contained using booms and removed using skimmers (The Hindu Bureau, 2023). During our physical

survey by boat and by road between 14th and 26th December 2023, we observed oil marks along the banks of the Kosasthalaiyar River (K River) and the Buckingham Canal (B Canal), identifying 20 zones where oil accumulation was notably high.

Zone 1: Entry Point 1 - Storm water canal discharge into surplus canal of Kosasthalaiyar River
Zone 2: Kattukuppam
Zone 3: B/w railway and road bridge
Zone 4: Near Ennore railway bridge
Zone 5: Thazhankuppam
Zone 6: Ennorekuppam
Zone 7: Nettukuppam
Zone 8: Bridge pier/island in K River - Sadayankuppam
Zone 9: Oil overflowed along B Canal
Zone 10: In mangrove islands
Zone 11: Ernavoor and Sathyamoorthy Nagar residential area
Zone 12: Ernavoor and Sathyamoorthy Nagar industry/marsh accessible areas
Zone 13: Storm water drain outside M/s CPCL
Zone 14: Storm water drains inside M/s CPCL
Zone 15: Land area within M/s CPCL, IAL, Steel
Zone 16: Oil staining the soil embankment in B Canal and K River
Zone 17: Oil staining the mangroves
Zone 18: River and canal sediments
Zone 19: Marine sediments and oil lost to sea
Zone 20: Entry Point 2 - Storm water discharge outlet at the south-eastern wall of CPCL into the Buckingham Canal

There was a large amount of oil stagnation near Ennore Creek (Zone 19) due to the combination of tidal activity and the river mouth's influence. In this season, the wave and tidal movements tend to carry particles toward the shoreline in a southwest direction. As a result, it takes longer for substances such as oil, to be dispersed back into the ocean. Zone 1 is a hotspot where a large influx of oil came from the storm water drain from M/s CPCL, entering the floodplains of K River, and eventually contaminating the river. In all the

accessible zones we had collected soil, water and some river sediment samples and quantified the oil that had been contaminated.

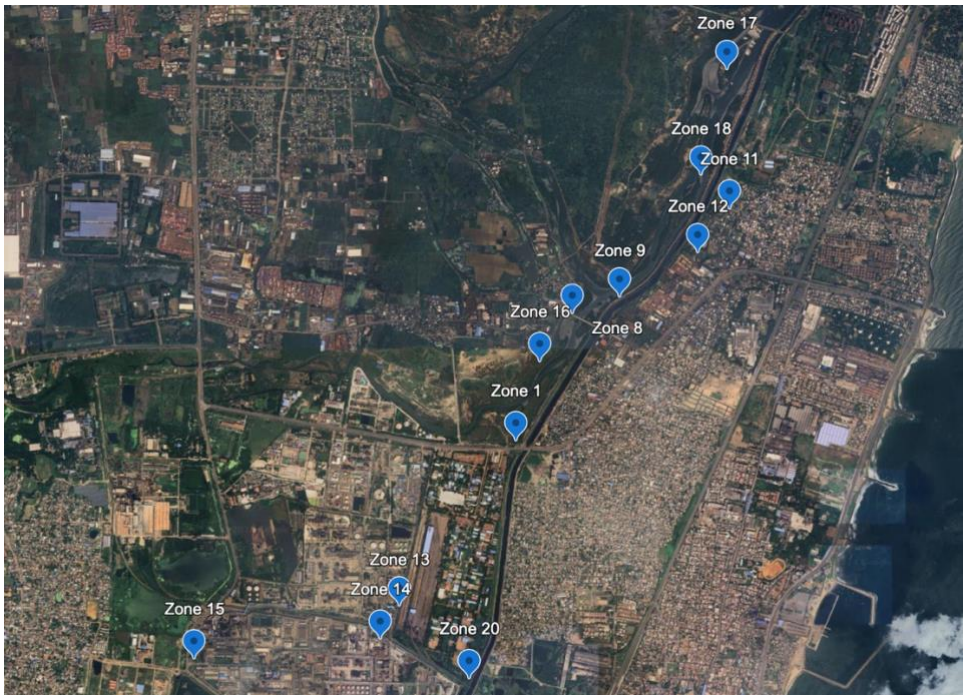


Figure 3: Contamination Zones from CPCL premises to the midstream of Buckingham Canal

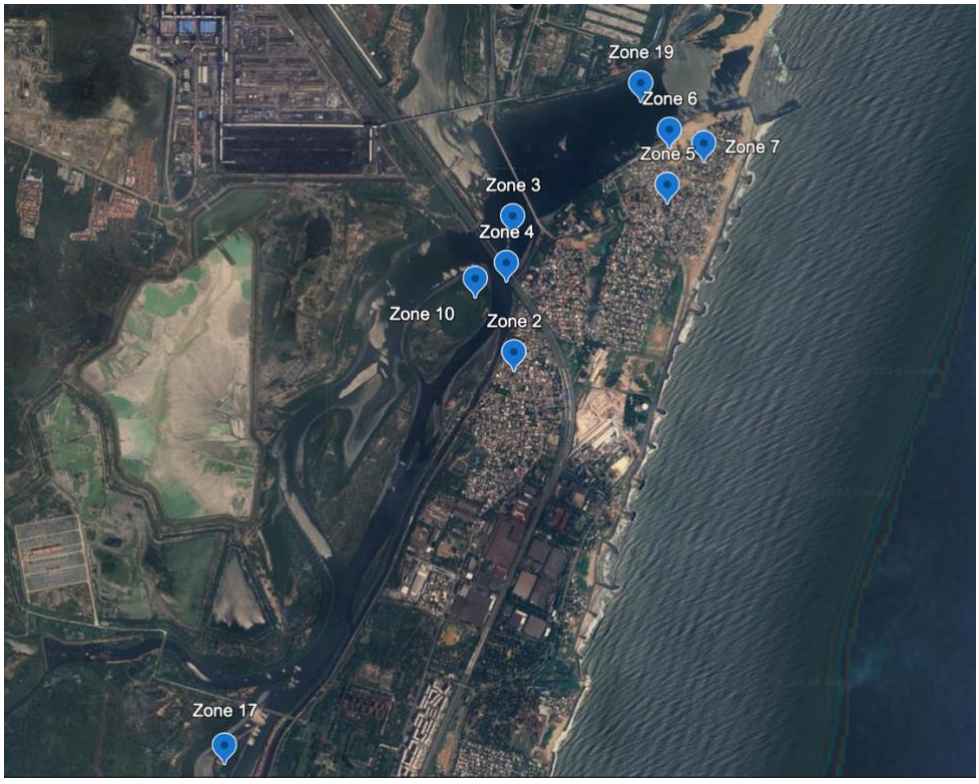


Figure 4: Contamination Zones from midstream of Buckingham Canal to Ennore Creek

During the flood event, B Canal experienced overflow of oil mixed water, inundating the residential areas of Ernavoor (Zone 11). Lamp posts positioned within the residential vicinity along the B Canal exhibited signs of oil spillage, while flood-affected houses showed oil stains on their walls, reaching heights of 5 to 6 feet. The overflowing oil mixed water adversely affected vegetation, residential buildings, vehicles, and the open wells that serve as sources of groundwater. The field images below provide visual representation of the extent of oil contamination within the residential zones of Ernavoor.

Figure 5: Highest oil mixed water level 7.5 feet above normal water level during the cyclone

Figure 6: Collection of samples from the oil overflown along the banks of B Canal.

Figure 7: Oil marks observed in the residential localities of Ernavoor.

Assessment Regions:

The extensive presence of heavy oil was detected in various locations along our route, indicating a significant spill. IIT Madras team surveyed along the B Canal and K river to identify the extent of the spill along the width and length of the waterways. We have divided the assessment regions to three stretches:

1. Downstream from Ennore Thermal Power Station (ETPS) to Creek:

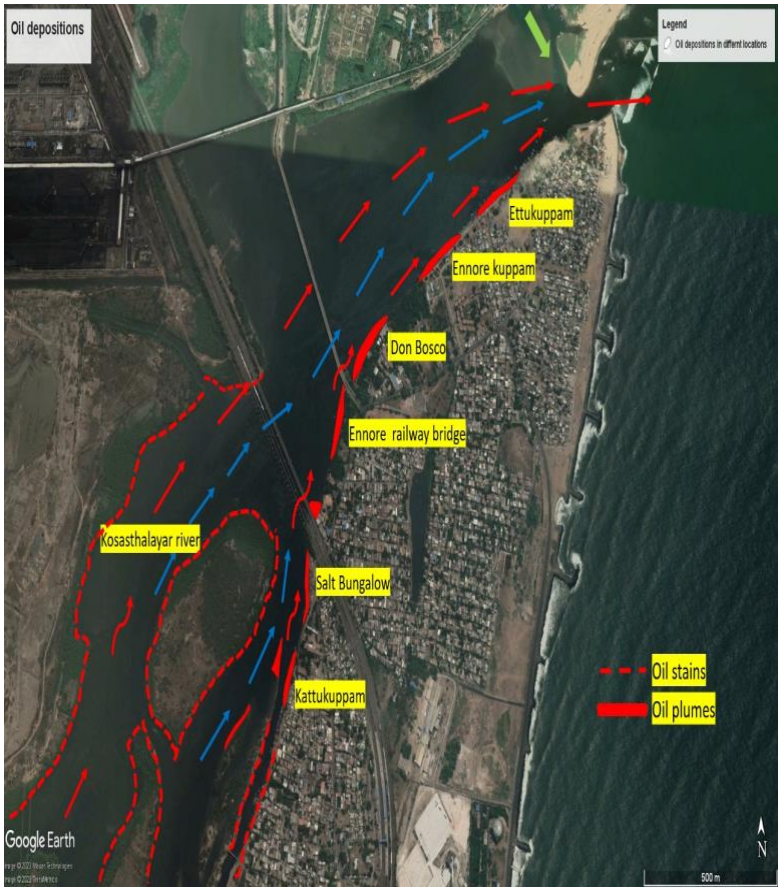


Figure 8: Assessment Region 1 - Downstream from ETPS to Creek Area

The depicted figure illustrates the flow of oil, represented by red arrows, along the B Canal and K River after the floodwaters receded. Dotted lines signify the presence of oil stains along all banks of these water bodies and islands. Hotspots, where substantial oil deposits occurred, are highlighted as red patches along the eastern banks of the Creek, extending from Kattukuppam to Nettukuppam.

2. Midstream from Ennore Thermal Power Station (ETPS) to Manali High Road Bridge:

The midstream stretch of B Canal extending from the junction of K River and surplus canal from Redhills up to ETPS is the crucial area to pay attention. The surplus from Puzhal and Poondi Lakes discharged high quantum of water into the two K River branches which trapped the oil in this mid-stream stretch. The flood water rose to 7 to 9 ft in this section carrying the

oil with it, over the B Canal bank into the adjoining residential and industrial areas of Ernavoor and Sathyamoorthy Nagar. Once the flood water/surplus water receded, the oil must have flown downstream into the Kattukuppam all the way to Nettukuppam.

Figure 9: Assessment Region 2 - Midstream From ETPS to Manali High Road Bridge

3. Upstream of B Canal from Manali High Road to Kodungaiyur

Two oil discharges from the M/s CPCL stormwater drain have occurred in the locations: one in the south (entry point 2), directly into the B Canal, and another in the north (entry point 1), flowing through the stormwater drain adjacent to India Additives, into the flood plains of K river (Zone 1 indicated by the large red patch). Stormwater drains within M/s CPCL were tracked, revealing breaches in the outlet and walls, with all drains and tanks heavily stained with oil. Numerous open oil-water collection tanks were present at ground level, lacking preventive measures to contain oil during flooding or to prevent its escape from the premises.

Figure 10: Assessment Region 3 - Upstream of B Canal from Manali High Road to Kodungaiyur showing the entry point of oil into the Buckingham Canal and Kosasthalaiyar River

The soil samples collected at Zone 1 had oil markings present up to 2m (max.) depth from the surface. This may have long-term impacts on the region as it is mostly an unconfined aquifer where there are possibilities of contamination of the ground water.

Figure 11: Drone image of Zone 1

Figure 12: Close up view of Zone 1

Verified through drone camera images, the dark patches in the above image signify the presence of oil pools surrounding the stormwater outlets flowing towards the K River. Extensive sampling of soil and water at this contaminated site revealed high oil content. Upstream from this contaminated site, deposits of oil-contaminated sludge are still present, likely resulting from backflow from this leakage point. However, no significant oil spill or sludge deposition was observed beyond 100 meters from this location, indicating that Zone 1 is likely the initial point of oil spillage or the source itself.

Figure 13: Earth moving machinery at the oil spill site

Figure 14: B canal possibly breached and oil stain covered.

Numerous earthmoving machines were on-site (Figure 13), along with several laborers tasked with covering the oil stains in the floodplain. Arrows pointing towards the two locations in the Buckingham Canal (Figure 14) distinctly indicate that the bund has been reworked following the oil spill, with one section appearing clean and the other section visibly stained with oil.

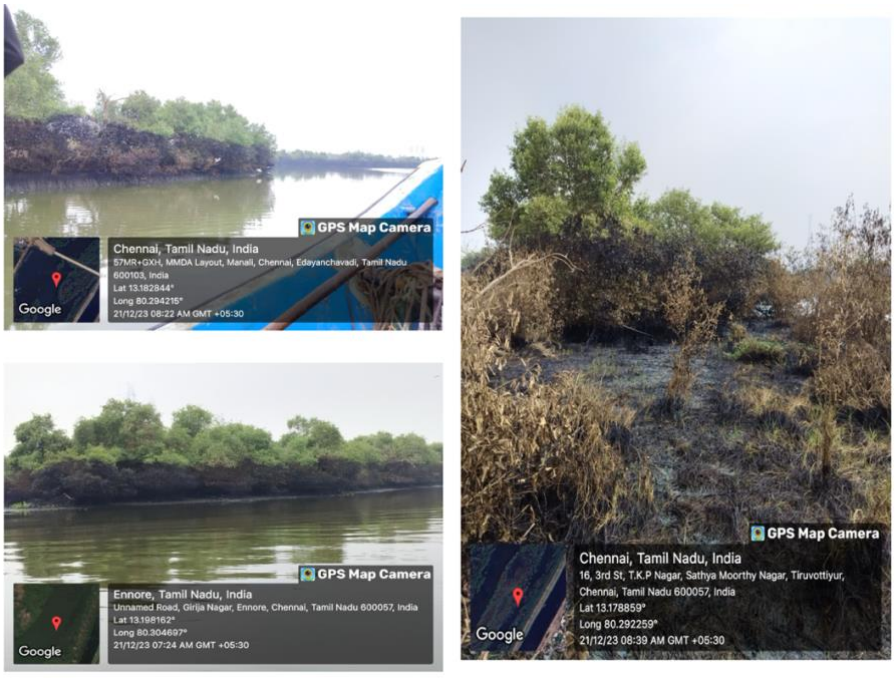


Figure 15: Mangroves with severe oil contamination

Figure 16: Dead birds, crabs, and fishes found in the contaminated site

The oil spill has posed a significant threat to biodiversity (Figure 15 and 16) in the affected area, impacting mangroves and various organisms such as crabs, fishes, and birds.

3. Field Assessments and Sampling

Field assessments were conducted along Buckingham Canal utilizing boats and by road in areas inaccessible by boat. Water and sediment samples were systematically collected at 500-meter intervals. Water samples, including any oil present, were obtained from both the top and bottom of the canal using a bailer. The depth of the canal was measured with a staff gauge, and flow velocity was assessed using an ultrasonic flow sensor. Sampling locations along a 12 km stretch from Indian Oil Cooperation Limited (IOCL) in Tondiarpet to Ennore Creek in Buckingham Canal are illustrated in Figure 2. Soil sediments and oil deposits were collected using a grab sampler and analysed in the laboratory for Total Petroleum Hydrocarbon (TPH) via gravimetry and gas-chromatography analysis.

Figure 17: Sampling locations along Buckingham Canal

Figure 18: Collecting sediment samples using a grab sampler

Figure 19: Sediment sample collection from midstream and banks

Figure 20: Depth measurement

Figure 21: Sampling of soil cores

Figure 22: Collecting water samples using a bailer

3.1 Drone Surveys

A drone survey was carried out to quantify the oil contamination spatially. Drones were employed to capture the hyper-spectral aerial images, that will help us differentiate water from oil. The drone images captured (Figure 24) show the oil sheen floating on B canal and K River.

Figure 23: Capturing high-resolution images using drone survey

Figure 24: Drone images showing oil contamination in B Canal and K River

3.2 Water Characteristics Measured Insitu:

In-situ water quality measurements, such as pH and total dissolved solids (TDS), were taken using a field probe, revealing pH values ranging from 7.4 to 8.0 and TDS values between 500 and 850 mg/L. The table below shows the insitu-water characteristics of the water samples.

Table 1: Insitu- water characteristics

Sample ID	Latitude	Longitude	Water level [m]	pH		TDS [mg/L]	
				Top water	Bottom water	Top water	Bottom water
SL 1	13.2200	80.31833	0.5	7.88	-	842	-
SL 2	13.21666	80.31638	1	7.97	7.80	804	855
SL 3	13.21305	80.31416	1	7.95	8.04	852	845
SL 4	13.20916	80.3125	1	7.92	7.99	844	840
SL 5	13.205	80.31027	1.5	7.88	7.94	824	824
SL 6	13.20217	80.30834	-				
SL 7	13.15433	80.28454	-	7.66	-	671	-
SL 8	13.1415	80.27866	-	7.63	7.73	683	700
SL 9	13.16015	80.2876	-	7.47	7.44	761	795
SL 10	13.16441	80.28916	-	7.7	7.65	740	744
SL 11	13.16938	80.28973	-	7.78	7.67	786	765
SL 12	13.17541	80.29114	-	7.61	7.54	733	752
SL 13	13.17923	80.29366	-	7.51	7.59	732	741
SL 14	13.18276	80.29591	-	7.66	-	634	-
SL 15	13.19324	80.30388	-	7.66	7.62	736	739
SL 16	13.18568	80.29944	-	7.87	7.72	759	751
SL 17	13.18949	80.30199	-	7.81	7.52	770	778
Nettukuppam	13.2311	80.32602	0.9	7.71	7.78	496	758
Thazhankuppam	13.22935	80.32321	0.8	7.77	7.68	581	624
DonBosco	13.22817	80.32137	0.6	7.93	8.00	457	498
EnnoreBridge	13.22726	80.3205	0.5	7.06	7.12	586	560
Salt Bungalow	13.22573	80.31999	0.7	7.04	7.11	536	924

3.3 Flow Measurement

Water flow measurements were carried out using an ultrasonic flow measurement device - FLOWFLAT. The velocity values ranged from 0.1 m/s to 0.7 m/s. The measurements were conducted in 10 locations within the B Canal and Ennore Creek at different depths based on the location's available flow depth. The table below summarises the velocity magnitudes in the B Canal and Ennore Creek.

