

**BEFORE THE NATIONAL GREEN TRIBUNAL,
SOUTHERN ZONAL BENCH, CHENNAI
ORIGINAL APPLICATION NO. 176 OF 2013 (SZ)
(EARLIER OA NO. 562 OF 2018 (PB))**

IN THE MATTER OF

V.P Krishnamoorthy

... Applicant

Versus

Union of India & Ors

... Respondents

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H.D. Varalaxmi

H D Varalaxmi
Regional Director

Central Pollution Control Board
Regional Directorate, Chennai - 60058

Place: Chennai
Dated: 16.08.2022

Compliance Status Report of CPCB and TNPCB in O. A. No. 176 of 2013 (SZ) (Earlier OA No. 562 of 2018 (PB)) in the matter of V. P. Krishnamurthy Vs. Union of India & Ors, as per order dated February 10, 2022

1.0 Background:

The Hon'ble National Green Tribunal, Southern Zone, Chennai, in O. A. No. 176 of 2013 (SZ) (Earlier O. A. No. 562 of 2018) in the matter of V. P. Krishnamoorthy Vs. Union of India & Ors, passed order dated 27.05.2021 that:

“6. It is seen from the compliance status report submitted by the Central Pollution Control Board and Tamil Nadu Pollution Control Board that though there was lot of improvements happened due to continues remediation process that has been undertaken by M/s. BPCL, but certain other things also will have to be carried out and they have given certain directions in this regard. Though they have mentioned in the status report that to install the Soil Gas Probes to monitor VOC in Vadose Zone of sub soil at 3 locations in affected area, which shall become part of revised remediation scheme, it was not installed. Further, they have mentioned that they have received a reply from M/s. BPCL that since the low concentration in the influent air samples of the SVE system, installation of soil gas probes may not help in monitoring the VOC. But they have not expressed their opinion as to whether that will have to be installed or not. If they have are not in agreement with the submissions made by M/s. BPCL, then they will have to express their opinion about the same, as M/s. BPCL has mentioned in their compliance report that if such a direction is given by the CPCB, they are ready to abide by the same as well.

7. So, the Central Pollution Control Board (CPCB) has to take a call on this issue and give necessary directions to M/s. BPCL in this regard.

8. It is also mentioned in the report that certain works have been undertaken by them regarding the augmentation of the SVE system by connecting as many wells as possible and by operating both the SVE Systems simultaneously to optimal extraction rate and reply to that stating that it was undertaken to be completed before 31st August, 2021. But nothing has been mentioned as to whether the same has been complied with and the usage is at optimal level as required by them. Further, in the conclusion portion of the report, certain recommendations have been given and the same will have to be carried out by M/s. BPCL in this regard.

9. The Central Pollution Control Board and the Tamil Nadu Pollution Control Board have to monitor the same as to whether the entire remediation process has been completed and whether that is sufficient to remove the damage caused to the soil and water and if there are any further steps to be taken in spite of compliance of the earlier recommendations, they are also directed to recommend the further Page 29 of 32 remediation, if any, required in this regard, so that M/s. BPCL can carry out the same and make the entire area pollution free as before.

13. The learned counsel Mr. A. Yogeshwaran appearing for the applicant in O.A. No.176/2013 (SZ) submitted that though the report of the CPCB shows the removal of Petroleum Hydro Carbon, they have not given the detailed report regarding the mass balance summary and what is are the further remedial measures required for remediating the same. The CPCB is also directed to mention these aspects as well in the report to be filed”.

A copy of the said order is annexed at **Annexure-I**.

2.0 Status of installation of Soil Gas Probe to monitor VOC in Vadose Zone:

A high level joint meeting was held under supervision of Chairman, CPCB, along with Chairman, TNPCB; CMD, Chennai Metro Rail Corporation Ltd (CMRL) and CMD, Bharat Petroleum Corporation Ltd (BPCL) to take stock of the situation on present remediation of BPCL oil contaminated site at Tondiarpet, Chennai and to finalize further Action Plan on Remediation. During the meeting followed by joint visit, on-going remediation works was reviewed and considering the field difficulties, recommended the action plans are to be implemented by M/s BPCL, wherein installation of Soil gas probes was also recommended as one of the action plans to monitor VOCs in Vadose zone of sub-soil. The said action plan supposed to be implemented upon completion of M/s CMRL works as a part of revised remediation scheme.