Table 2: Velocity values in different locations of B Canal

ID	Velocity [m/s]	Depth of flow [m]	Depth of velocity measurement [m]
L2	0.255	0.5	0.15
	0.385		0.40
L3	0.645	1	0.40
	0.734		0.90
L4	0.334	1	0.30
	0.390		0.90
L5	0.400	1.5	0.50
	0.452		1.00
	0.496		1.20
L6	0.214	0.3	0.25
L7	0.308	0.15	0.10
L10	0.104	0.2	0.10
	0.117		0.15
L12	0.150	0.38	0.15
	0.472		0.35
Nettukuppam	0.214	0.9	0.30
	0.243		0.6
Thazhankuppam	0.105	0.8	0.3

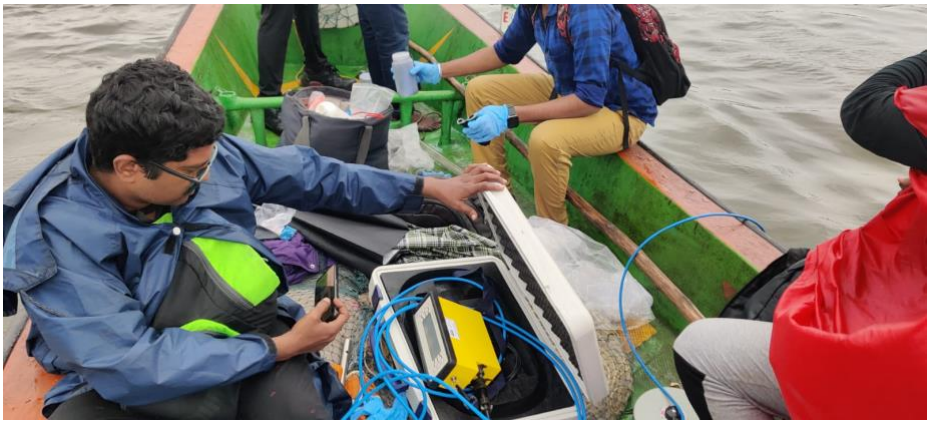


Figure 25: Water quality using field probe and flow measurement using FLOWFLAT

3.4 Flood Water Level Measurement at M/s CPCL Premises

The installation of water level meters at M/s CPCL by IIT Madras provided valuable data regarding the timing and extent of the peak water level, particularly noting the peak occurring on December 5th, 2023. This suggests that a significant influx of water has exacerbated the spread and impact of the oil spill in several ways.

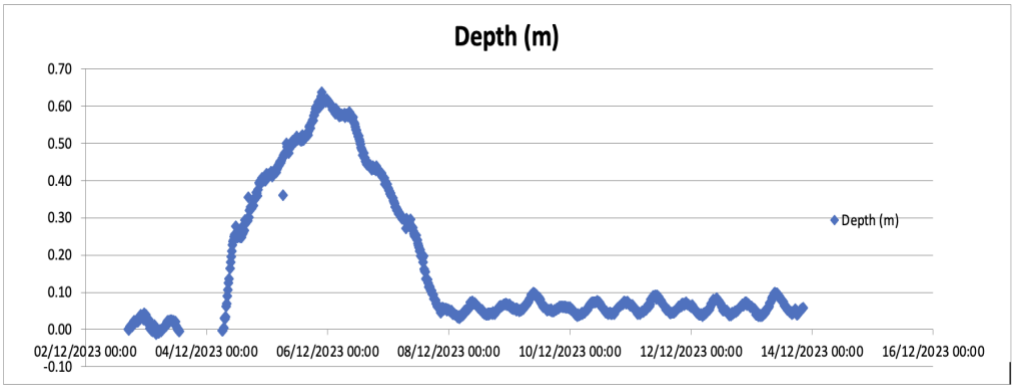


Figure 26: Water level metre at M/s CPCL West Gate

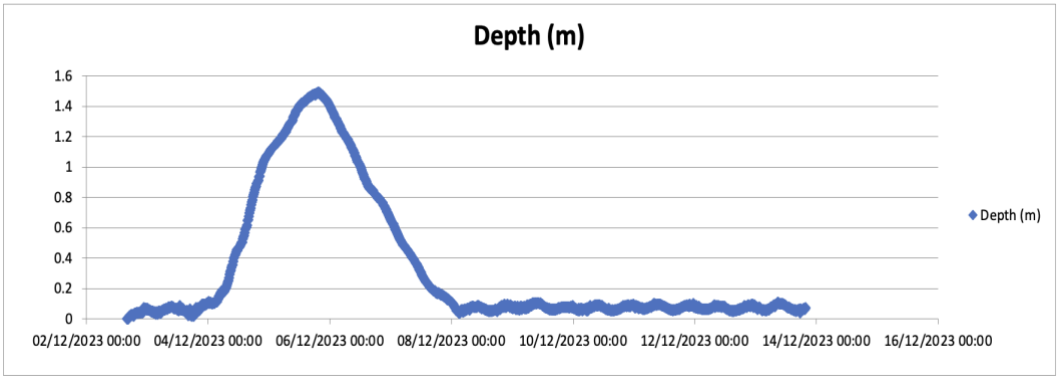


Figure 27: Water level metre at Bottling plant at CPCL

4. Laboratory Analysis

Oily sludge, a semi-solid waste, contains hazardous hydrocarbon substances and is composed of an emulsion of water, petroleum hydrocarbons, heavy metals, and solid particles. Water and sediment samples collected continuously over a three day period in various locations along the B Canal and Ennore Creek were subjected to analysis for Total Petroleum Hydrocarbon (TPH) utilizing both gravimetric and gas chromatography-mass spectrometry (GC-MS) methods. The TPH content in water ranged from 0.28 to 7.21 grams per litre (g/L), while in sediments, it ranged from 13.6 to 46.55 grams per kilogram (g/kg). These findings indicate the extent of hydrocarbon contamination in both the aquatic environment and sedimentary deposits within the affected areas.

Table 3: TPH concentrations in water and sediments/soil

Contaminations in 7 Zones which notably showed a high level of oil contamination		**Water**	**Sediment/Soil**
Location	**Area [sq.m.]**	**TPH conc (g/L)**	**TPH (g/Kg)**
Zone 1 Entry Point 1 - Storm water canal discharge into surplus canal of Kosasthalaiyar River	100601	1-2.27	13.6-30.44
Zone 2 (Kattukuppam)	3007	6.195 - 7.21	NA
Zone 3 (B/w railway and road bridge)	3163	5.32-7.13	18-31.8
Zone 4 (Near Ennore railway bridge)	2886	1.02-2.5	15.32-41
Zone 5 (Thazhankuppam)	5139	0.28-0.54	38-40.38
Zone 6 (Ennorekuppam)	3742	sample not collected	sample not collected
Zone 7 (Nettukuppam)	3232	2.45-3.01	46-46.55
Location	**Area [sq.m.]**	**TPH conc (g/L)**	**TPH (g/Kg)**
Buckingham Canal	121765	0.43-3.29	33-110
Kosasthalaiyar River	1032988	0.44-0.97	17-38.9
Residential areas near B Canal (oil pool)	11403	NA	24-120

Gas Chromatography Mass Spectrometry analysis was conducted to determine the type of oil that was spilled during the floods. A total of four samples, specifically the field sample, crude oil, furnace oil, and slop oil, were subjected to analysis using GC- MS. The chromatogram of the field sample was compared with those of crude oil, furnace oil, and slop oil to accurately identify the source of the oil. Upon examination of the chromatogram patterns, a precise retention time match was identified between the field sample and furnace oil. However, upon analysing the individual compounds in each chromatogram (across all four samples) for their m/z fragmentation pattern, it was noted that many compounds in the field sample (such as Decane, Dodecane, Tridecane, Hexadecane, Phytane, etc.) corresponded with those in slop oil and furnace oil. Consequently, it is plausible that the oil present in the flood water originated from either furnace oil or slop oil. To precisely identify the source of the oil type, bio-marker fingerprinting analysis is required.

5. Quantification of Oil in the Contaminated Areas

The total oil present in the major environmental compartments during our sampling events in the 19 zones can be summarized into five categories:

a. Oil present in soil:

The soil contamination extent was surveyed by boat and by road through physical investigation and through drone investigation to identify the impacted zones. The total area of the impacted zones were estimated using Google Earth Pro. The depth of soil contamination varied between 1-2.5 feet in Zone 1 to 8. Estimates referring to the results of laboratory analysis an average oil concentration of 30g/kg was considered for the estimates. The volume of oil that could be entrapped in the soil is within the range of 487 cu.m. to 1623 cu.m.

Table 4: Volume of oil estimated in soil

Oil contamination in Soil		**Volume of soil contaminated (cu.m.)**	**Mass of soil contaminated (kg)**	**Oil measured in soil (concentration ~30g/kg)**	**Oil in cu.m.**	**Assuming only 30% of the soil is contaminated**
Location	**Area (sq.m.)**	**Upto 1 foot depth cu.m.**				**Sn = 0.3**
Zone 1: Entry Point 1 - Storm water canal discharge into surplus canal of Kosasthalaiyar River	30296	9088.8	24085.32	722.55	903.19	**270.95**
Zone 2 (Kattukuppam)	3007	902.1	2390.56	71.71	89.64	**26.89**
Zone 3 (B/w railway and road bridge)	3163	948.9	2514.58	75.43	94.29	**28.28**
Zone 4 (near Ennore railway bridge)	2886	865.8	2294.37	68.83	86.03	**25.81**
Zone 5 (Thazhankuppam)	5139	1541.7	4085.50	122.56	153.20	**45.96**
Zone 6 (Ennorekuppam)	3742	1122.6	2974.89	89.24	111.55	**33.46**
Zone 7 (Nettukuppam)	3232	969.6	2569.44	77.08	96.35	**28.90**
Zone 8 (bridge pier/ island in K River near Sadayankuppam)	3000	900	2385	71.55	89.43	**26.83**
Total volume of oil in cu.m. accounted so far are conservative estimates.					1623.73	**487.12**

Figure 28: Soil Contamination Zones

Figure 29: Soil Contamination Zones

b. Oil pools in islands and B Canal overflow:

Oil was found ponding along the B Canal in the upstream stretch where maximum flood levels had taken the oil above the bank of the canal and into the eastern residential and industrial areas. Oil was also found ponding within the mangrove islands after the flood water receded. Largest oil ponding was observed in Zone 1. Area of the contamination zones for oil pools were estimated using Google Earth Pro. The volume of oil ponded could be anywhere between 31.4 cu.m. to 314 cu.m.

Table 5: Volume of oil estimated in oil pools

Oil pools in hotspots	Area (sq.m.)	1 mm ponding depth	5 mm ponding depth	10 mm ponding depth	Lowest Estimate (1mm)
Overflowed along B canal	11403	11.40	57.01	114.03	**11.40**
In mangrove islands	10000	10	50	100	**10**
Oil pool near pipelines	10000	10	50	100	**10**
Total volume of oil in cu.m.		31.40	157.01	314.03	**31.40**

Figure 30: Oil pools on K river flood plain

c. Oil sheen on B Canal and K River:

Oil sheen was found on B Canal and K river, where the volume of oil has been calculated for 10 micron and 50 micron sheen thickness. Area of the contamination zones for oil sheen were provided by the coast guard. A conservative estimate would be between 1.21 cu.m. to 10.32 cu.m for 10 micron thickness. It should be noted that CPCL has already removed major part of the oily sludge floating on the river using booms and skimmers amounting to 395 tonnes.

Table 6: Volume of oil as oil sheen estimated on B Canal and K River

Oil sheen in water courses from drone				
Location	**Area (sq.m)**	**Sheen thickness - 10 micron**	**Sheen Thickness - 50 micron**	**Lowest Estimate (10 micron)**
Buckingham Canal	121765	1.21	6.08	**1.21**
Kosasthalaiyar River	1032988	10.32	51.64	**10.32**
Total volume of oil in cu.m.			57.73	**11.54**

d. Oil present in residential and industrial areas:

A survey team was deployed to assess the spread of oil in the residential and industrial zone. The team marked the oil level and referenced it with Mean Sea level using DGPS survey at every location. Three levels of inundation with total area inundated and the oil level in each zone was marked in different colours.

The area under each zone is given below along with presumed depth of oil which was present when the flood water inundated their area. The average quantum of oil inundation is estimated as 117 cu.m. assuming only 0.1 mm of oil.

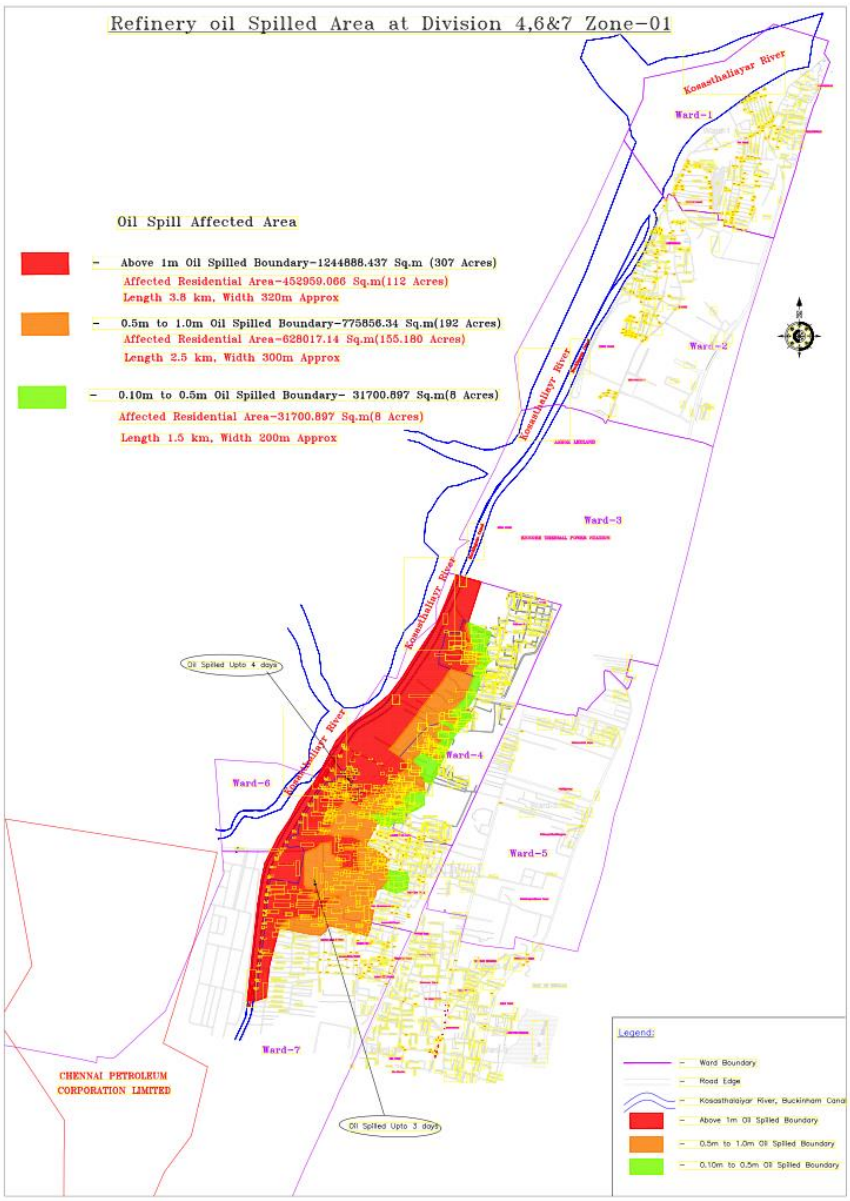


Figure 31: Map showing three levels of inundation

Table 7: Volume of oil estimated in residential and industrial areas

Oil mark in the residential areas (physical survey)	**Area [sq.m.]**	**0.1 mm oil layer**	**0.5 mm oil layer**	**1 mm oil layer**	**5 mm oil layer**	**Lowest Estimate (0.1 mm)**
Ernavoor high impact > 1m	452959	45.29	226.47	452.95	2264.79	**45.29**
Ernavoor medium impact 0.5 to 1.0.m	628017	62.80	314.00	628.01	3140.08	**62.80**
Ernavoor low impact <0.5 m	31700	3.17	15.85	31.7	158.5	**3.17**
Behind IOCL	66135	6.61	33.06	66.13	330.67	**6.61**
Total volume of oil in cu.m.		117.88	589.40	1178.81	5894.05	**117.88**

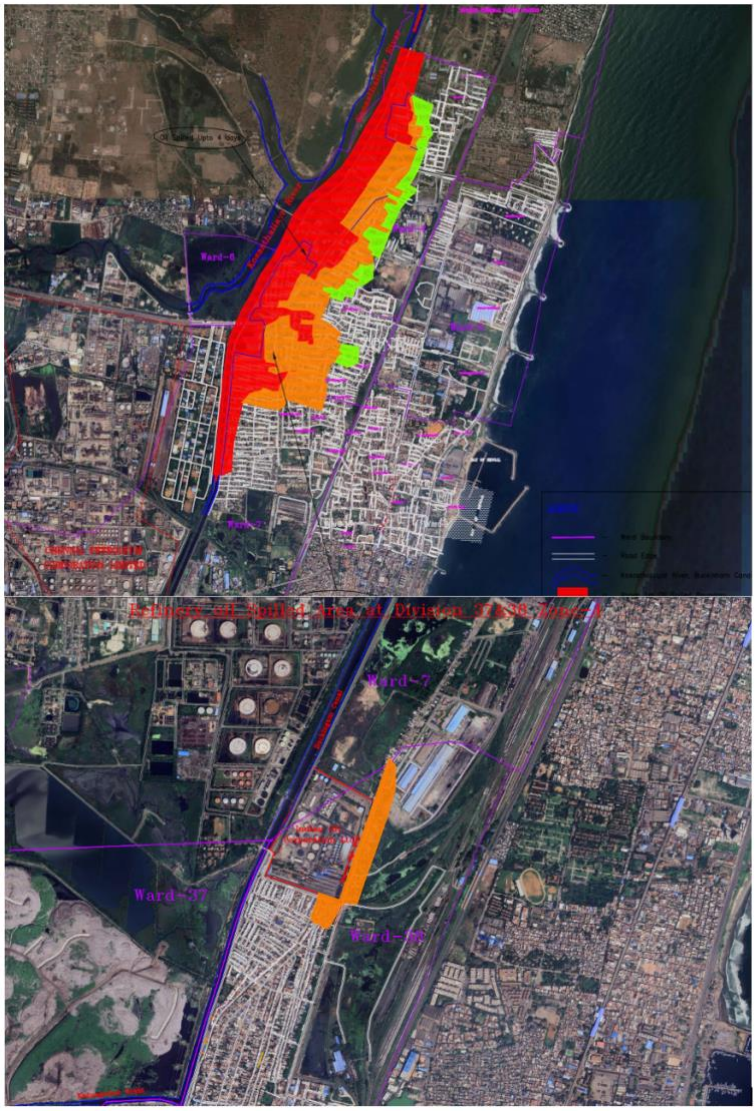


Figure 32: Close up view of the affected residential and industrial areas

e. Oil stains on mangroves and river banks:

Based on the observed length and height of the stains left behind on the banks of the K river and B canal, we estimated the oil on the river banks and mangroves assuming different thicknesses of oil layer starting from 0.01 mm, 0.1 mm and 1 mm. The average volume of oil inundation is conservatively estimated as 0.3849 cu.m. assuming only 0.01 mm of oil was floating on water.