It is submitted that in this study, Consultant of M/s BPCL conducted detailed site assessment work at Tondiarpet during 2015 (before CMRL work) and 2021 (Post CMRL work). Soil and groundwater samples are collected and used to estimate the remediation efforts at site. Shallow soil concentration of petroleum hydrocarbon with percentage of reduction is given below:

Well Location	Depth	Sample year	DRO	GRO	TPH	% of reduction
	(Ft bgs)		mg/kg			
MW-1A/B	6.5	2015	955	BDL	955	99.92
	6.5	2021	0.51	BDL	0.70	
MW-6A/27A	16.5	2015	166.17	BDL	166.17	99.87
	16.5	2021	0.21	BDL	0.21	
MW-17A/25A	10	2015	46	259	305	99.42
	10	2021	1.68	BDL	1.78	
SVE-3/MW26A	11.5	2015	346.96	BDL	346.96	99.06
	11.5	2022	0.14	BDL	3.26	

Based on the detailed site assessment work, the result varies from low concentration in the shallow soil to below detectable concentration. Since the low concentration in the influent air samples of the SVE system has been observed, installation of soil gas probes may not require in monitoring of VOC.

3.0 Status of action taken to augment Soil Vapour Extraction (SVE) system by connecting as many wells as possible and by operating both the SVE systems simultaneously to optimal extraction rate;

The consultant of M/s BPCL i.e. M/s Stratus Environmental Inc. opted Soil Vapour Extraction (SVE-I) System as remedial option and the same was commissioned on 20.05.2016. The SVE -I system consists of 10 HP extraction blower to extract petroleum hydrocarbon vapours from the contaminated area through extraction wells and to abate them in a catalytic oxidizer & thermal oxidizer rated at 250 cubic feet per minute (CFM). Initially, installed 32 Monitoring wells (22 shallow & 10 deep wells), 9 Air Spurge (AS) Wells and 9 Soil Vapour Extraction Wells (SVE). Due to M/s CMRL works, 19 wells (9 monitoring wells, 5 AS and 5 SVE) got abandoned. After completion of M/s CMRL works, consultant installed 13 new wells (7 MW, 4 SVEW and 2 AS) as per the space availability & accessibility. In this regard, the map showing present working wells is depicted in **Annexure – 2**.

3.1 The SVE- I system was connected to a network of 14 wells comprising 9 remediation wells (SVE-1, SVE-2, SVE-3, SVE-4, SVE-5, SVE-7, SVE-8, SVE-9, SVE-10) and 5 monitoring wells (MW-2A, MW-3A, MW-4A, MW-16A MW-17A). Due to construction activity of M/s CMRL, 01 Monitoring Well (i.e. MW-17A), 03 Soil Vapour Extraction Wells (SVE) (SVE-2, SVE-3, SVE-10) and 04 AS wells (AS-1, AS-3, AS-8 and AS-10) got abandoned and 04 soil vapour wells (SVE-1, SVE-4, SVE-5 and SVE-7) network connectivity with the SVE- 1 system disrupted. Thereafter, the associated pipelines of 13 wells, namely: SVE-2A, SVE-3A, SVE-4, SVE-5, SVE-7, SVE-8, SVE-9, MW-16A, AS-4, AS-5, AS-7, AS-3A, MW-25A (were rerouted and extraction of Soil vapours was continued from 8 wells (SVE-2A, SVE-3A, SVE-4, SVE-5, SVE-7, SVE-8, SVE-9, MW-16A) and Air Sparging only operational from MW- 25A., However, the other 4 air spurge wells (AS-4, AS-5, AS-7, AS-3A) are not in operation due to non-accessibility. As per the field record maintained and data submitted, soil vapour extraction was carried out from 8 wells during September, 2020 to May, 2022. Due to removal of temporally constructed underground wall (Dewall) by M/s CMRL, pipeline of 04 Air Spurge (AS) wells and 05 Soil vapour extraction wells were disconnected. Since May 2022, 03 soil vapour extraction wells (SVE - 8, SVE-9 & MW-16A) and one air spurge well (MW-25A) were in operation. The map showing wells connected to SVE-I system is depicted **in Annexure – 3**. Due to continuous rain in November 2021, the SVE- I system was not operated during the period.