Figure 33: Classifying the K river with the height of the oil mark in different stretches

Table 8: Volume of oil estimated on mangroves and river bank

Oil stain on banks	Length in km	Height of oil mark in m	0.01 mm	0.1 mm	1 mm	Lowest Estimate (0.01 mm)
Buckingham canal sections	15.1	0.3	0.04	0.45	4.53	**0.04**
Kosasthalaiyar section 1 (CPCL pipe line to B Canal intersection)	11.4	0.3	0.03	0.34	3.42	**0.03**
Kosasthalaiyar section 2 (CPCL pipeline to B Canal intersection)	5.8	0.3	0.01	0.17	1.74	**0.01**
Kosasthalaiyar section 3 (CPCL to Kaatukuppam)	4.7	0.3	0.01	0.14	1.41	**0.01**
Ennore Creek (Kattukuppam to Kosathalaiyar River mouth)	1.9	0.3	0.0057	0.057	0.57	**0.0057**
Oil stain on mangroves						
Kosasthalaiyar section 1, 2ft oil mark	11.4	0.6	0.068	0.68	6.84	**0.068**
Kosasthalaiyar section 2, 5ft oil mark	5.8	1.5	0.087	0.87	8.7	**0.087**
Kosasthalaiyar section 3, 8ft oil mark	4.7	2.4	0.11	1.12	11.28	**0.11**
Total volume of oil in cu.m.			0.38	3.84	38.49	**0.38**

Overall Estimates:

The oil present in the environment as observed between December 14th TO 24th, 2023 and reconfirmed on February 22nd, 2024 based on our best possible estimates and accessibility are below:

a. Oil present in soil – Estimated between 487 to 1623 cu.m. (*Not including M/s CPCL land area, inaccessible industry areas and marsh areas)
b. Oil pools in islands and B canal overflow – Estimated between 31.4 cu.m. to 314 cu.m.
c. Oil sheen on B Canal and K River: Estimated between 11.55cu.m. to 57.74 cu.m.
d. Oil stains and inundation in residential area – Estimated between 117 to 589 cu.m.
e. Oil stains on mangroves and river banks – Estimated between 0.3849 to 38.49 cu.m.

In summary the oil present in the environment is 647 cu.m. or 517 tonnes (most conservative) to 2622 cu.m. or 2097 tonnes (least conservative). The range is provided here considering the uncertainty of the depth of oil in pools, extent of depth and uniformity of soil contamination, film thickness on mangroves and walls of the residential areas.

Also these estimates has not been considered:

1. ***Floating oily Sludge removed by CPCL from the surface water and banks of Kosasthalaiyar river and Buckingham canal (395 tonnes as reported in the news media).***
2. ***Sediments - Only random samples (Oil concentration: 1000-30,000mg/kg) had been taken and a complete assessment cannot be done due to flowing water. We can take it up in future studies which will be conducted in more detail for impact assessment.***
3. ***Water – Variable with time and space due to continuous leaching of oil from banks and soil and sediment. However, it remains relatively minor compared to soil contamination.***
4. ***Other upstream locations inside and outside CPCL inundated by high flood where oil was observed.***
5. ***Inaccessible islands and marshlands of Kosasthalaiyar River.***
6. ***Oil released into sea and coasts beyond Ennore Creek.***

7. ***CPCL premises – Soil and Storm water drains within premises which were observed to have oil.***

6. Oil Estimates in Open Tanks of M/s CPCL

Google Earth images were used to assess the open tanks in M/s CPCL close to the two storm water outlets. The total area of these open tanks are worked out as 95,058 sq.m.

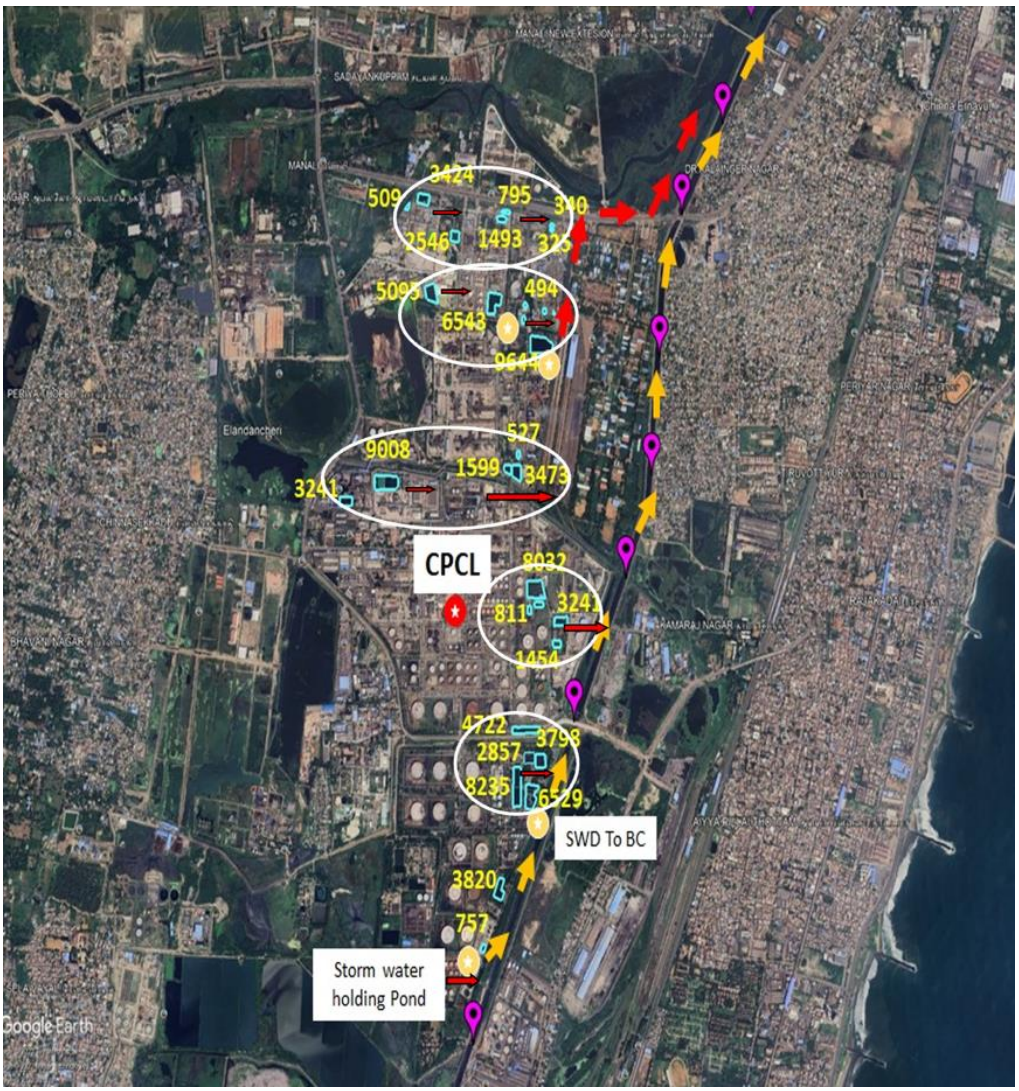


Figure 34: Open tank locations and area in sq.m.

We identified 12 out of 29 tanks containing oil-contaminated water, with six of them discharging into the stormwater drain located north of M/s CPCL (Zone 1), while the remaining six drained into the southern drain of the premises (Zone 20). Table 9 provides an

average estimate of the volume of oil stored in these tanks based on varying oil thicknesses of 1 mm, 5 mm and 10 mm.

Table 9: Location and area of open tanks present in M/s CPCL

Tank ID	Latitude	Longitude	Open tank Area sq.m]
0	13.1585	80.2839	3241
1	13.1747	80.278	2547
2	13.159	80.2821	812
3	13.1592	80.2826	1192
4	13.1598	80.2825	8032
5	13.1644	80.274	9008
6	13.1648	80.2809	1599
7	13.1647	80.2814	3473
8	13.1654	80.2816	527
9	13.17	80.2829	9645
10	13.1719	80.2802	6544
11	13.1764	80.2762	3424
12	13.1757	80.281	795
13	13.1754	80.2807	1493
14	13.1723	80.2766	5096
15	13.1714	80.2832	483
16	13.1713	80.2837	129
17	13.1751	80.2836	341
18	13.1749	80.2836	326
19	13.1761	80.2752	509
20	13.1711	80.2819	714
21	13.1717	80.282	491
22	13.1637	80.2716	3241
23	13.1476	80.2802	3820
24	13.1514	80.2821	6529
25	13.1518	80.2813	8236
26	13.1528	80.2826	3799
27	13.1576	80.2836	1454
28	13.1529	80.282	2857
29	13.1541	80.2818	4702

Table 10: Volume of oil estimated in the open tanks of M/s CPCL

	Tanks that drain to northern storm water drain	**Tanks that drain into southern storm water drain**
	6544	3799
	9645	2857
	491	8236
	1599	6529
	3473	4701
	527	3820
Total area of tanks sq.m.	**22279**	**29942**
Volume of oil in tanks in cu.m. assuming 1 mm	22.27	29.94
Volume of oil in tanks in cu.m. assuming 5 mm	111.39	149.71
Volume of oil in tanks in cu.m. assuming 10 mm	222.79	299.42

The volume of oil estimated in these exposed tanks amounts to 522 cubic meters or 417 tonnes, representing an oil thickness of 10 mm. The oil estimates from our assessment (517 tonnes) and the oily sludge removed by CPCL (395 tonnes) together sums up to 917 tonnes without including the inaccessible areas and bottom sediments of B Canal and K river. This mismatch suggests that the flood induced release from the open tanks may not have been the sole reason of the oil spill. Other possibilities could be breach of oil from other storage tanks of CPCL premises. Fingerprinting analysis using GC-MS suggests that it could be slop oil or furnace oil or mix of both.

7. Coast Guard Assessment:

On the 14th or 15th of December 2023, an assessment was conducted by the coast guard to estimate the oil spill, ten days after the flooding incident. Despite the passage of time,

remnants of oil and sheen were still detected in both inland water bodies and the sea. Estimates were derived from observations made via their helicopter-mounted camera, revealing approximately 11.6 cubic meters of oil in inland water and 12.4 cubic meters in the sea.

It's important to note that these figures may underestimate the actual volume of oil present, as there could have been higher levels of oil in the intervening days between the spill release and the assessment on December 15th. Additionally, the assessment did not fully account for the oil present in various other environments. This includes oil present in the soil, pooled on land surfaces, present on islands, coating the banks of rivers, and the stains on mangrove forests. The assessment also did not consider oil dispersed within water columns or deposited within sediments. Therefore, the actual extent of the oil contamination may be greater than indicated by the coast guard's estimate. For more detailed infirmation please refer to Appendix A

8. Tamil Nadu Pollution Control Board's Survey of M/s CPCL Premises:

The Tamil Nadu Pollution Control Board deployed its technical team to conduct an inspection at M/s CPCL, where they identified areas of concern. A Technical Committee Report was subsequently released, evaluating various sections including the stormwater drainage system, petcoke processing area, the ETP area, sludge storage tanks and ponds, sludge bioremediation process area, and crude oil storage area. Numerous observations were documented during the inspection, indicating potential areas of environmental risk.

According to the report, the average quantity of slop oil collected from different sources of the M/s CPCL premises and stored in slop tanks typically ranges between 50 KLD to 150 KLD. However, during the flood, this collection process would likely have been halted, presenting a substantial risk of washout from the ponds and effluent treatment plants. Additionally, the accumulation of oil-bearing sludge in the sludge ponds that occurred due to the maintenance of eight crude oil/sludge storage tanks, also posed a potential risk of overflow into nearby drains and water bodies during the flood. The team estimated that more than 400 KL of slop oil may have been washed away due to rising water levels. Despite

severe weather alerts, M/s CPCL reportedly lacked sufficient precautionary measures to address oil spillage, highlighting a critical gap in disaster preparedness. For more information on quantity of slop oil collected, total quantity of sludge, mass balance etc., please refer to Appendix B.

9. Recommendations and Scope for Future Work

Recommendations for Future Actions:

1. Conduct Post-Restoration Assessments: It is imperative to conduct thorough assessments after the restoration efforts of Kosasthalaiyar River, its sediments, islands, mangroves and flood plains at the surplus canal before declaring previously contaminated zones as safe. If oil residues are found restoration activity should be initiated again considering the sensitivity of the ecosystem including soil, water, flora and fauna.
2. Enhance Storage Infrastructure: Consider elevating oil sludge and slop oil storage tanks or implementing dykes to contain any potential spills. These measures can help minimize the risk of contamination and mitigate the impact of future accidents.
3. Prevent Oil Discharge from Stormwater Locations: Implement measures to prevent the discharge of oil from stormwater locations, such as installing appropriate containment systems or improving drainage infrastructure.
4. Buckingham Canal Dredging: Given the heavy siltation and long term contamination of oil in the canal consider dredging the canal to enhance its carrying capacity. This action can help improve water flow and reduce the risk of further contamination but can be more challenging as well.
5. Prevention of contamination: Continuous monitoring of the storm water drains in the Ennore industrial area and Buckingham Canal is mandatory to prevent and track contamination from industries and residential areas.

Scope for Future Work:

1. To conduct comprehensive assessments to quantify the level of contamination in water and sediment samples collected from Buckingham Canal and Ennore Creek. This data

will provide more valuable insights into the extent of pollution and aid in planning remediation efforts.

2. To quantify the amount of oil discharged into the sea during the spill event. Accurate measurements will help in assessing the environmental impact accurately.
3. To conduct detailed investigations in inaccessible areas to obtain more accurate estimates of contamination. Utilize advanced technologies and sampling techniques to access remote or challenging locations.
4. To bioremediate excavated soil in covered sheds with proper monitoring, thereby restoring contaminated soil to a healthier state.
5. Environmental Impact Assessment of the spill on water, soil, flora and fauna and Social Impact Assessment of the communities.

These recommendations and future work will contribute to better understanding and management of oil spill impacts in the Ennore region, ultimately leading to improved environmental protection and avoiding future oil spills.

10. Conclusion

The oil spill in Ennore water bodies during the Michaung Cyclone, has led to extensive environmental degradation and socio-economic impacts in the affected regions of North Chennai. This preliminary assessment report underlines the severity and spatial extent of the oil contamination in Buckingham Canal, Kosasthalaiyar River and its surrounding areas.

Field investigations revealed oil accumulation in various zones along the banks, islands and surplus canals of the Kosasthalaiyar River and banks of Buckingham Canal, with significant hotspots identified. The spillage not only contaminated water bodies but also inundated residential areas, causing damage to property, vegetation, and livelihoods. Moreover, the spill has posed a significant threat to biodiversity - affecting mangroves, birds and aquatic organisms. The quantification of the impact will be assessed in Phase 2 of the project.

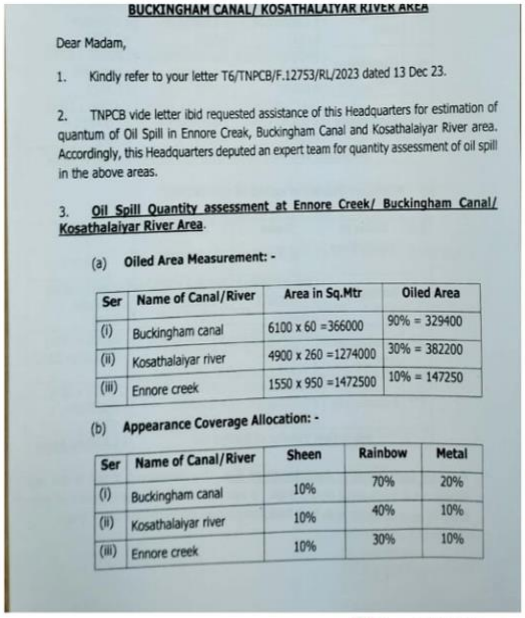
The field surveys and mapping of the oil spill's aerial extent using drones provided valuable insights into the movement of oil and spatial distribution of contamination. Laboratory analysis of water and sediment samples confirmed widespread total petroleum hydrocarbon

contamination indicating the intensity of the contamination. Flooding of CPCL's open tanks during the flood was suspected as a primary source of the spill by Tamil Nadu Pollution Control Board. The estimates derived from IITM's comprehensive analysis indicates approximately more than 1000 tonnes could have been released to the environment.

Addressing the aftermath of the oil spill requires collaborative efforts from various stakeholders, implementing the recommendations outlined in this report, undertaking further research and continuous monitoring to mitigate the impacts of the oil spill and restore the well-being of affected communities and ecosystems in the Ennore region.