As per the recommendation of High level committee, SVE - II system having extraction capacity 500 CFM and blower capacity of 20 HP, was commissioned in November, 2019 and operation started in February, 2020 by extracting vapours from one well. Thereafter, from September, 2020 onwards SVE- II system was also operated with five other wells (MW- 4A, 2A, SVE-1, SVE-11 & SVE-12) and subsequently one more well (MW-26A) was installed in July, 2021. As per the field record maintained, SVE-II system was operated continuously by extracting soil vapour from said 6 wells till October, 2021. At first Air Sparging was started with one well (AS-6) in November, 2020, subsequently increased to two Air Spurge wells (AS-6 & BUAS1) in July, 2021. As per the suggestion of CPCB, 4 Air Spurge Wells (AS-6, BUAS-1, AS-2 & ASD1) were operated in September, 2021 for collecting more soil vapours. **Due to continuous rain and water level rise in the wells and subsequent technical problem arise in blower, the SVE-II0 system was stopped for 5 months (01.11.2021 to 31.03.2022)**. On rectification of the problem in blower (during April, 2022), operation of the SVE-II System resumed with six soil vapour extraction wells (MW- 4A, 2A, SVE-1, SVE-11 & SVE-12 & MW-26 A)

and 4 said air spurge wells. In this regard, the map showing the wells connected to SVE-II system is depicted in **Annexure – 4**.

3.2 SVE Systems – Performance Summary

- SVE-I system operated during May, 2016 to June 2022 for **41,252 hours** and SVE-II system operated from January, 2020 to June, 2022 for **5,341 hours** (**Annexure - 5**).
- As on June, 2022, SVE-I and SVE-II systems extracted approx. **15,164.41 kg and 2,181.12 kg of petroleum hydrocarbons**, respectively (**Annexure – 5**).
- As on June 2022, total quantity of petroleum hydrocarbon vapor extracted beneath the sub-surface soil through SVE-I & II systems is **17,345.53 kg** (approximately).

3.3 Mass Balance Summary of Total Petroleum Hydrocarbons (TPH) during May, 2016 – June, 2022

As per the study conducted, it was estimated that about 34,178.57 kg of Petroleum Hydrocarbon in beneath of sub-surface soil and groundwater. During remediation work and soil excavation by M/sCMRL and natural attenuation, mass balance is given below:

- a. Estimated petroleum mass as per the study conducted in 2015 - 34,178.57 kg
- b. Petroleum mass removed during remediation activity (SVE- I & II) –17,345.53 kg (**Annexure -5**)
- c. Petroleum Mass removed through Socks absorbents (2015-2020) – 69.093kg (**Annexure – 6**)
- d. Petroleum Mass removed through soil excavation by M/s CMRL during (2018-19) – 4,849.137 kg (**Annexure- 7**)
- e. Petroleum Mass removed by Natural attenuation during (2015- 2022) – 11,464.717 kg (**Annexure - 8**)

Estimated remaining mass in soil = (a – b - c – d – e)

i.e. (34,178 – 17345.53 – 69.09 – 4,849.137 – 11,464.717) = 450.093 kg

3.4 Installation of Reference Monitoring wells to compare the VOCs

As per the suggestion of CPCB, consultant to M/s BPCL has 03 constructed monitoring wells at selected reference locations in 500 m to 750 m up-gradient of the contaminated site in consultation with the officials of TNPCB & CPCB to compare the concentration of Petroleum compounds. A map showing the locations and results of the analysis is depicted in **Annexure – 9a & 9b**.

Soil samples were taken every 5 feet to observe the strata and 8 samples from each well were analysed, as per the analysis report, all samples were reported as below quantification limit.

Similarly, samples of groundwater also analysed for all shallow and deep wells, groundwater analytical data indicates that groundwater within the shallow and deep screened monitoring wells is impacted with low concentrations of petroleum hydrocarbons.

4.0 Assessment of ongoing remediation work through conducting performance of SVE-I & II system:

- i) As per field record, SVE-I system operated for **41,252 hours** during May, 2016 to June 2022 and SVE-II system operated for **5,341 hours** during January, 2020 to June 2022.
- ii) Due to M/s CMRL work and heavy rain, SVE-I and SVE-II systems were stopped for about one month and 5 months respectively. During joint monitoring by CPCB and TNPCB on July 12, 2022, both the SVE systems were found in operational.
- iii) SVE-I system was connected with available 3 vapour extraction wells (SVE- 8, 9 & MW-16A) and one air spurge well. During monitoring, extraction of petroleum hydrocarbon mass was observed from all 3 wells and operating at 98 - 99 cfm against the designed capacity of 250 cfm by sparging air from one well for better extraction of vapours.
- iv) At the time of inspection, SVE-II system was connected with 6 monitoring wells (MW-4A, 2A, SVE- 1,11,12 & 26 A) and 4 air spurge wells. It was operating at 210-225 cfm against the designed capacity of 500 cfm.

- v) As per records, SVE-I system has been operating round the clock and soil vapours extracted from 8 wells at a rate of about 27-28 cfm, which is diluted with air to 96-99 cfm. Similarly, SVE –II system was found operated for 11 -12 hrs in a day and soil vapours extracted from 5 wells at a rate of 140 – 155, which is diluted with air to 210 - 225 cfm. As per field data maintained by the operator, the hours of operation, field flow rate, inlet-outlet VOC concentration values, system flow rate and field data of past 18 month for SVE –I system and 11 months for SVE II system are annexed at **Annexure-10**.
- vi) Monthly performance data indicates that so far about 17,345.53 kg of Gasoline Range Organics (GRO) has been extracted from soil and groundwater till June, 2022. SVE-I system extracted in the range of 17.19 to 43.34 kg/month till October 2021, the concentration of extracted vapours reported as BDL continuously since December, 2021, in spite of zero concentration the system is operated for 24 hrs. The SVE-II system extracted the GRO in the range of 40.90 to 101.58 kg/month but in the month of June inlet concentration was reported as BDL. Summary of Monthly performance data of both SVE systems are depicted in **Annexure-5**.
- vii) Monitoring team conducted performance of both SVE systems by taking gas samples from inlets and outlets. The performance of both SVE systems is given at **Annexure-11**. Study indicates that SVE-I system was operating by extracting soil vapours @ 28.3 cfm with TVOC concentration of 0.3 ppm the same was fed with diluting air and maintaining system inlet flow @ 98.3cfm with TVOC concentration of 0.2 ppm. As per the monitoring report the destruction efficiency was found 100% w.r.t DRO and TPH. The less field concentration indicates that TPH vapours in the subsurface soil is reduced due to combined effect of soil excavation by CMRL and operation of SVE-I system. However, light petroleum smells were experienced in the ground water in residential area located adjacent to Agasthya Theatre. Whereas, SVE-II system was operating by extracting soil vapours @ 145 cfm with TVOC concentration of 4 ppm the same was fed with diluting air and maintaining system inlet flow @ 220.80 cfm with TVOC concentration of 3 ppm. As per the monitoring report, destruction efficiency was found 100%.