11. Appendix

A. Coast Guard Assessment



BUCKINGHAM CANAL/ KOSATHALAIYAR RIVER AREA

Dear Madam,

1. Kindly refer to your letter T6/TNPCB/F.12753/RL/2023 dated 13 Dec 23.

2. TNPCB vide letter ibid requested assistance of this Headquarters for estimation of quantum of Oil Spill in Ennore Creak, Buckingham Canal and Kosathalaiyar River area. Accordingly, this Headquarters deputed an expert team for quantity assessment of oil spill in the above areas.

3. **Oil Spill Quantity assessment at Ennore Creek/ Buckingham Canal/ Kosathalaiyar River Area.**

(a) **Oiled Area Measurement: -**

Ser	Name of Canal/River	Area in Sq.Mtr	Oiled Area
(i)	Buckingham canal	6100 x 60 =366000	90% = 329400
(ii)	Kosathalaiyar river	4900 x 260 =1274000	30% = 382200
(iii)	Ennore creek	1550 x 950 =1472500	10% = 147250

(b) **Appearance Coverage Allocation: -**

Ser	Name of Canal/River	Sheen	Rainbow	Metal
(i)	Buckingham canal	10%	70%	20%
(ii)	Kosathalaiyar river	10%	40%	10%
(iii)	Ennore creek	10%	30%	10%

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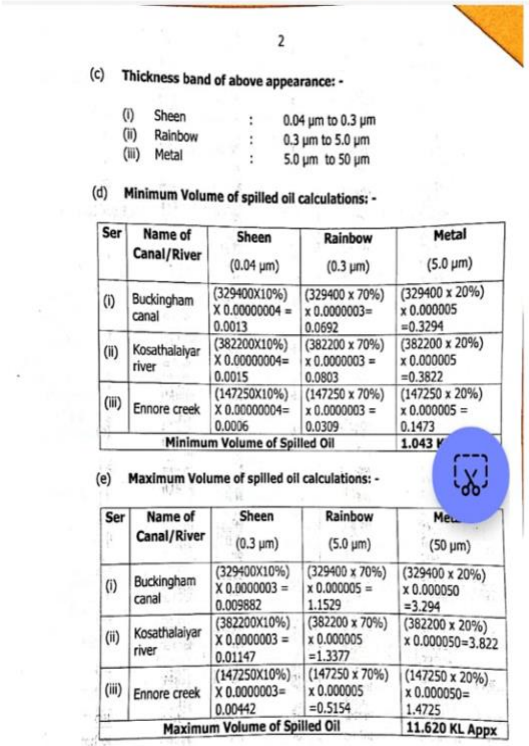

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(c) **Thickness band of above appearance: -**

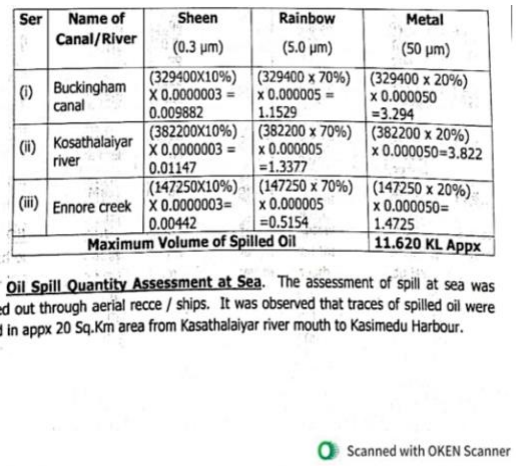
(i) Sheen : 0.04 µm to 0.3 µm
(ii) Rainbow : 0.3 µm to 5.0 µm
(iii) Metal : 5.0 µm to 50 µm

(d) **Minimum Volume of spilled oil calculations: -**

Ser	Name of Canal/River	Sheen (0.04 µm)	Rainbow (0.3 µm)	Metal (5.0 µm)
(i)	Buckingham canal	(329400X10%) X 0.00000004 = 0.0013	(329400 x 70%) x 0.0000003= 0.0692	(329400 x 20%) x 0.000005 =0.3294
(ii)	Kosathalaiyar river	(382200X10%) X 0.00000004= 0.0015	(382200 x 70%) x 0.0000003 = 0.0803	(382200 x 20%) x 0.000005 =0.3822
(iii)	Ennore creek	(147250X10%) X 0.00000004= 0.0006	(147250 x 70%) x 0.0000003 = 0.0309	(147250 x 20%) x 0.000005 = 0.1473
Minimum Volume of Spilled Oil				1.043 K

(e) **Maximum Volume of spilled oil calculations: -**

Ser	Name of Canal/River	Sheen (0.3 µm)	Rainbow (5.0 µm)	Me... (50 µm)
(i)	Buckingham canal	(329400X10%) X 0.0000003 = 0.009882	(329400 x 70%) x 0.000005 = 1.1529	(329400 x 20%) x 0.000050 =3.294
(ii)	Kosathalaiyar river	(382200X10%) X 0.0000003 = 0.01147	(382200 x 70%) x 0.000005 =1.3377	(382200 x 20%) x 0.000050=3.822
(iii)	Ennore creek	(147250X10%) X 0.0000003= 0.00442	(147250 x 70%) x 0.000005 =0.5154	(147250 x 20%) x 0.000050= 1.4725
Maximum Volume of Spilled Oil				11.620 KL Appx



Ser	Name of Canal/River	Sheen (0.3 µm)	Rainbow (5.0 µm)	Metal (50 µm)
(i)	Buckingham canal	(329400X10%) X 0.0000003 = 0.009882	(329400 x 70%) x 0.000005 = 1.1529	(329400 x 20%) x 0.000050 =3.294
(ii)	Kosathalaiyar river	(382200X10%) X 0.0000003 = 0.01147	(382200 x 70%) x 0.000005 =1.3377	(382200 x 20%) x 0.000050=3.822
(iii)	Ennore creek	(147250X10%) X 0.0000003= 0.00442	(147250 x 70%) x 0.000005 =0.5154	(147250 x 20%) x 0.000050= 1.4725
Maximum Volume of Spilled Oil				11.620 KL Appx

4. **Oil Spill Quantity Assessment at Sea.** The assessment of spill at sea was carried out through aerial recce / ships. It was observed that traces of spilled oil were found in appx 20 Sq.Km area from Kasathalaiyar river mouth to Kasimedu Harbour.

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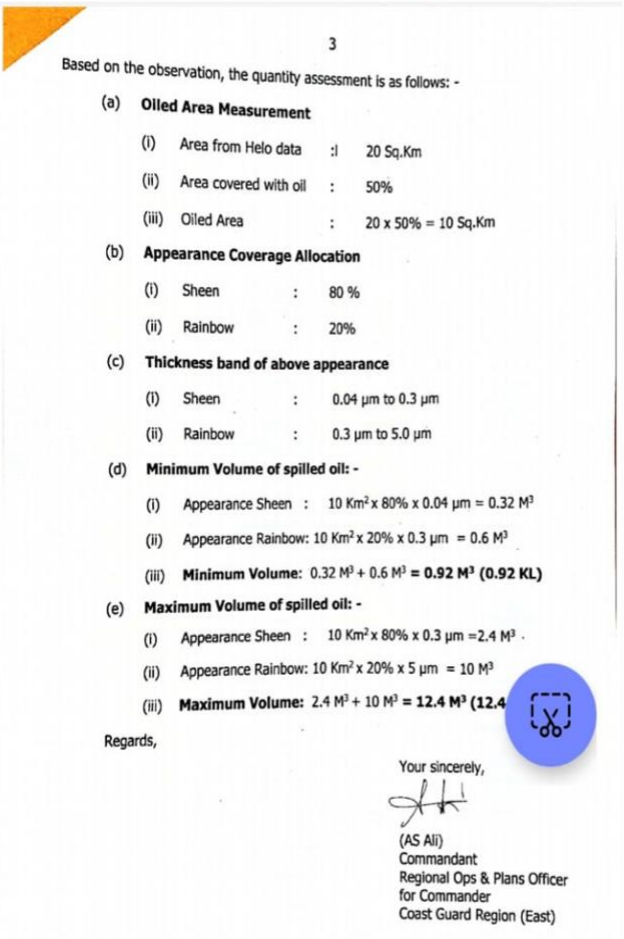

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Based on the observation, the quantity assessment is as follows: -

(a) **Oiled Area Measurement**

(i) Area from Helo data : 20 Sq.Km
(ii) Area covered with oil : 50%
(iii) Oiled Area : 20 x 50% = 10 Sq.Km

(b) **Appearance Coverage Allocation**

(i) Sheen : 80 %
(ii) Rainbow : 20%

(c) **Thickness band of above appearance**

(i) Sheen : 0.04 µm to 0.3 µm
(ii) Rainbow : 0.3 µm to 5.0 µm

(d) **Minimum Volume of spilled oil: -**

(i) Appearance Sheen : 10 Km^2 x 80% x 0.04 µm = 0.32 M^3
(ii) Appearance Rainbow: 10 Km^2 x 20% x 0.3 µm = 0.6 M^3
(iii) **Minimum Volume:** 0.32 M^3 + 0.6 M^3 **= 0.92 M^3 (0.92 KL)**

(e) **Maximum Volume of spilled oil: -**

(i) Appearance Sheen : 10 Km^2 x 80% x 0.3 µm =2.4 M^3
(ii) Appearance Rainbow: 10 Km^2 x 20% x 5 µm = 10 M^3
(iii) **Maximum Volume:** 2.4 M^3 + 10 M^3 **= 12.4 M^3 (12.4**

Regards,

Your sincerely,

(AS Ali)
Commandant
Regional Ops & Plans Officer
for Commander
Coast Guard Region (East)

B. Tamil Nadu Pollution Control Board's Survey of M/s CPCL Premises

6. Findings of the Team based on the information provided by the M/s CPCL:

As per the suggestions of the Team TNPCB requested M/s CPCL to provide certain details viz; quantity of slop oil, O&M details, the mass balance of raw materials, sludge storage, etc. M/s CPCL has submitted the following details vide letter dated 14.12.2023, the details are as below;

<table>
<tr><th>SI NO</th><th>Information requested</th><th>Information provided by CPCL</th></tr>
<tr><td>i</td><td>Oily waste material collected from day to day operations, from all the storm water ponds, ETPs and other sources and its quantity, its storage method and disposals details</td><td>Slop Oil quantity collected from storm water ponds, ETPs and other sources for the last three months is furnished below
<table>
<tr><td>Month</td><td>Quantity, KL</td></tr>
<tr><td>September</td><td>1939</td></tr>
<tr><td>October</td><td>4528</td></tr>
<tr><td>November</td><td>1238</td></tr>
</table>
Slop oil is stored in Slop Tanks and reprocessed with Crude.</td></tr>
<tr><td>ii</td><td>Whether cleaning operation carried out before Michaung flood, its collection details.</td><td>Details of major activities carried out as part of pre monsoon preparedness is furnished below:
▪ Storm water canal cleaning
▪ Building roof cleaning
▪ Dewatering pumps checking & availability</td></tr>
<tr><td>iii</td><td>Whether all the refineries are in operation during the flood, if not details shall be furnished. Further receipt of crude oil from 1st December 2023 to 9th December 2023 shall be furnished</td><td>Out of 3 Refineries, only one Refinery was in operation during flood. Other two Refineries were under circulation.
Details of Crude Oil Receipt from 01.12.23 to 09.12.23 is furnished below:
<table>
<tr><td>Date</td><td>Crude receipt in TMT</td></tr>
<tr><td>01.12.23</td><td rowspan="4">No receipt</td></tr>
<tr><td>02.12.23</td></tr>
<tr><td>03.12.23</td></tr>
<tr><td>04.12.23</td></tr>
<tr><td>05.12.23 20.48 hrs to 07.12.23 06.00 hrs</td><td>135</td></tr>
<tr><td>09.12.23 18.54 hrs to 11.12.23 hrs 07.12 hrs</td><td>99</td></tr>
</table></td></tr>
<tr><td>iv</td><td>Total quantity of Sludge stored inside the premises and its</td><td>Quantity of Sludge Stored in CPCL is 2300 KL in sludge pond. The sludge would be mechanically treated to extract oil and residual material would be</td></tr>
</table>

<table>
<tr><td></td><td>method of disposal</td><td>bioremediated. Extract oil would be reprocessed thro' crude tanks</td></tr>
<tr><td>v</td><td>Frequency of conducting spillage deduction along with details of records maintained.</td><td>Spillage Detection & Repair study is carried out yearly once in CPCL and the report is submitted to TNPCB regularly. The latest report is submitted in Jan 23 (Annexure-A)</td></tr>
<tr><td>vi</td><td>Mass balance of raw material and product manufactured</td><td>Mass balance in Tons/ day furnished below
<table><tr><td>Crude through put</td><td>28.8</td></tr><tr><td>LPG</td><td>1.0</td></tr><tr><td>Naphtha</td><td>2.4</td></tr><tr><td>Petrol (M.S)</td><td>3.0</td></tr><tr><td>ATF</td><td>3.2</td></tr><tr><td>Diesel</td><td>15.0</td></tr><tr><td>Lobs/Wax</td><td>0.8</td></tr><tr><td>Bitumen</td><td>1.2</td></tr><tr><td>Internal fuel</td><td>2.2</td></tr></table></td></tr>
<tr><td>vii</td><td>Number of unused storage tanks and number of it for maintenance

The details of date of clean in progress taken for crude oil tanks, slops storage and other.</td><td>Details of idle and M&I tanks is furnished as
Tanks released and under Maintenance
<table><tr><th>Sl. No.</th><th>Tank No.</th><th>Service</th><th>Remarks</th></tr><tr><td>1</td><td>343</td><td>DWO(HH)</td><td>Released in Oct 23</td></tr><tr><td>2</td><td>412</td><td>SK(LAB)</td><td>Released in Sep 23</td></tr><tr><td>3</td><td>418</td><td>ATF</td><td>Released in Oct 23</td></tr><tr><td>4</td><td>107</td><td>Crude</td><td>Released in Oct 23</td></tr><tr><td>5</td><td>820</td><td>Dry slop</td><td>Released in Sep 23</td></tr><tr><td>6</td><td>310</td><td>HN/DAO</td><td>Released in Mar'23</td></tr><tr><td>7</td><td>311</td><td>IN/HN/DAO</td><td>Released in Mar'23</td></tr><tr><td>8</td><td>309</td><td>Raff</td><td>Released in Jun'23</td></tr></table></td></tr>
</table>

<table>
<tr>
<td></td>
<td></td>
<td>
<table>
<tr><td>9</td><td>201</td><td>RFO</td><td>Released in Jun’23</td></tr>
<tr><td>10</td><td>204-D-1</td><td>VBU Feed</td><td>Released in Jun’23.</td></tr>
<tr><td>11</td><td>312</td><td>IN/HN/DAO</td><td>Released in Sep’23</td></tr>
<tr><td>12</td><td>919</td><td>Wax</td><td>Released in Oct’23</td></tr>
<tr><td>13</td><td>345</td><td>DWO/RAFF</td><td>Released in Sep’23</td></tr>
</table>
Details of tanks unused tanks:
<table>
<tr><th>Sl. No.</th><th>Tank No.</th><th>Service</th></tr>
<tr><td>1</td><td>806</td><td>Slop Oil</td></tr>
<tr><td>2</td><td>383</td><td>Wax</td></tr>
<tr><td>3</td><td>384</td><td>Wax</td></tr>
</table>
</td>
</tr>
<tr>
<td>viii</td>
<td>Details of the sludge stored in the open yard</td>
<td>All sludge is stored in concrete pit with impervious layer and is at higher elevation.</td>
</tr>
<tr>
<td>ix</td>
<td>Any operations carried out to protect the refinery to avoid untoward incidents during the flood time</td>
<td>➢ One Refinery out of 3 Refineries was operated to maintain product supply to market.
➢ Tractors trailers & fire truck were operated to bring Manpower & Material inside Refinery</td>
</tr>
<tr>
<td>x</td>
<td>The details of Characteristics of waste oil collected from ETPs & storm water collection ponds</td>
<td>Slop oil is a mixture of oil collected from various sources. Slop Oil is reprocessed with crude. Since the qty of slop oil is very minimal, analysis is not required. However as per instruction, one sample was analysed today (14.12.23) and the result is furnished below.
a) Density-0.873 gm/cc
b) Sulphur- 2.09 %
c) Flash- 37 Deg C
d) Viscosity @ 40 Deg C- 6.6</td>
</tr>
<tr>
<td>xi</td>
<td>The details of products sent to Manali customers and control mechanism provided to safe guard during no demand period</td>
<td>
<table>
<tr><th>Industry</th><th>Products</th><th>In case of No demand</th></tr>
<tr><td>TPL</td><td>LABFS</td><td>Will be absorbed in Diesel pool / converted to ATF</td></tr>
<tr><td>MPL</td><td>Propylene</td><td>Will be sold as LPG</td></tr>
</table>
</td>
</tr>
</table>

			KPL	PBFS		
				LPBFS		
			Cetex Petrochemicals	Butene2		
				MEKFS		

From the above information, the Team noticed the following;

- As per the information given at Sl. (i), it is inferred that the average slop oil collected from ETPs and other sources ranges from 50 kld to 150 kld. Due to heavy rain since December 03 and 04, 2023, the collection of slop oil might not be happened, this slop oil might be washed away due to rising of water levels in all ponds since the ponds were just above the ground level. As per this information, the quantity washed away might be more than 400 kl.
- As per the information given at Sl.(iv), it is inferred that 2300 kl oil-bearing sludge is being stored in the sludge pond. The same was observed during the team visit and noticed that the sludge stored was up to the brim level, the oil mixed sludge might be washed away to drain due to the flood which is directly leading to the Buckingham Canal.
- As per the information given at Sl(vii), it is inferred that eight crude oil storage tanks were taken for maintenance during September – October 2023. The oil-bearing sludge required to be separated through centrifugation and the same has to be taken for bio remediation. At least 90 days are required to complete one cycle of bio remediation. Eight tanks were taken for maintenance in the last three months, the oil bearing sludge might be stored in the ponds, due to the flood, these sludge might be washed away. One of the nearby industry namely M/s Indian Additives Ltd, reported to the TNPCB team on 04.12.2023 that the mixture of thick Black oil & water was gushed into their premises. The statement of industry also confirms that the probability of washing of oil-bearing sludge from their storage dykes.
- Inspite of sever cyclonic and heavy rain fall alert by IMD and Govt. of Tamil Nadu, the unit is not taken any precautionary measures to contain the oil spillage from

their ponds and ETPs. And also unit is not having either flood management plan or emergency contingency plan to contain oil spillage.

12. References

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2. Chakraborty, P., et al. (2021). Passive air sampling of PCDD/Fs, PCBs, PAEs, DEHA, and PAHs from informal electronic waste recycling and allied sectors in Indian megacities. Environmental Science & Technology, 55(14), 9469-9478.

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6. Wire. (2023, December 15). 20 tonnes of oil-soaked soil, 7000 litres of affected water removed: TN govt on Chennai oil spill. The Wire. Retrieved from https://thewire.in/environment/20-tonnes-of-oil-soaked-soil-7000-litres-of-affected-water-removed-tn-govt-on-chennai-oil-spill

ASSESSMENT OF ENNORE OIL SPILL DURING MICHAUNG CYLCONE

PRELIMINARY ASSESSMENT REPORT

March 2024

Environment Engineering Division

Department of Civil Engineering

Indian Institute of Technology Madras, Chennai - 600036

Executive Summary

The "MICHAUNG" cyclonic storm caused extensive oil spillage from Chennai Petroleum Corporation Limited (M/s CPCL). The resulting contamination adversely affected biodiversity, daily life, and livelihoods in the impacted regions. IIT Madras research team conducted a comprehensive field assessment, mapping oil contamination across 20 zones. Notable hotspots included stormwater outlets of M/s CPCL, residential areas and industrial areas in Ennore. Field surveys, mapping efforts using drones, questionnaire surveys provided deep insights into the extent of oil contamination. Oil pools, sheens, and stains were observed in residential, industrial, and natural areas, threatening biodiversity, and public health.

Two sources of the oil spill into the environment were identified. One being the storm water discharge outlet at the south-eastern wall of CPCL into the Buckingham Canal and the other being the storm water canal discharging into surplus canal of Kosasthalaiyar River. The flood levels of the Kosasthalaiyar River rose to 5 to 6 ft above the Buckingham Canal bund level causing the entry of oil and water into the adjoining residential areas of Ernavoor and Sathyamoorthy Nagar. The mangroves along the banks and the islands in Kosasthalaiyar River were impacted up to a height of 10 ft near the surplus canal and 3 ft in other areas with complete loss of mangrove saplings. The team observed several dead fish and crabs and oil coated birds.

Laboratory analysis of water, soil and sediment samples revealed Total Petroleum Hydrocarbon (TPH) concentrations ranging from 0.28 to 7.21 g/L in water and 13.6 to 46.55 g/kg in sediments. The estimated volume of oil contamination in the environment ranged from 517 tonnes to 2097 tonnes without including oily sludge collected by CPCL and oil in inaccessible islands and sediments of Kosasthalaiyar River. The oil estimates from our assessment (517 tonnes) and the oily sludge removed by CPCL (395 tonnes) together sums up to 912 tonnes without including the inaccessible areas and bottom sediments of B Canal and K river. Fingerprinting analysis using GC-MS suggests that it could be slop oil or furnace oil or mix of both.

The Tamil Nadu Pollution Control Board's survey of M/s CPCL premises has suspected breaches in stormwater drainage systems and potential risks associated with oil storage and handling practices. An assessment of the open tanks in M/s CPCL premises indicated that 417 tonnes of oil could have been stored before flooding which is much less than 912 tonnes of oil estimated. This mismatch suggests that the flood induced release from the open tanks

may not have been the sole reason of the oil spill. Other possibilities could be breach of oil from enclosed storage tanks of CPCL premises. Urgent remedial actions are imperative to mitigate the environmental and socio-economic consequences of this oil spillage. Efforts should focus on environmental restoration, alongside regulatory measures to enhance industrial safety.

Contents

1. Introduction

A severe cyclonic storm named "MICHAUNG," which formed over the Bay of Bengal, resulted in exceptionally heavy rainfall in the coastal districts of North Tamil Nadu and South Andhra Pradesh states (IMD, 2023). Chennai city experienced significant rainfall, with the Nungambakkam Meteorological Station recording a maximum of 530 mm between December 2 and 4, 2023. This extreme weather event had detrimental effects on the daily lives, livelihoods, and biodiversity of the affected regions.

Chennai Petroleum Corporation Limited, also known as CPCL, which stands as one of the foremost public sector refining companies in India, found itself at the centre of another crisis. Cyclone Michaung led to the leakage of oil deposits from M/s CPCL's guard ponds and stormwater drain ponds. These deposits were released on the flood plains of Kosasthalaiyar River and into the Buckingham Canal. The oil was carried along with the flood water through these waterways ultimately reaching the Ennore Creek and contaminating the Bay of Bengal.

The IIT Madras research team started their field campaign to assess the oil spill contaminations in water and sediments for a 12 km stretch in Buckingham Canal. The field campaign encompassed various activities, including flow measurements in Buckingham Canal, the collection of water and sediment samples, and mapping the spread of oil contamination in the affected area. This preliminary assessment report provides in-depth findings from both field investigations and laboratory analysis, offering insights into the severity of the oil spill contamination. Additionally, it provides a summary of the coast guard's estimation of the oil spill, along with insights gathered from the Tamil Nadu Pollution Control Board (TNPCB) Committee Report.

Figure 1: Oil spread near Ennore railway bridge

Figure 2: Oil contamination in Buckingham Canal

2. Mapping the Extent of Oil Contamination

IITM started their on-site investigations after the first response measures undertaken by CPCL. By then, oily sludge of 395 tonnes floating on the river and the banks were contained using booms and removed using skimmers (The Hindu Bureau, 2023). During our physical

survey by boat and by road between 14th and 26th December 2023, we observed oil marks along the banks of the Kosasthalaiyar River (K River) and the Buckingham Canal (B Canal), identifying 20 zones where oil accumulation was notably high.

Zone 1: Entry Point 1 - Storm water canal discharge into surplus canal of Kosasthalaiyar River
Zone 2: Kattukuppam
Zone 3: B/w railway and road bridge
Zone 4: Near Ennore railway bridge
Zone 5: Thazhankuppam
Zone 6: Ennorekuppam
Zone 7: Nettukuppam
Zone 8: Bridge pier/island in K River - Sadayankuppam
Zone 9: Oil overflowed along B Canal
Zone 10: In mangrove islands
Zone 11: Ernavoor and Sathyamoorthy Nagar residential area
Zone 12: Ernavoor and Sathyamoorthy Nagar industry/marsh accessible areas
Zone 13: Storm water drain outside M/s CPCL
Zone 14: Storm water drains inside M/s CPCL
Zone 15: Land area within M/s CPCL, IAL, Steel
Zone 16: Oil staining the soil embankment in B Canal and K River
Zone 17: Oil staining the mangroves
Zone 18: River and canal sediments
Zone 19: Marine sediments and oil lost to sea
Zone 20: Entry Point 2 - Storm water discharge outlet at the south-eastern wall of CPCL into the Buckingham Canal

There was a large amount of oil stagnation near Ennore Creek (Zone 19) due to the combination of tidal activity and the river mouth's influence. In this season, the wave and tidal movements tend to carry particles toward the shoreline in a southwest direction. As a result, it takes longer for substances such as oil, to be dispersed back into the ocean. Zone 1 is a hotspot where a large influx of oil came from the storm water drain from M/s CPCL, entering the floodplains of K River, and eventually contaminating the river. In all the

accessible zones we had collected soil, water and some river sediment samples and quantified the oil that had been contaminated.

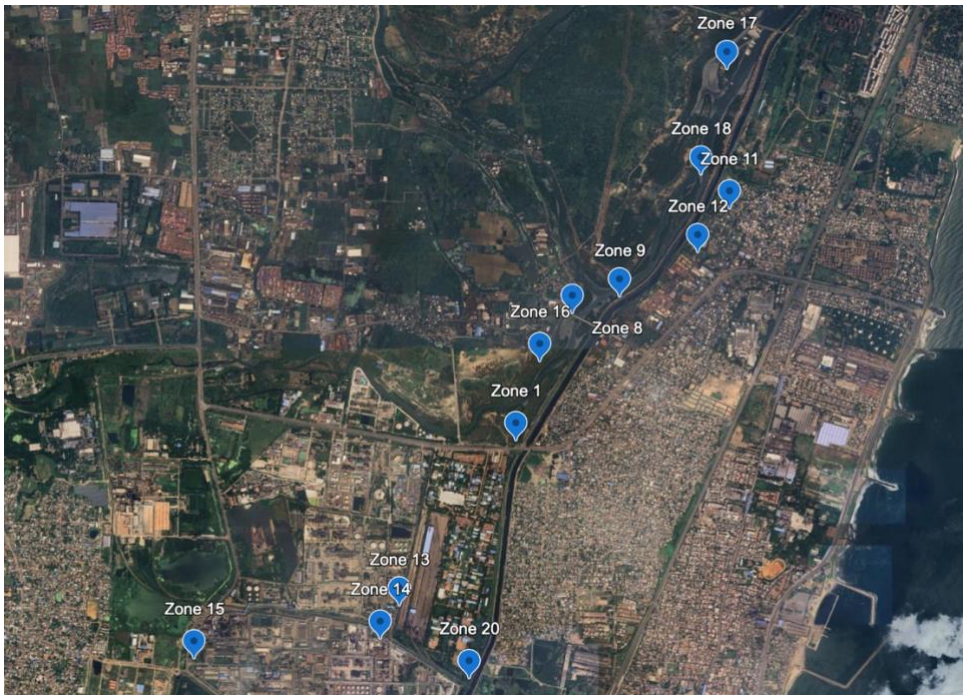

Figure 3: Contamination Zones from CPCL premises to the midstream of Buckingham Canal

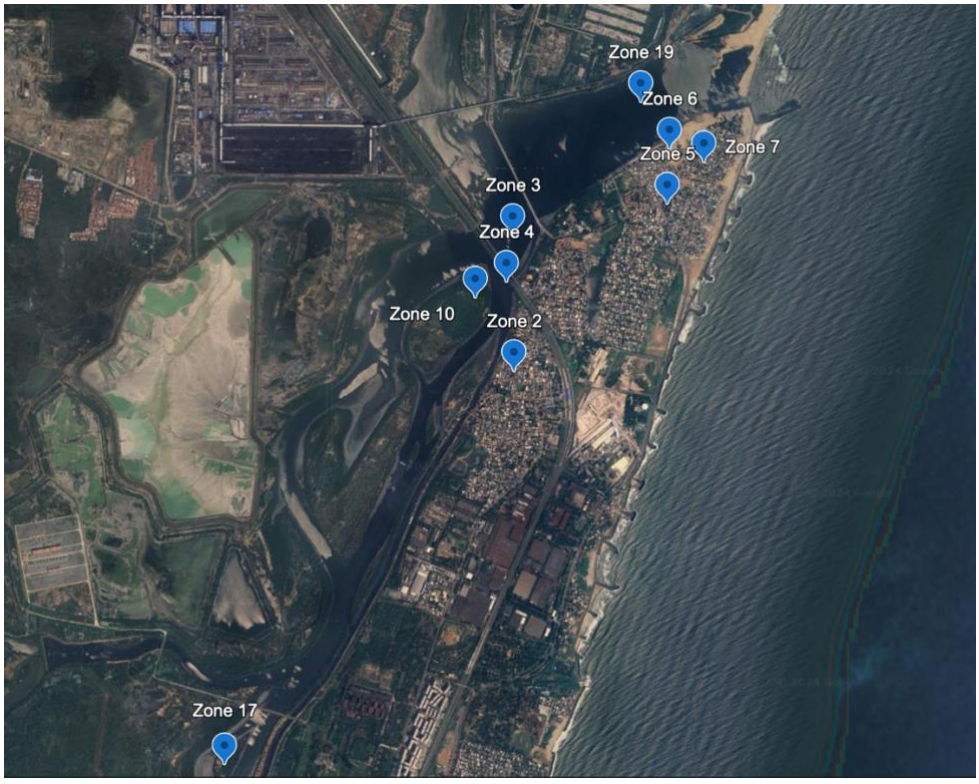

Figure 4: Contamination Zones from midstream of Buckingham Canal to Ennore Creek

During the flood event, B Canal experienced overflow of oil mixed water, inundating the residential areas of Ernavoor (Zone 11). Lamp posts positioned within the residential vicinity along the B Canal exhibited signs of oil spillage, while flood-affected houses showed oil stains on their walls, reaching heights of 5 to 6 feet. The overflowing oil mixed water adversely affected vegetation, residential buildings, vehicles, and the open wells that serve as sources of groundwater. The field images below provide visual representation of the extent of oil contamination within the residential zones of Ernavoor.

Figure 5: Highest oil mixed water level 7.5 feet above normal water level during the cyclone

Figure 6: Collection of samples from the oil overflown along the banks of B Canal.

Figure 7: Oil marks observed in the residential localities of Ernavoor.

Assessment Regions:

The extensive presence of heavy oil was detected in various locations along our route, indicating a significant spill. IIT Madras team surveyed along the B Canal and K river to identify the extent of the spill along the width and length of the waterways. We have divided the assessment regions to three stretches:

1. Downstream from Ennore Thermal Power Station (ETPS) to Creek:

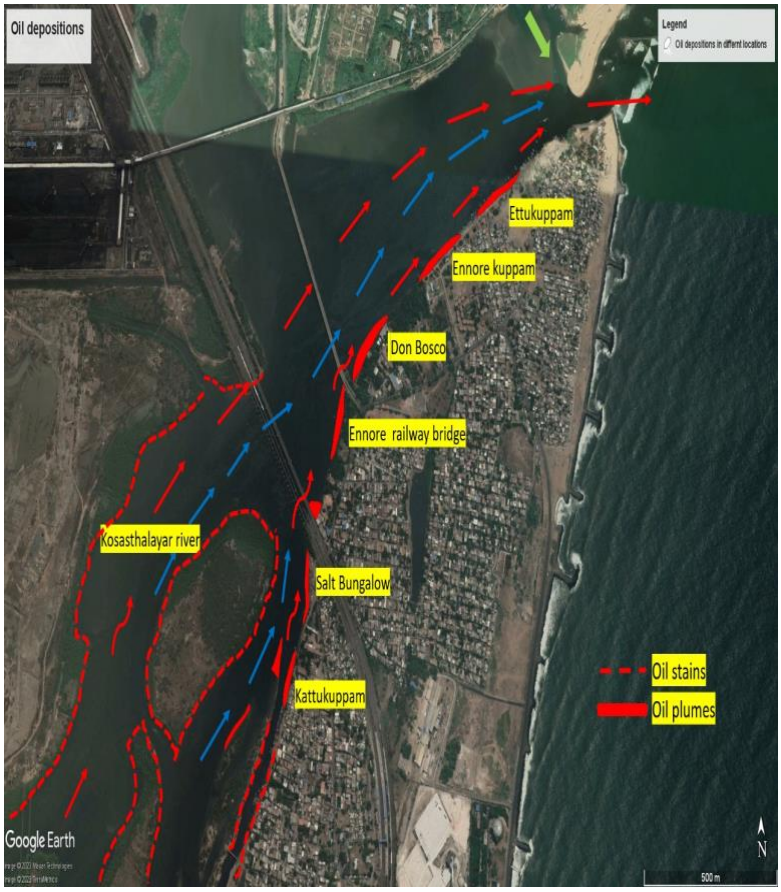

Figure 8: Assessment Region 1 - Downstream from ETPS to Creek Area

The depicted figure illustrates the flow of oil, represented by red arrows, along the B Canal and K River after the floodwaters receded. Dotted lines signify the presence of oil stains along all banks of these water bodies and islands. Hotspots, where substantial oil deposits occurred, are highlighted as red patches along the eastern banks of the Creek, extending from Kattukuppam to Nettukuppam.

2. Midstream from Ennore Thermal Power Station (ETPS) to Manali High Road Bridge:

The midstream stretch of B Canal extending from the junction of K River and surplus canal from Redhills up to ETPS is the crucial area to pay attention. The surplus from Puzhal and Poondi Lakes discharged high quantum of water into the two K River branches which trapped the oil in this mid-stream stretch. The flood water rose to 7 to 9 ft in this section carrying the

oil with it, over the B Canal bank into the adjoining residential and industrial areas of Ernavoor and Sathyamoorthy Nagar. Once the flood water/surplus water receded, the oil must have flown downstream into the Kattukuppam all the way to Nettukuppam.

Figure 9: Assessment Region 2 - Midstream From ETPS to Manali High Road Bridge

3. Upstream of B Canal from Manali High Road to Kodungaiyur

Two oil discharges from the M/s CPCL stormwater drain have occurred in the locations: one in the south (entry point 2), directly into the B Canal, and another in the north (entry point 1), flowing through the stormwater drain adjacent to India Additives, into the flood plains of K river (Zone 1 indicated by the large red patch). Stormwater drains within M/s CPCL were tracked, revealing breaches in the outlet and walls, with all drains and tanks heavily stained with oil. Numerous open oil-water collection tanks were present at ground level, lacking preventive measures to contain oil during flooding or to prevent its escape from the premises.

Figure 10: Assessment Region 3 - Upstream of B Canal from Manali High Road to Kodungaiyur showing the entry point of oil into the Buckingham Canal and Kosasthalaiyar River

The soil samples collected at Zone 1 had oil markings present up to 2m (max.) depth from the surface. This may have long-term impacts on the region as it is mostly an unconfined aquifer where there are possibilities of contamination of the ground water.

Figure 11: Drone image of Zone 1

Figure 12: Close up view of Zone 1

Verified through drone camera images, the dark patches in the above image signify the presence of oil pools surrounding the stormwater outlets flowing towards the K River. Extensive sampling of soil and water at this contaminated site revealed high oil content. Upstream from this contaminated site, deposits of oil-contaminated sludge are still present, likely resulting from backflow from this leakage point. However, no significant oil spill or sludge deposition was observed beyond 100 meters from this location, indicating that Zone 1 is likely the initial point of oil spillage or the source itself.

Figure 13: Earth moving machinery at the oil spill site

Figure 14: B canal possibly breached and oil stain covered.