5.0 Water Quality study conducted by CPCB and TNPCB

A team of officials from CPCB and TNPCB carried out groundwater sampling in oil contaminated site at Tondairpet, Chennai on July 12, 2022. Samples were collected from monitoring wells located in and around the impacted area, the map showing shallow and deep monitoring wells in the area is depicted in **Annexure – 12 and analysis reports is annexed at Annexure - 13**. Observations and findings of the groundwater quality study is given below:

- i) Presently, 15 shallow wells (MW 25A, 16A, 3A, 4A, 2A, 20A, 5A, 13A, 23A, 30A, 28A, 26A, 7A, 15A, 18A) are existing to monitor the groundwater quality in the contaminated site. At the time of sampling it was experienced mild *VOC smell in the water of two wells (MW 4A & 2A) and light smell in seven wells (Annexure 13 - Table 1)*.
- ii) It is observed that, groundwater quality in shallow wells located in outer delineated boundary (MW 28A, 23A, 13A, 5A, 22A, 18A & 7A) shows no traces of any petroleum compounds. Apart from these, a well 3A near to SVE-II also reported no trace of petroleum compounds. In six monitoring wells (25A, 16A, 30A, 2A, 15A, 26A & 4A) located within the influenced area reported the traces of TPH, VOC, DRO, GRO & THC).
- iii) Similarly, 7 deep wells (MW 25B, 16B, 3B, 5B, 23B, 7B & 26B) are existing, out of these in 2 deep wells (3B & 7B) which are located near to hot spot of the area traces of petroleum compounds were reported. In 5 wells (MW 25B, 16B, 23B, 5B & 26 B) no trace of petroleum compound observed (**Annexure 13- Table-2**).
- iv) Concentration of Mineral Oil was found within permissible limit of 0.5 mg/L in all monitored wells. The mass reduction in terms of DRO, TPH and TOC in groundwater for seven-year span is depicted in the **Annexure 14**. The graph clearly indicates the >98 % reduction w.r.t DRO, TPH and TOC in comparison with concentration observed in 2015.
- v) During joint field visit on 01.06.2022 by the officials of CPCB & TNPCB to verify the status of remediation work, residences near to Agasthya, Theatre reported the complaint on petroleum smell in their own wells which are being used for own

purpose. Hence, groundwater samples were taken from two wells of residences and observed traces of petroleum compounds in both well (**Annexure 13 – Table 3**). One residence informed that they are treating through RO and using for household as well as drinking purpose, another residence informed that they are using only for plants and cleaning purpose.

- vi) The team also collected samples from reference wells which are located away from 500m from the hot spot, the analysis results (**Annexure 13- Table 4 &5**) indicates the traces of petroleum compounds in all three shallow wells and two deep wells (RMW-2B &3B).
- vii) The team also collected water samples from the water collected during M/s CMRL excavation and stored at M/s BPCL premises for treatment. As on date of inspection, about 4,330 kL of water being treated against the total stored water of 5,450 kL. As per the analysis results (**Annexure 13 – Table: 6**) M/s BPCL is operating treatment system efficiently and treated water is being used for firefighting system and gardening purpose.
- viii) As per the analysis report, no trace of petroleum compounds observed in the outer wells of direction North, East and West directions. However, traces of petroleum compounds were observed in core area as well as in South-East direction of outer delineated boundary of contaminated area.

6.0 Status of Health Study by ICMR

- ICMR submitted the proposal vide letter dated May 12, 2021 to TNPCB, expressed that commencement of study only after subsidence of the COVID -19 Pandemic.
- On follow up of CPCB, TNPCB organised meeting on 11.08.2021 at TNPCB, H.O., Chennai to review the status of ICMR to take up of project. The meeting was attended by the officials of CPCB, TNPCB, ICMR and BPCL. In the meeting ICMR expressed willingness to start the study on issue of work order by TNPCB along with payment of 90 % of project cost i.e. Rs. 92,81,055.50. In the meeting, it was convinced that payment to ICMR will be routed through TNPCB.