Numerous earthmoving machines were on-site (Figure 13), along with several laborers tasked with covering the oil stains in the floodplain. Arrows pointing towards the two locations in the Buckingham Canal (Figure 14) distinctly indicate that the bund has been reworked following the oil spill, with one section appearing clean and the other section visibly stained with oil.

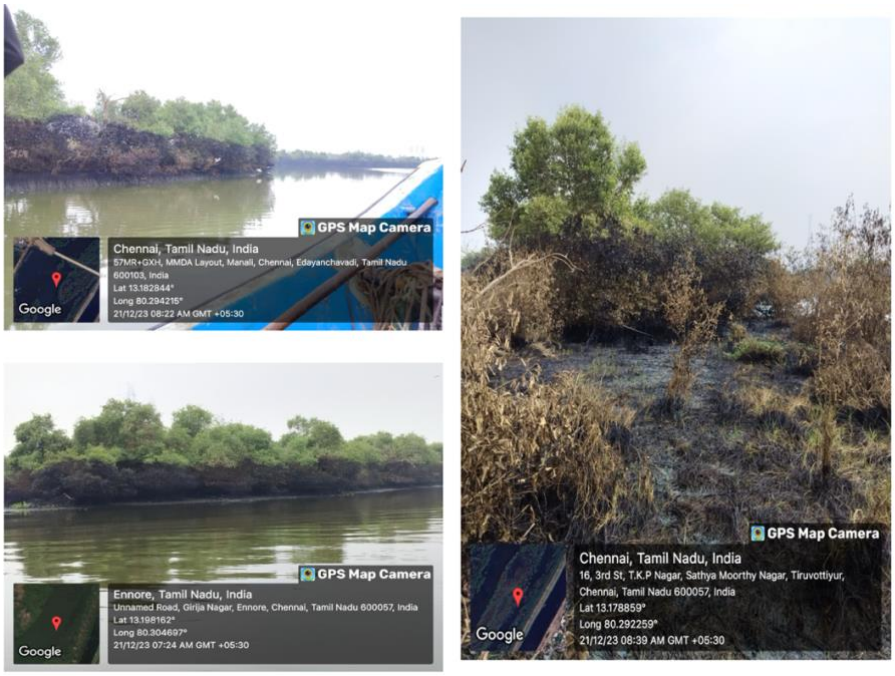

Figure 15: Mangroves with severe oil contamination

Figure 16: Dead birds, crabs, and fishes found in the contaminated site

The oil spill has posed a significant threat to biodiversity (Figure 15 and 16) in the affected area, impacting mangroves and various organisms such as crabs, fishes, and birds.

3. Field Assessments and Sampling

Field assessments were conducted along Buckingham Canal utilizing boats and by road in areas inaccessible by boat. Water and sediment samples were systematically collected at 500-meter intervals. Water samples, including any oil present, were obtained from both the top and bottom of the canal using a bailer. The depth of the canal was measured with a staff gauge, and flow velocity was assessed using an ultrasonic flow sensor. Sampling locations along a 12 km stretch from Indian Oil Cooperation Limited (IOCL) in Tondiarpet to Ennore Creek in Buckingham Canal are illustrated in Figure 2. Soil sediments and oil deposits were collected using a grab sampler and analysed in the laboratory for Total Petroleum Hydrocarbon (TPH) via gravimetry and gas-chromatography analysis.

Figure 17: Sampling locations along Buckingham Canal

Figure 18: Collecting sediment samples using a grab sampler

Figure 19: Sediment sample collection from midstream and banks

Figure 20: Depth measurement

Figure 21: Sampling of soil cores

Figure 22: Collecting water samples using a bailer

3.1 Drone Surveys

A drone survey was carried out to quantify the oil contamination spatially. Drones were employed to capture the hyper-spectral aerial images, that will help us differentiate water from oil. The drone images captured (Figure 24) show the oil sheen floating on B canal and K River.

Figure 23: Capturing high-resolution images using drone survey

Figure 24: Drone images showing oil contamination in B Canal and K River

3.2 Water Characteristics Measured Insitu:

In-situ water quality measurements, such as pH and total dissolved solids (TDS), were taken using a field probe, revealing pH values ranging from 7.4 to 8.0 and TDS values between 500 and 850 mg/L. The table below shows the insitu-water characteristics of the water samples.

Table 1: Insitu- water characteristics

Sample ID	Latitude	Longitude	Water level [m]	pH		TDS [mg/L]	
				Top water	Bottom water	Top water	Bottom water
SL 1	13.2200	80.31833	0.5	7.88	-	842	-
SL 2	13.21666	80.31638	1	7.97	7.80	804	855
SL 3	13.21305	80.31416	1	7.95	8.04	852	845
SL 4	13.20916	80.3125	1	7.92	7.99	844	840
SL 5	13.205	80.31027	1.5	7.88	7.94	824	824
SL 6	13.20217	80.30834	-				
SL 7	13.15433	80.28454	-	7.66	-	671	-
SL 8	13.1415	80.27866	-	7.63	7.73	683	700
SL 9	13.16015	80.2876	-	7.47	7.44	761	795
SL 10	13.16441	80.28916	-	7.7	7.65	740	744
SL 11	13.16938	80.28973	-	7.78	7.67	786	765
SL 12	13.17541	80.29114	-	7.61	7.54	733	752
SL 13	13.17923	80.29366	-	7.51	7.59	732	741
SL 14	13.18276	80.29591	-	7.66	-	634	-
SL 15	13.19324	80.30388	-	7.66	7.62	736	739
SL 16	13.18568	80.29944	-	7.87	7.72	759	751
SL 17	13.18949	80.30199	-	7.81	7.52	770	778
Nettukuppam	13.2311	80.32602	0.9	7.71	7.78	496	758
Thazhankuppam	13.22935	80.32321	0.8	7.77	7.68	581	624
DonBosco	13.22817	80.32137	0.6	7.93	8.00	457	498
EnnoreBridge	13.22726	80.3205	0.5	7.06	7.12	586	560
Salt Bungalow	13.22573	80.31999	0.7	7.04	7.11	536	924

3.3 Flow Measurement

Water flow measurements were carried out using an ultrasonic flow measurement device - FLOWFLAT. The velocity values ranged from 0.1 m/s to 0.7 m/s. The measurements were conducted in 10 locations within the B Canal and Ennore Creek at different depths based on the location's available flow depth. The table below summarises the velocity magnitudes in the B Canal and Ennore Creek.

Table 2: Velocity values in different locations of B Canal

ID	Velocity [m/s]	Depth of flow [m]	Depth of velocity measurement [m]
L2	0.255	0.5	0.15
	0.385		0.40
L3	0.645	1	0.40
	0.734		0.90
L4	0.334	1	0.30
	0.390		0.90
L5	0.400	1.5	0.50
	0.452		1.00
	0.496		1.20
L6	0.214	0.3	0.25
L7	0.308	0.15	0.10
L10	0.104	0.2	0.10
	0.117		0.15
L12	0.150	0.38	0.15
	0.472		0.35
Nettukuppam	0.214	0.9	0.30
	0.243		0.6
Thazhankuppam	0.105	0.8	0.3

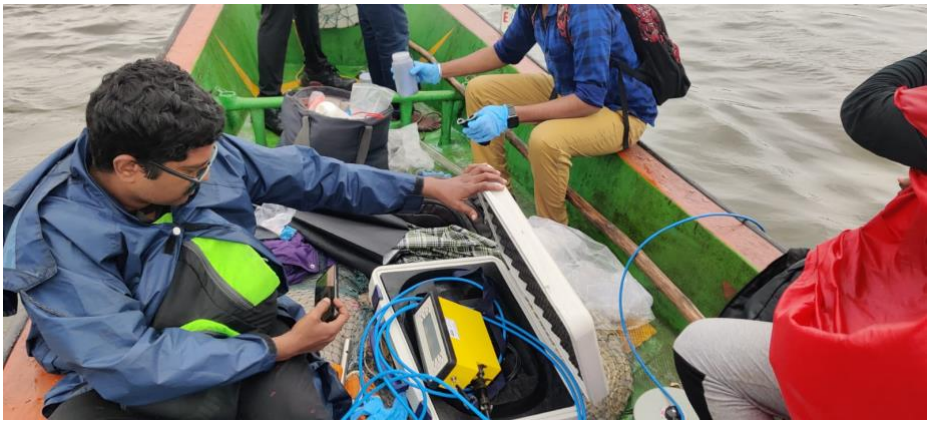

Figure 25: Water quality using field probe and flow measurement using FLOWFLAT

3.4 Flood Water Level Measurement at M/s CPCL Premises

The installation of water level meters at M/s CPCL by IIT Madras provided valuable data regarding the timing and extent of the peak water level, particularly noting the peak occurring on December 5th, 2023. This suggests that a significant influx of water has exacerbated the spread and impact of the oil spill in several ways.

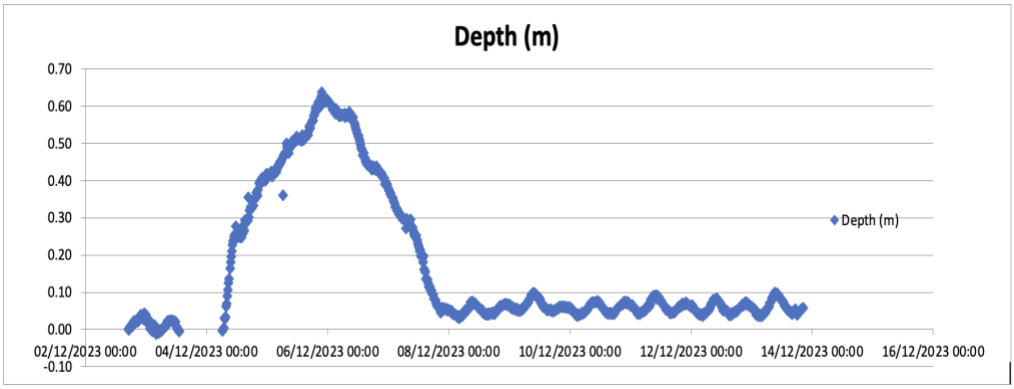

Figure 26: Water level metre at M/s CPCL West Gate

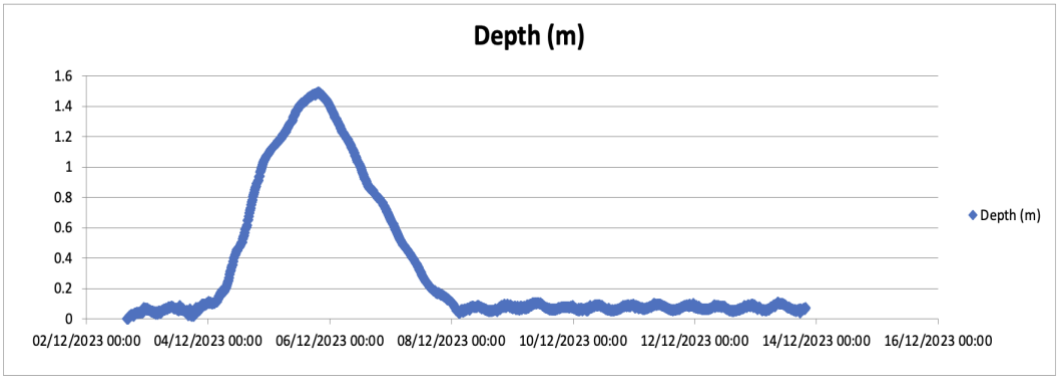

Figure 27: Water level metre at Bottling plant at CPCL

4. Laboratory Analysis

Oily sludge, a semi-solid waste, contains hazardous hydrocarbon substances and is composed of an emulsion of water, petroleum hydrocarbons, heavy metals, and solid particles. Water and sediment samples collected continuously over a three day period in various locations along the B Canal and Ennore Creek were subjected to analysis for Total Petroleum Hydrocarbon (TPH) utilizing both gravimetric and gas chromatography-mass spectrometry (GC-MS) methods. The TPH content in water ranged from 0.28 to 7.21 grams per litre (g/L), while in sediments, it ranged from 13.6 to 46.55 grams per kilogram (g/kg). These findings indicate the extent of hydrocarbon contamination in both the aquatic environment and sedimentary deposits within the affected areas.

Table 3: TPH concentrations in water and sediments/soil

Contaminations in 7 Zones which notably showed a high level of oil contamination		**Water**	**Sediment/Soil**
Location	**Area [sq.m.]**	**TPH conc (g/L)**	**TPH (g/Kg)**
Zone 1 Entry Point 1 - Storm water canal discharge into surplus canal of Kosasthalaiyar River	100601	1-2.27	13.6-30.44
Zone 2 (Kattukuppam)	3007	6.195 - 7.21	NA
Zone 3 (B/w railway and road bridge)	3163	5.32-7.13	18-31.8
Zone 4 (Near Ennore railway bridge)	2886	1.02-2.5	15.32-41
Zone 5 (Thazhankuppam)	5139	0.28-0.54	38-40.38
Zone 6 (Ennorekuppam)	3742	sample not collected	sample not collected
Zone 7 (Nettukuppam)	3232	2.45-3.01	46-46.55
Location	**Area [sq.m.]**	**TPH conc (g/L)**	**TPH (g/Kg)**
Buckingham Canal	121765	0.43-3.29	33-110
Kosasthalaiyar River	1032988	0.44-0.97	17-38.9
Residential areas near B Canal (oil pool)	11403	NA	24-120

Gas Chromatography Mass Spectrometry analysis was conducted to determine the type of oil that was spilled during the floods. A total of four samples, specifically the field sample, crude oil, furnace oil, and slop oil, were subjected to analysis using GC- MS. The chromatogram of the field sample was compared with those of crude oil, furnace oil, and slop oil to accurately identify the source of the oil. Upon examination of the chromatogram patterns, a precise retention time match was identified between the field sample and furnace oil. However, upon analysing the individual compounds in each chromatogram (across all four samples) for their m/z fragmentation pattern, it was noted that many compounds in the field sample (such as Decane, Dodecane, Tridecane, Hexadecane, Phytane, etc.) corresponded with those in slop oil and furnace oil. Consequently, it is plausible that the oil present in the flood water originated from either furnace oil or slop oil. To precisely identify the source of the oil type, bio-marker fingerprinting analysis is required.

5. Quantification of Oil in the Contaminated Areas

The total oil present in the major environmental compartments during our sampling events in the 19 zones can be summarized into five categories:

a. Oil present in soil:

The soil contamination extent was surveyed by boat and by road through physical investigation and through drone investigation to identify the impacted zones. The total area of the impacted zones were estimated using Google Earth Pro. The depth of soil contamination varied between 1-2.5 feet in Zone 1 to 8. Estimates referring to the results of laboratory analysis an average oil concentration of 30g/kg was considered for the estimates. The volume of oil that could be entrapped in the soil is within the range of 487 cu.m. to 1623 cu.m.

Table 4: Volume of oil estimated in soil

Oil contamination in Soil		**Volume of soil contaminated (cu.m.)**	**Mass of soil contaminated (kg)**	**Oil measured in soil (concentration ~30g/kg)**	**Oil in cu.m.**	**Assuming only 30% of the soil is contaminated**
Location	**Area (sq.m.)**	**Upto 1 foot depth cu.m.**				**Sn = 0.3**
Zone 1: Entry Point 1 - Storm water canal discharge into surplus canal of Kosasthalaiyar River	30296	9088.8	24085.32	722.55	903.19	**270.95**
Zone 2 (Kattukuppam)	3007	902.1	2390.56	71.71	89.64	**26.89**
Zone 3 (B/w railway and road bridge)	3163	948.9	2514.58	75.43	94.29	**28.28**
Zone 4 (near Ennore railway bridge)	2886	865.8	2294.37	68.83	86.03	**25.81**
Zone 5 (Thazhankuppam)	5139	1541.7	4085.50	122.56	153.20	**45.96**
Zone 6 (Ennorekuppam)	3742	1122.6	2974.89	89.24	111.55	**33.46**
Zone 7 (Nettukuppam)	3232	969.6	2569.44	77.08	96.35	**28.90**
Zone 8 (bridge pier/ island in K River near Sadayankuppam)	3000	900	2385	71.55	89.43	**26.83**
Total volume of oil in cu.m. accounted so far are conservative estimates.					1623.73	**487.12**

Figure 28: Soil Contamination Zones

Figure 29: Soil Contamination Zones

b. Oil pools in islands and B Canal overflow:

Oil was found ponding along the B Canal in the upstream stretch where maximum flood levels had taken the oil above the bank of the canal and into the eastern residential and industrial areas. Oil was also found ponding within the mangrove islands after the flood water receded. Largest oil ponding was observed in Zone 1. Area of the contamination zones for oil pools were estimated using Google Earth Pro. The volume of oil ponded could be anywhere between 31.4 cu.m. to 314 cu.m.

Table 5: Volume of oil estimated in oil pools

Oil pools in hotspots	Area (sq.m.)	1 mm ponding depth	5 mm ponding depth	10 mm ponding depth	Lowest Estimate (1mm)
Overflowed along B canal	11403	11.40	57.01	114.03	**11.40**
In mangrove islands	10000	10	50	100	**10**
Oil pool near pipelines	10000	10	50	100	**10**
Total volume of oil in cu.m.		31.40	157.01	314.03	**31.40**

Figure 30: Oil pools on K river flood plain

c. Oil sheen on B Canal and K River:

Oil sheen was found on B Canal and K river, where the volume of oil has been calculated for 10 micron and 50 micron sheen thickness. Area of the contamination zones for oil sheen were provided by the coast guard. A conservative estimate would be between 1.21 cu.m. to 10.32 cu.m for 10 micron thickness. It should be noted that CPCL has already removed major part of the oily sludge floating on the river using booms and skimmers amounting to 395 tonnes.

Table 6: Volume of oil as oil sheen estimated on B Canal and K River

Oil sheen in water courses from drone				
Location	**Area (sq.m)**	**Sheen thickness - 10 micron**	**Sheen Thickness - 50 micron**	**Lowest Estimate (10 micron)**
Buckingham Canal	121765	1.21	6.08	**1.21**
Kosasthalaiyar River	1032988	10.32	51.64	**10.32**
Total volume of oil in cu.m.			57.73	**11.54**

d. Oil present in residential and industrial areas:

A survey team was deployed to assess the spread of oil in the residential and industrial zone. The team marked the oil level and referenced it with Mean Sea level using DGPS survey at every location. Three levels of inundation with total area inundated and the oil level in each zone was marked in different colours.

The area under each zone is given below along with presumed depth of oil which was present when the flood water inundated their area. The average quantum of oil inundation is estimated as 117 cu.m. assuming only 0.1 mm of oil.

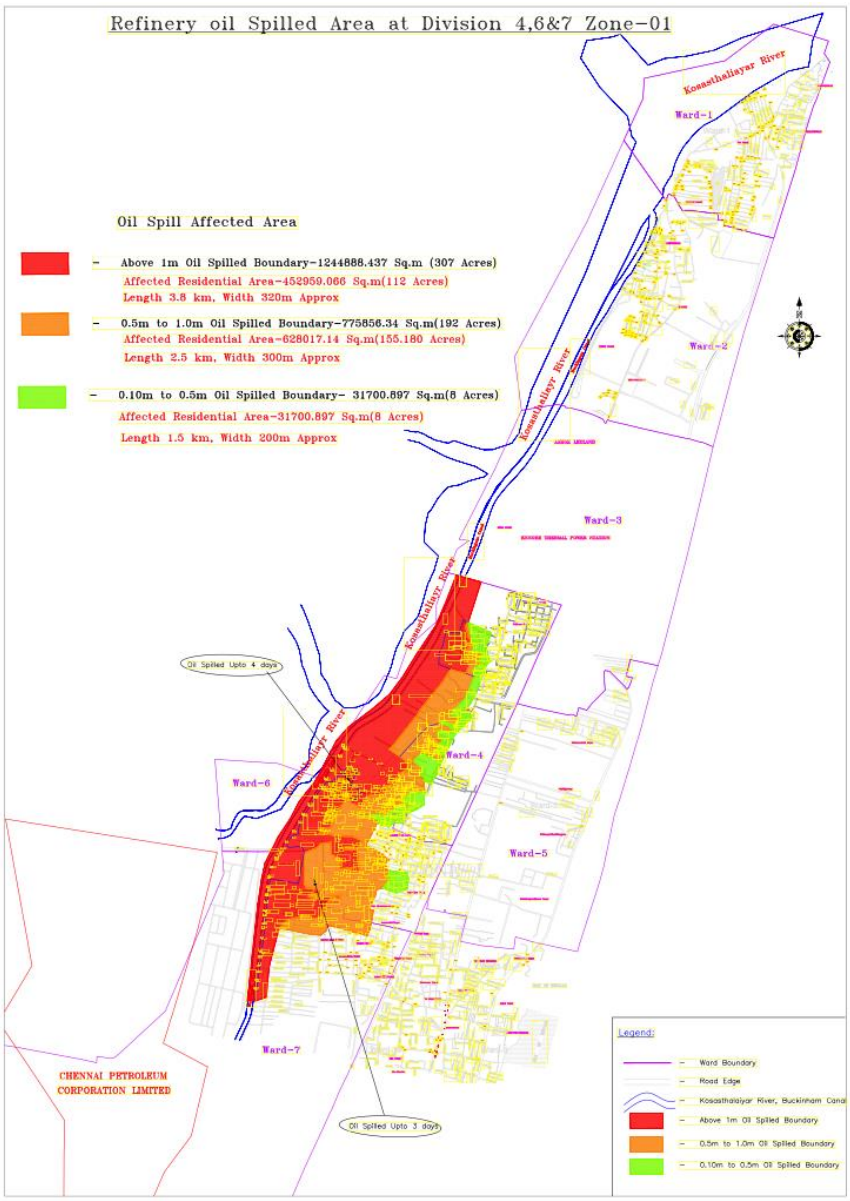

Figure 31: Map showing three levels of inundation

Table 7: Volume of oil estimated in residential and industrial areas

Oil mark in the residential areas (physical survey)	**Area [sq.m.]**	**0.1 mm oil layer**	**0.5 mm oil layer**	**1 mm oil layer**	**5 mm oil layer**	**Lowest Estimate (0.1 mm)**
Ernavoor high impact > 1m	452959	45.29	226.47	452.95	2264.79	**45.29**
Ernavoor medium impact 0.5 to 1.0.m	628017	62.80	314.00	628.01	3140.08	**62.80**
Ernavoor low impact <0.5 m	31700	3.17	15.85	31.7	158.5	**3.17**
Behind IOCL	66135	6.61	33.06	66.13	330.67	**6.61**
Total volume of oil in cu.m.		117.88	589.40	1178.81	5894.05	**117.88**

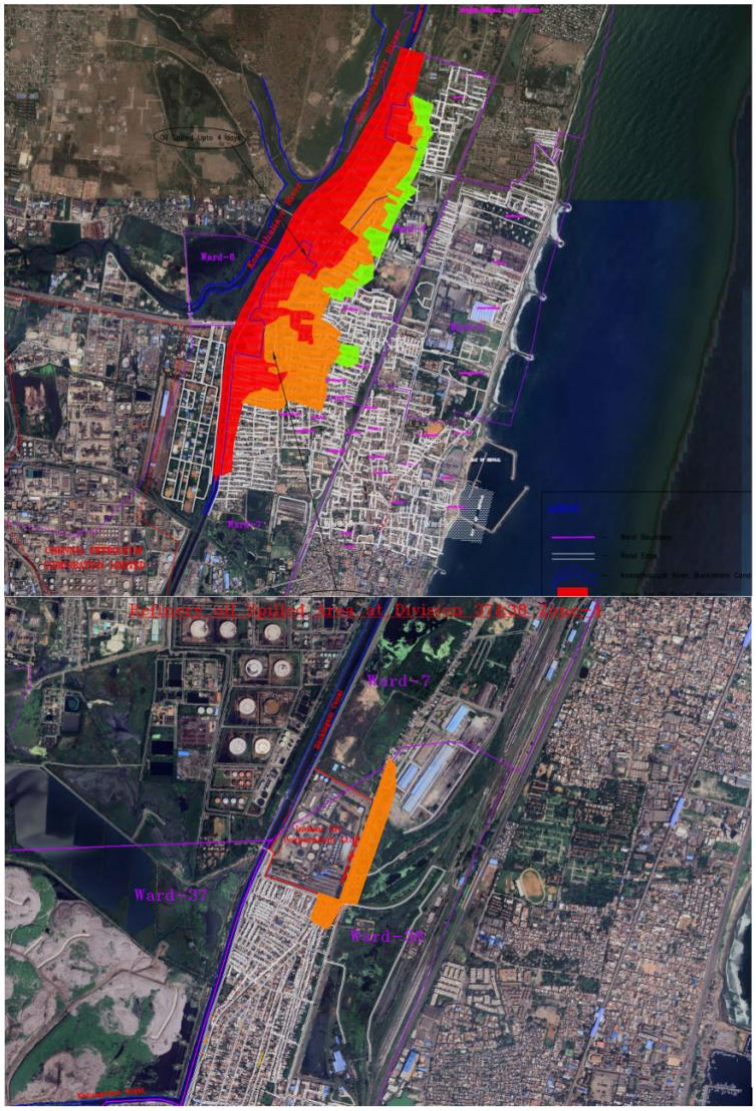

Figure 32: Close up view of the affected residential and industrial areas

e. Oil stains on mangroves and river banks:

Based on the observed length and height of the stains left behind on the banks of the K river and B canal, we estimated the oil on the river banks and mangroves assuming different thicknesses of oil layer starting from 0.01 mm, 0.1 mm and 1 mm. The average volume of oil inundation is conservatively estimated as 0.3849 cu.m. assuming only 0.01 mm of oil was floating on water.

Figure 33: Classifying the K river with the height of the oil mark in different stretches

Table 8: Volume of oil estimated on mangroves and river bank

Oil stain on banks	Length in km	Height of oil mark in m	0.01 mm	0.1 mm	1 mm	Lowest Estimate (0.01 mm)
Buckingham canal sections	15.1	0.3	0.04	0.45	4.53	**0.04**
Kosasthalaiyar section 1 (CPCL pipe line to B Canal intersection)	11.4	0.3	0.03	0.34	3.42	**0.03**
Kosasthalaiyar section 2 (CPCL pipeline to B Canal intersection)	5.8	0.3	0.01	0.17	1.74	**0.01**
Kosasthalaiyar section 3 (CPCL to Kaatukuppam)	4.7	0.3	0.01	0.14	1.41	**0.01**
Ennore Creek (Kattukuppam to Kosathalaiyar River mouth)	1.9	0.3	0.0057	0.057	0.57	**0.0057**
Oil stain on mangroves						
Kosasthalaiyar section 1, 2ft oil mark	11.4	0.6	0.068	0.68	6.84	**0.068**
Kosasthalaiyar section 2, 5ft oil mark	5.8	1.5	0.087	0.87	8.7	**0.087**
Kosasthalaiyar section 3, 8ft oil mark	4.7	2.4	0.11	1.12	11.28	**0.11**
Total volume of oil in cu.m.			0.38	3.84	38.49	**0.38**

Overall Estimates:

The oil present in the environment as observed between December 14th TO 24th, 2023 and reconfirmed on February 22nd, 2024 based on our best possible estimates and accessibility are below:

a. Oil present in soil – Estimated between 487 to 1623 cu.m. (*Not including M/s CPCL land area, inaccessible industry areas and marsh areas)
b. Oil pools in islands and B canal overflow – Estimated between 31.4 cu.m. to 314 cu.m.
c. Oil sheen on B Canal and K River: Estimated between 11.55cu.m. to 57.74 cu.m.
d. Oil stains and inundation in residential area – Estimated between 117 to 589 cu.m.
e. Oil stains on mangroves and river banks – Estimated between 0.3849 to 38.49 cu.m.

In summary the oil present in the environment is 647 cu.m. or 517 tonnes (most conservative) to 2622 cu.m. or 2097 tonnes (least conservative). The range is provided here considering the uncertainty of the depth of oil in pools, extent of depth and uniformity of soil contamination, film thickness on mangroves and walls of the residential areas.

Also these estimates has not been considered:

1. ***Floating oily Sludge removed by CPCL from the surface water and banks of Kosasthalaiyar river and Buckingham canal (395 tonnes as reported in the news media).***
2. ***Sediments - Only random samples (Oil concentration: 1000-30,000mg/kg) had been taken and a complete assessment cannot be done due to flowing water. We can take it up in future studies which will be conducted in more detail for impact assessment.***
3. ***Water – Variable with time and space due to continuous leaching of oil from banks and soil and sediment. However, it remains relatively minor compared to soil contamination.***
4. ***Other upstream locations inside and outside CPCL inundated by high flood where oil was observed.***
5. ***Inaccessible islands and marshlands of Kosasthalaiyar River.***
6. ***Oil released into sea and coasts beyond Ennore Creek.***

7. ***CPCL premises – Soil and Storm water drains within premises which were observed to have oil.***

6. Oil Estimates in Open Tanks of M/s CPCL

Google Earth images were used to assess the open tanks in M/s CPCL close to the two storm water outlets. The total area of these open tanks are worked out as 95,058 sq.m.

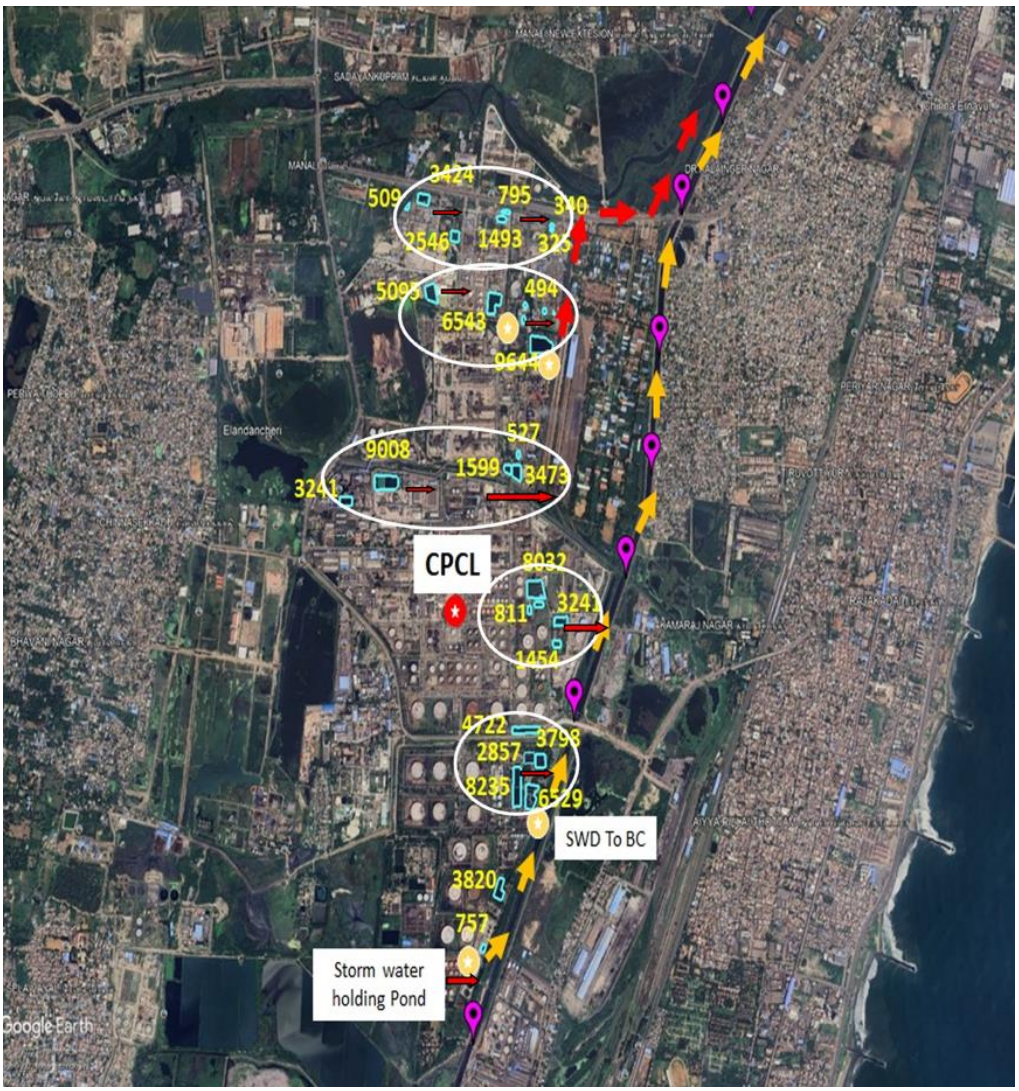

Figure 34: Open tank locations and area in sq.m.

We identified 12 out of 29 tanks containing oil-contaminated water, with six of them discharging into the stormwater drain located north of M/s CPCL (Zone 1), while the remaining six drained into the southern drain of the premises (Zone 20). Table 9 provides an

average estimate of the volume of oil stored in these tanks based on varying oil thicknesses of 1 mm, 5 mm and 10 mm.

Table 9: Location and area of open tanks present in M/s CPCL

Tank ID	Latitude	Longitude	Open tank Area sq.m]
0	13.1585	80.2839	3241
1	13.1747	80.278	2547
2	13.159	80.2821	812
3	13.1592	80.2826	1192
4	13.1598	80.2825	8032
5	13.1644	80.274	9008
6	13.1648	80.2809	1599
7	13.1647	80.2814	3473
8	13.1654	80.2816	527
9	13.17	80.2829	9645
10	13.1719	80.2802	6544
11	13.1764	80.2762	3424
12	13.1757	80.281	795
13	13.1754	80.2807	1493
14	13.1723	80.2766	5096
15	13.1714	80.2832	483
16	13.1713	80.2837	129
17	13.1751	80.2836	341
18	13.1749	80.2836	326
19	13.1761	80.2752	509
20	13.1711	80.2819	714
21	13.1717	80.282	491
22	13.1637	80.2716	3241
23	13.1476	80.2802	3820
24	13.1514	80.2821	6529
25	13.1518	80.2813	8236
26	13.1528	80.2826	3799
27	13.1576	80.2836	1454
28	13.1529	80.282	2857
29	13.1541	80.2818	4702

Table 10: Volume of oil estimated in the open tanks of M/s CPCL

	Tanks that drain to northern storm water drain	**Tanks that drain into southern storm water drain**
	6544	3799
	9645	2857
	491	8236
	1599	6529
	3473	4701
	527	3820
Total area of tanks sq.m.	**22279**	**29942**
Volume of oil in tanks in cu.m. assuming 1 mm	22.27	29.94
Volume of oil in tanks in cu.m. assuming 5 mm	111.39	149.71
Volume of oil in tanks in cu.m. assuming 10 mm	222.79	299.42

The volume of oil estimated in these exposed tanks amounts to 522 cubic meters or 417 tonnes, representing an oil thickness of 10 mm. The oil estimates from our assessment (517 tonnes) and the oily sludge removed by CPCL (395 tonnes) together sums up to 917 tonnes without including the inaccessible areas and bottom sediments of B Canal and K river. This mismatch suggests that the flood induced release from the open tanks may not have been the sole reason of the oil spill. Other possibilities could be breach of oil from other storage tanks of CPCL premises. Fingerprinting analysis using GC-MS suggests that it could be slop oil or furnace oil or mix of both.

7. Coast Guard Assessment:

On the 14th or 15th of December 2023, an assessment was conducted by the coast guard to estimate the oil spill, ten days after the flooding incident. Despite the passage of time,

remnants of oil and sheen were still detected in both inland water bodies and the sea. Estimates were derived from observations made via their helicopter-mounted camera, revealing approximately 11.6 cubic meters of oil in inland water and 12.4 cubic meters in the sea.

It's important to note that these figures may underestimate the actual volume of oil present, as there could have been higher levels of oil in the intervening days between the spill release and the assessment on December 15th. Additionally, the assessment did not fully account for the oil present in various other environments. This includes oil present in the soil, pooled on land surfaces, present on islands, coating the banks of rivers, and the stains on mangrove forests. The assessment also did not consider oil dispersed within water columns or deposited within sediments. Therefore, the actual extent of the oil contamination may be greater than indicated by the coast guard's estimate. For more detailed infirmation please refer to Appendix A

8. Tamil Nadu Pollution Control Board's Survey of M/s CPCL Premises:

The Tamil Nadu Pollution Control Board deployed its technical team to conduct an inspection at M/s CPCL, where they identified areas of concern. A Technical Committee Report was subsequently released, evaluating various sections including the stormwater drainage system, petcoke processing area, the ETP area, sludge storage tanks and ponds, sludge bioremediation process area, and crude oil storage area. Numerous observations were documented during the inspection, indicating potential areas of environmental risk.