- Subsequently, ICMR expressed vide email dated August 12, 2021 that “since the reported number of COVID 19 cases have been reduced, we wish to undertake the study upon receipt of the funds from TNPCB, funds can be transferred from TNPCB to the account of ICMR-NIE mentioned in the mandate form or through a DD drawn in favour of “The Director, ICMR NIE”, payable at Chennai”. Accordingly, BPCL drawn DD for Rs. 92,81,055.50 dated 27.10.2021 and submitted to TNPCB requesting to forward the same to ICMR for starting of health study in the affected area as well as in non-affected areas **Annexure 14**.
- As per the ICMR proposal, the duration of the study was 10 months (1 month for preparatory activities, 6 months for field data collection and 3 months for laboratory testing and data analysis), the study duration starts from the date of receipt of funds.
- On receipt of 90% of the project cost, ICMR initiated the study from unexposed Area (Royapuram) on 23.02.2022 and completed the field study on 29.04.2022. Similarly, the study in exposed area (Tondairpet) was started on 02.05.2022 and expected to complete by August 15, 2022. The field study was witnessed by the officials of CPCB and TNPCB.
- As per the progress report submitted by ICMR, in unexposed area clinical evaluation was carried out for 2,748 people, in which 336 were selected for detailed study by taking samples for lab analysis. Similarly, in exposed area 1,413 people were selected for clinical evaluation and 232 people were selected for detailed study. ICMR informed that due to non-co-operation from public field investigation get delayed, lab reports are yet to receive, on completion of field study and lab analysis the complete report will be submitted to TNPCB & CPCB. A copy of progress report submitted by ICMR is annexed as **Annexure 16**.

7.0 Conclusions:

- i) Based on the detailed site assessment, the result varies from low concentration in the shallow soil to below detectable concentration. Since the low concentration in the influent air samples of the SVE system has been observed, installation of soil gas probes may not require in monitoring of VOC.

- ii) Due to removal of temporally constructed underground wall (Dewall) by M/s CMRL, pipeline of 4 Air Spurge (AS) wells and 5 Soil vapour extraction wells were disconnected. Since May 2022, the remaining 3 soil vapour extraction wells (SVE - 8, 9 & MW - 16A) and one air spurge well (25A) were connected to SVE-I system and operating continuously in spite of BDL/less concentration in extracted vapours.
- iii) The SVE-II system was operated with six soil vapour extraction wells (MW- 4A, 2A, SVE- 1, 11, 12 & 26 A) and 4 air spurge wells.
- iv) As per the study conducted based on the petroleum compounds concentration in soil and ground water, the estimated petroleum mass was 34,178.75 kg. In due course of remediation, petroleum mass removed through SVE-I & II - 17,345.53 kg, through socks absorbent - 69.093 kg, through CMRL excavation -4849.137 kg and due to Natural Attenuation – 11,464.717 kg and remaining petroleum mass in soil – 450.093 kg. As per the mass balance, 98.68 % of petroleum mass is being reduced due to cumulative effect of remediation as well as M/s CMRL soil excavation.
- v) As per the Reference well monitoring, no trace of petroleum compound observed in the soil, however traces of petroleum compounds were observed in the groundwater.
- vi) Both SVE systems are in operational and available wells are connected to both SVE systems, the inlet concentration at SVE-I & II indicates the significant reduction in the impact area.
- vii) The groundwater analytical data indicates that concentration of petroleum hydrocarbons in groundwater within the shallow and deep-screened monitoring wells has decreased significantly since 2015. As per Guidance document for assessment and remediation of contaminated sites, concentration of Chemicals of Concern in groundwater found less than screening levels (benzene at -0.005 mg/L, xylenes - 0.5 mg/L, toluene - 0.7 mg/L TPH - 0.5 mg/L and ethylbenzene -0.3 mg/L).
- viii) ICMR conducted health study in unexposed area through clinical evaluation for 2,748 people, in which 336 were selected for detailed study by taking samples for lab analysis. Similarly, in exposed area 1,413 people were selected for clinical evaluation and 232 people were selected for detailed study. ICMR informed that due to non-co-operation from public, field investigation gets delayed, lab reports are yet

to receive, on completion of filed study and lab analysis the complete report will be submitted to TNPCB & CPCB.

8.0 As per the findings of groundwater quality monitoring and the progress in carrying out health study by ICMR, the following are submitted for kind consideration of Hon'ble Tribunal:

- i) May kindly grant additional six month time for completion of qualitative health study in affected area by ICMR with project funding from M/s BPCL by considering the constraint due to non-co-operation of public to complete the field study.
- ii) M/s BPCL may discontinue the SVE-I system from present location and relocate the same to nearby Residence area where petroleum compounds reported in the groundwater.
- iii) SVE-II system shall be operated for another 6 months or may be extended its operation based on the performance assessment carried out by CPCB and TNPCB.
- iv) M/s BPCL may direct to pump the groundwater in the affected area in regular interval and to treat the same in existing treatment system at least for 6 months.

Hon'ble Tribunal may be pleased to pass appropriate order.


16/8/2022

Dr. R. Umayakunjaram
District Environmental Engineer
Tamil Nadu Pollution Control Board
Arumbakkam, Chennai-600 106



H. D. Varalaxmi
Regional Director
Central Pollution Control Board
Regional Directorate, Chennai – 600 058

Item No.5 to 14:

**BEFORE THE NATIONAL GREEN TRIBUNAL
SOUTHERN ZONE, CHENNAI**

Original Application No.176/2013 (SZ)
(Earlier O.A. No. 562/2018)

With

Original Application No.34/2014 (SZ)
(Earlier O.A. No. 563/2018)

With

Original Application No.35/2014 (SZ)
(Earlier O.A. No. 564/2018)

With

Original Application No.36/2014 (SZ)
(Earlier O.A. No. 565/2018)

With

Original Application No.37/2014 (SZ)
(Earlier O.A. No. 566/2018)

With

Original Application No. 38/2014 (SZ)
(Earlier O.A. No.567/2018)

With

Original Application No.39/2014 (SZ)
(Earlier O.A. No. 568/2018)

With

Original Application No. 40/2014 (SZ)
(Earlier O.A. No.569/2018)

With

Original Application No. 41/2014 (SZ)
(Earlier O.A. No.570/2018)

With

Original Application No. 42/2014 (SZ)
(Earlier O.A. No. 571/2018)

V.P.Krishnamoorthy

Versus

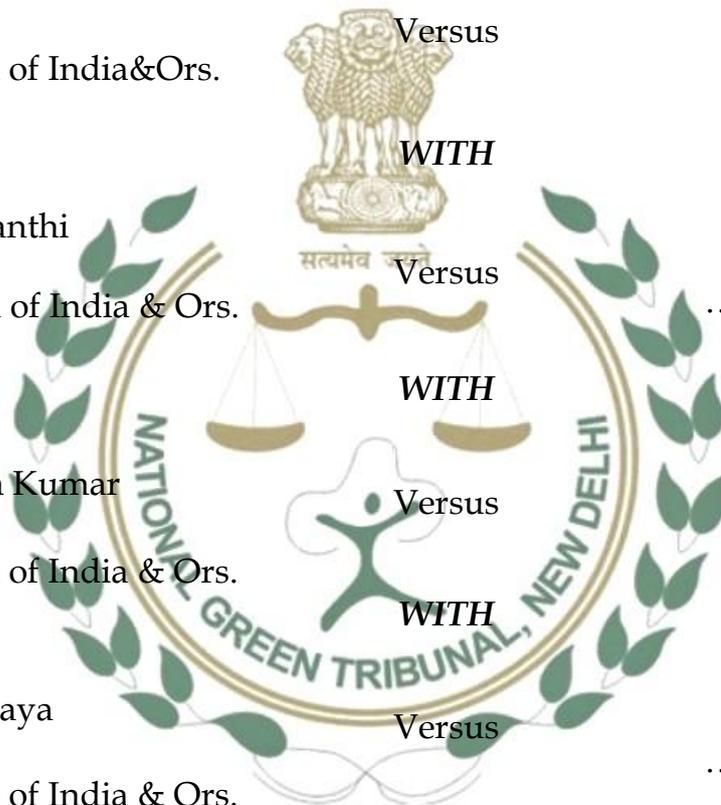
....Applicant(s)

The Union of India&Ors.