According to the report, the average quantity of slop oil collected from different sources of the M/s CPCL premises and stored in slop tanks typically ranges between 50 KLD to 150 KLD. However, during the flood, this collection process would likely have been halted, presenting a substantial risk of washout from the ponds and effluent treatment plants. Additionally, the accumulation of oil-bearing sludge in the sludge ponds that occurred due to the maintenance of eight crude oil/sludge storage tanks, also posed a potential risk of overflow into nearby drains and water bodies during the flood. The team estimated that more than 400 KL of slop oil may have been washed away due to rising water levels. Despite

severe weather alerts, M/s CPCL reportedly lacked sufficient precautionary measures to address oil spillage, highlighting a critical gap in disaster preparedness. For more information on quantity of slop oil collected, total quantity of sludge, mass balance etc., please refer to Appendix B.

9. Recommendations and Scope for Future Work

Recommendations for Future Actions:

1. Conduct Post-Restoration Assessments: It is imperative to conduct thorough assessments after the restoration efforts of Kosasthalaiyar River, its sediments, islands, mangroves and flood plains at the surplus canal before declaring previously contaminated zones as safe. If oil residues are found restoration activity should be initiated again considering the sensitivity of the ecosystem including soil, water, flora and fauna.
2. Enhance Storage Infrastructure: Consider elevating oil sludge and slop oil storage tanks or implementing dykes to contain any potential spills. These measures can help minimize the risk of contamination and mitigate the impact of future accidents.
3. Prevent Oil Discharge from Stormwater Locations: Implement measures to prevent the discharge of oil from stormwater locations, such as installing appropriate containment systems or improving drainage infrastructure.
4. Buckingham Canal Dredging: Given the heavy siltation and long term contamination of oil in the canal consider dredging the canal to enhance its carrying capacity. This action can help improve water flow and reduce the risk of further contamination but can be more challenging as well.
5. Prevention of contamination: Continuous monitoring of the storm water drains in the Ennore industrial area and Buckingham Canal is mandatory to prevent and track contamination from industries and residential areas.

Scope for Future Work:

1. To conduct comprehensive assessments to quantify the level of contamination in water and sediment samples collected from Buckingham Canal and Ennore Creek. This data

will provide more valuable insights into the extent of pollution and aid in planning remediation efforts.

2. To quantify the amount of oil discharged into the sea during the spill event. Accurate measurements will help in assessing the environmental impact accurately.
3. To conduct detailed investigations in inaccessible areas to obtain more accurate estimates of contamination. Utilize advanced technologies and sampling techniques to access remote or challenging locations.
4. To bioremediate excavated soil in covered sheds with proper monitoring, thereby restoring contaminated soil to a healthier state.
5. Environmental Impact Assessment of the spill on water, soil, flora and fauna and Social Impact Assessment of the communities.

These recommendations and future work will contribute to better understanding and management of oil spill impacts in the Ennore region, ultimately leading to improved environmental protection and avoiding future oil spills.

10. Conclusion

The oil spill in Ennore water bodies during the Michaung Cyclone, has led to extensive environmental degradation and socio-economic impacts in the affected regions of North Chennai. This preliminary assessment report underlines the severity and spatial extent of the oil contamination in Buckingham Canal, Kosasthalaiyar River and its surrounding areas.

Field investigations revealed oil accumulation in various zones along the banks, islands and surplus canals of the Kosasthalaiyar River and banks of Buckingham Canal, with significant hotspots identified. The spillage not only contaminated water bodies but also inundated residential areas, causing damage to property, vegetation, and livelihoods. Moreover, the spill has posed a significant threat to biodiversity - affecting mangroves, birds and aquatic organisms. The quantification of the impact will be assessed in Phase 2 of the project.

The field surveys and mapping of the oil spill's aerial extent using drones provided valuable insights into the movement of oil and spatial distribution of contamination. Laboratory analysis of water and sediment samples confirmed widespread total petroleum hydrocarbon

contamination indicating the intensity of the contamination. Flooding of CPCL's open tanks during the flood was suspected as a primary source of the spill by Tamil Nadu Pollution Control Board. The estimates derived from IITM's comprehensive analysis indicates approximately more than 1000 tonnes could have been released to the environment.

Addressing the aftermath of the oil spill requires collaborative efforts from various stakeholders, implementing the recommendations outlined in this report, undertaking further research and continuous monitoring to mitigate the impacts of the oil spill and restore the well-being of affected communities and ecosystems in the Ennore region.

11. Appendix

A. Coast Guard Assessment

BUCKINGHAM CANAL/ KOSATHALAIYAR RIVER AREA

Dear Madam,

1. Kindly refer to your letter T6/TNPCB/F.12753/RL/2023 dated 13 Dec 23.

2. TNPCB vide letter ibid requested assistance of this Headquarters for estimation of quantum of Oil Spill in Ennore Creak, Buckingham Canal and Kosathalaiyar River area. Accordingly, this Headquarters deputed an expert team for quantity assessment of oil spill in the above areas.

3. **Oil Spill Quantity assessment at Ennore Creek/ Buckingham Canal/ Kosathalaiyar River Area**.

(a) **Oiled Area Measurement: -**

Ser	Name of Canal/River	Area in Sq.Mtr	Oiled Area
(i)	Buckingham canal	6100 x 60 =366000	90% = 329400
(ii)	Kosathalaiyar river	4900 x 260 =1274000	30% = 382200
(iii)	Ennore creek	1550 x 950 =1472500	10% = 147250

(b) **Appearance Coverage Allocation: -**

Ser	Name of Canal/River	Sheen	Rainbow	Metal
(i)	Buckingham canal	10%	70%	20%
(ii)	Kosathalaiyar river	10%	40%	10%
(iii)	Ennore creek	10%	30%	10%

Scanned with OKEN Scanner

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(c) **Thickness band of above appearance: -**

(i) Sheen : 0.04 µm to 0.3 µm
(ii) Rainbow : 0.3 µm to 5.0 µm
(iii) Metal : 5.0 µm to 50 µm

(d) **Minimum Volume of spilled oil calculations: -**

Ser	Name of Canal/River	Sheen (0.04 µm)	Rainbow (0.3 µm)	Metal (5.0 µm)
(i)	Buckingham canal	(329400X10%) X 0.00000004 = 0.0013	(329400 x 70%) x 0.0000003= 0.0692	(329400 x 20%) x 0.000005 =0.3294
(ii)	Kosathalaiyar river	(382200X10%) X 0.00000004= 0.0015	(382200 x 70%) x 0.0000003 = 0.0803	(382200 x 20%) x 0.000005 =0.3822
(iii)	Ennore creek	(147250X10%) X 0.00000004= 0.0006	(147250 x 70%) x 0.0000003 = 0.0309	(147250 x 20%) x 0.000005 = 0.1473
Minimum Volume of Spilled Oil				1.043 K

(e) **Maximum Volume of spilled oil calculations: -**

Ser	Name of Canal/River	Sheen (0.3 µm)	Rainbow (5.0 µm)	Me... (50 µm)
(i)	Buckingham canal	(329400X10%) X 0.0000003 = 0.009882	(329400 x 70%) x 0.000005 = 1.1529	(329400 x 20%) x 0.000050 =3.294
(ii)	Kosathalaiyar river	(382200X10%) X 0.0000003 = 0.01147	(382200 x 70%) x 0.000005 =1.3377	(382200 x 20%) x 0.000050=3.822
(iii)	Ennore creek	(147250X10%) X 0.0000003= 0.00442	(147250 x 70%) x 0.000005 =0.5154	(147250 x 20%) x 0.000050= 1.4725
Maximum Volume of Spilled Oil				11.620 KL Appx

4. **Oil Spill Quantity Assessment at Sea**. The assessment of spill at sea was carried out through aerial recce / ships. It was observed that traces of spilled oil were found in appx 20 Sq.Km area from Kasathalaiyar river mouth to Kasimedu Harbour.

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Based on the observation, the quantity assessment is as follows: -

(a) **Oiled Area Measurement**

(i) Area from Helo data :I 20 Sq.Km
(ii) Area covered with oil : 50%
(iii) Oiled Area : 20 x 50% = 10 Sq.Km

(b) **Appearance Coverage Allocation**

(i) Sheen : 80 %
(ii) Rainbow : 20%

(c) **Thickness band of above appearance**

(i) Sheen : 0.04 µm to 0.3 µm
(ii) Rainbow : 0.3 µm to 5.0 µm

(d) **Minimum Volume of spilled oil: -**

(i) Appearance Sheen : 10 Km^2 x 80% x 0.04 µm = 0.32 M^3
(ii) Appearance Rainbow: 10 Km^2 x 20% x 0.3 µm = 0.6 M^3
(iii) **Minimum Volume:** 0.32 M^3 + 0.6 M^3 **= 0.92 M^3 (0.92 KL)**

(e) **Maximum Volume of spilled oil: -**

(i) Appearance Sheen : 10 Km^2 x 80% x 0.3 µm =2.4 M^3
(ii) Appearance Rainbow: 10 Km^2 x 20% x 5 µm = 10 M^3
(iii) **Maximum Volume:** 2.4 M^3 + 10 M^3 **= 12.4 M^3 (12.4**

Regards,

Your sincerely,

(AS Ali)
Commandant
Regional Ops & Plans Officer
for Commander
Coast Guard Region (East)

B. Tamil Nadu Pollution Control Board's Survey of M/s CPCL Premises

6. Findings of the Team based on the information provided by the M/s CPCL:

As per the suggestions of the Team TNPCB requested M/s CPCL to provide certain details viz; quantity of slop oil, O&M details, the mass balance of raw materials, sludge storage, etc. M/s CPCL has submitted the following details vide letter dated 14.12.2023, the details are as below;

<table>
<tr><th>SI NO</th><th>Information requested</th><th>Information provided by CPCL</th></tr>
<tr><td>i</td><td>Oily waste material collected from day to day operations, from all the storm water ponds, ETPs and other sources and its quantity, its storage method and disposals details</td><td>Slop Oil quantity collected from storm water ponds, ETPs and other sources for the last three months is furnished below
<table>
<tr><td>Month</td><td>Quantity, KL</td></tr>
<tr><td>September</td><td>1939</td></tr>
<tr><td>October</td><td>4528</td></tr>
<tr><td>November</td><td>1238</td></tr>
</table>
Slop oil is stored in Slop Tanks and reprocessed with Crude.</td></tr>
<tr><td>ii</td><td>Whether cleaning operation carried out before Michaung flood, its collection details.</td><td>Details of major activities carried out as part of pre monsoon preparedness is furnished below:
▪ Storm water canal cleaning
▪ Building roof cleaning
▪ Dewatering pumps checking & availability</td></tr>
<tr><td>iii</td><td>Whether all the refineries are in operation during the flood, if not details shall be furnished. Further receipt of crude oil from 1st December 2023 to 9th December 2023 shall be furnished</td><td>Out of 3 Refineries, only one Refinery was in operation during flood. Other two Refineries were under circulation.
Details of Crude Oil Receipt from 01.12.23 to 09.12.23 is furnished below:
<table>
<tr><td>Date</td><td>Crude receipt in TMT</td></tr>
<tr><td>01.12.23</td><td rowspan="4">No receipt</td></tr>
<tr><td>02.12.23</td></tr>
<tr><td>03.12.23</td></tr>
<tr><td>04.12.23</td></tr>
<tr><td>05.12.23 20.48 hrs to 07.12.23 06.00 hrs</td><td>135</td></tr>
<tr><td>09.12.23 18.54 hrs to 11.12.23 hrs 07.12 hrs</td><td>99</td></tr>
</table></td></tr>
<tr><td>iv</td><td>Total quantity of Sludge stored inside the premises and its</td><td>Quantity of Sludge Stored in CPCL is 2300 KL in sludge pond. The sludge would be mechanically treated to extract oil and residual material would be</td></tr>
</table>

<table>
<tr><td></td><td>method of disposal</td><td>bioremediated. Extract oil would be reprocessed thro' crude tanks</td></tr>
<tr><td>v</td><td>Frequency of conducting spillage deduction along with details of records maintained.</td><td>Spillage Detection & Repair study is carried out yearly once in CPCL and the report is submitted to TNPCB regularly. The latest report is submitted in Jan 23 (Annexure-A)</td></tr>
<tr><td>vi</td><td>Mass balance of raw material and product manufactured</td><td>Mass balance in Tons/ day furnished below
<table><tr><td>Crude through put</td><td>28.8</td></tr><tr><td>LPG</td><td>1.0</td></tr><tr><td>Naphtha</td><td>2.4</td></tr><tr><td>Petrol (M.S)</td><td>3.0</td></tr><tr><td>ATF</td><td>3.2</td></tr><tr><td>Diesel</td><td>15.0</td></tr><tr><td>Lobs/Wax</td><td>0.8</td></tr><tr><td>Bitumen</td><td>1.2</td></tr><tr><td>Internal fuel</td><td>2.2</td></tr></table></td></tr>
<tr><td>vii</td><td>Number of unused storage tanks and number of it for maintenance

The details of date of clean in progress taken for crude oil tanks, slops storage and other.</td><td>Details of idle and M&I tanks is furnished as
Tanks released and under Maintenance
<table><tr><th>Sl. No.</th><th>Tank No.</th><th>Service</th><th>Remarks</th></tr><tr><td>1</td><td>343</td><td>DWO(HH)</td><td>Released in Oct 23</td></tr><tr><td>2</td><td>412</td><td>SK(LAB)</td><td>Released in Sep 23</td></tr><tr><td>3</td><td>418</td><td>ATF</td><td>Released in Oct 23</td></tr><tr><td>4</td><td>107</td><td>Crude</td><td>Released in Oct 23</td></tr><tr><td>5</td><td>820</td><td>Dry slop</td><td>Released in Sep 23</td></tr><tr><td>6</td><td>310</td><td>HN/DAO</td><td>Released in Mar'23</td></tr><tr><td>7</td><td>311</td><td>IN/HN/DAO</td><td>Released in Mar'23</td></tr><tr><td>8</td><td>309</td><td>Raff</td><td>Released in Jun'23</td></tr></table></td></tr>
</table>

<table>
<tr><td></td><td></td><td>
<table>
<tr><td>9</td><td>201</td><td>RFO</td><td>Released in Jun’23</td></tr>
<tr><td>10</td><td>204-D-1</td><td>VBU Feed</td><td>Released in Jun’23.</td></tr>
<tr><td>11</td><td>312</td><td>IN/HN/DAO</td><td>Released in Sep’23</td></tr>
<tr><td>12</td><td>919</td><td>Wax</td><td>Released in Oct’23</td></tr>
<tr><td>13</td><td>345</td><td>DWO/RAFF</td><td>Released in Sep’23</td></tr>
</table>
Details of tanks unused tanks:
<table>
<tr><th>Sl. No.</th><th>Tank No.</th><th>Service</th></tr>
<tr><td>1</td><td>806</td><td>Slop Oil</td></tr>
<tr><td>2</td><td>383</td><td>Wax</td></tr>
<tr><td>3</td><td>384</td><td>Wax</td></tr>
</table>
</td></tr>
<tr><td>viii</td><td>Details of the sludge stored in the open yard</td><td>All sludge is stored in concrete pit with impervious layer and is at higher elevation.</td></tr>
<tr><td>ix</td><td>Any operations carried out to protect the refinery to avoid untoward incidents during the flood time</td><td>➢ One Refinery out of 3 Refineries was operated to maintain product supply to market.
➢ Tractors trailers & fire truck were operated to bring Manpower & Material inside Refinery</td></tr>
<tr><td>x</td><td>The details of Characteristics of waste oil collected from ETPs & storm water collection ponds</td><td>Slop oil is a mixture of oil collected from various sources. Slop Oil is reprocessed with crude. Since the qty of slop oil is very minimal, analysis is not required. However as per instruction, one sample was analysed today (14.12.23) and the result is furnished below.
a) Density-0.873 gm/cc
b) Sulphur- 2.09 %
c) Flash- 37 Deg C
d) Viscosity @ 40 Deg C- 6.6</td></tr>
<tr><td>xi</td><td>The details of products sent to Manali customers and control mechanism provided to safe guard during no demand period</td><td>
<table>
<tr><th>Industry</th><th>Products</th><th>In case of No demand</th></tr>
<tr><td>TPL</td><td>LABFS</td><td>Will be absorbed in Diesel pool / converted to ATF</td></tr>
<tr><td>MPL</td><td>Propylene</td><td>Will be sold as LPG</td></tr>
</table>
</td></tr>
</table>

			KPL	PBFS		
				LPBFS		
			Cetex Petrochemicals	Butene2		
				MEKFS		

From the above information, the Team noticed the following;

- As per the information given at Sl. (i), it is inferred that the average slop oil collected from ETPs and other sources ranges from 50 kld to 150 kld. Due to heavy rain since December 03 and 04, 2023, the collection of slop oil might not be happened, this slop oil might be washed away due to rising of water levels in all ponds since the ponds were just above the ground level. As per this information, the quantity washed away might be more than 400 kl.
- As per the information given at Sl.(iv), it is inferred that 2300 kl oil-bearing sludge is being stored in the sludge pond. The same was observed during the team visit and noticed that the sludge stored was up to the brim level, the oil mixed sludge might be washed away to drain due to the flood which is directly leading to the Buckingham Canal.
- As per the information given at Sl(vii), it is inferred that eight crude oil storage tanks were taken for maintenance during September – October 2023. The oil-bearing sludge required to be separated through centrifugation and the same has to be taken for bio remediation. At least 90 days are required to complete one cycle of bio remediation. Eight tanks were taken for maintenance in the last three months, the oil bearing sludge might be stored in the ponds, due to the flood, these sludge might be washed away. One of the nearby industry namely M/s Indian Additives Ltd, reported to the TNPCB team on 04.12.2023 that the mixture of thick Black oil & water was gushed into their premises. The statement of industry also confirms that the probability of washing of oil-bearing sludge from their storage dykes.
- Inspite of sever cyclonic and heavy rain fall alert by IMD and Govt. of Tamil Nadu, the unit is not taken any precautionary measures to contain the oil spillage from

their ponds and ETPs. And also unit is not having either flood management plan or emergency contingency plan to contain oil spillage.

12. References

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