....Respondent(s)

WITH

K.S.Jayaraman		....Applicant(s)
	Versus	
The Union of India&Ors.		....Respondent(s)
	WITH	
R.Selvi		....Applicant(s)
	Versus	
The Union of India&Ors.		....Respondent(s)
	WITH	
K.Umachandran		....Applicant(s)
	Versus	
The Union of India&Ors.		....Respondent(s)
	WITH	
Smt. S. Shanthi		....Applicant(s)
	Versus	
The Union of India & Ors.		....Respondent(s)
	WITH	
G. Mahesh Kumar		....Applicant(s)
	Versus	
The Union of India & Ors.		....Respondent(s)
	WITH	
Smt. R. Vijaya		....Applicant(s)
	Versus	
The Union of India & Ors.		....Respondent(s)
	WITH	
K. Sampath Kumar		....Applicant(s)
	Versus	
The Union of India & Ors.		....Respondent(s)
	WITH	
K. Kamalakannan		....Applicant(s)
	Versus	
The Union of India & Ors.		....Respondent(s)



WITH

G. Purushothaman

Versus

....Applicant(s)

The Union of India & Ors.

....Respondent(s)

Date of hearing: 10.02.2022.

O.A. No.176/2013:-

For Applicant(s):

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For Respondent(s):

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Mr. S. Sai Sathya Jith for R3.

Mr. Krishna Srinivasan represented

M/s. Ramasubramaniam Associates for R6.

Mr. D.S. Ekambaram along with

Mrs. P. Jayalakshmi for R12.

O.A. No.34 to 42/2014:-

For Applicant(s):

Mr. Kandhan Doraisamy.

For Respondent(s):

Mr. Krishna Srinivasan represented

M/s. Ramasubramaniam Associates for R3.

Dr. D. Shanmuganathan for R4.

Mr. S. Sai Sathya Jith for R5.

CORAM:

HON'BLE MR. JUSTICE K. RAMAKRISHNAN, JUDICIAL MEMBER

HON'BLE Dr. SATYAGOPAL KORLAPATI, EXPERT MEMBER

ORDER

1. As per order dated 27.05.2021, this Tribunal had extracted the order passed on 08.07.2020 in Para (1) of the order and considered the status report submitted by the Central Pollution Control Board dated

15.12.2020, e-filed on 09.03.2021 and extracted in Para (5) of the order and also considered the reply affidavit with regard to the objection filed by M/s. BPCL to the earlier report and the same was extracted in Para (7) of the order and then, passed the following order:-

“8. It is seen from the reply statement that they have given a detailed reasons as to why they have come to such conclusion in their report regarding the compliance report showing some deficiencies in the SVE system and directing the M/s. BPCL to modify the same. Being an expert body on this aspect, we accept the reply submitted by the Central Pollution Control Board in this regard and direct the M/s. BPCL to carry out the directions issued by the Central Pollution Control Board as requested for in this reply statement namely, direct the M/s. BPCL to carry out detailed site investigation and risk investigation study to evolve Site Specific Target Levels (SSTLs) for remediation of oil contaminated site at Tondiarpet, Chennai and direct the M/s. BPCL to augment SVE system by connecting as many wells as possible and by operating both the SVE system simultaneously to optimal extraction rate.

9. So, M/s. BPCL is directed to carry out these directions issued by the Central Pollution Control Board as part of remediation process.

10. The learned counsel appearing for the M/s. BPCL submitted that they have already complied with the direction as well. If that be the case, the Central Pollution Control Board is directed to inspect these areas with the Tamil Nadu Pollution Control Board and ascertain as to whether the directions issued by them have been complied with or not. If it is not complied with, then they are directed to issue further necessary direction in this regard and submit a detailed report to this Tribunal before the next hearing date.

11. The Tamil Nadu Pollution Control Board is also directed to carry out the directions issued by the Central Pollution Control Board in their status report which has been mentioned above.

12. The matter is pending since 2013 onwards and the remediation process are still in progress. Unless the remediation process is completed, it cannot be said that the purpose of directions issued by this Tribunal have been fully complied with or implemented and the damage caused to the environment has been restored to its original position.

13. Mr. Kandhan Doraisamy, the learned counsel appearing for the applicants in O.A. No.34/2014 to 42/2014 submitted that during the lock down period, the water as undertaken by the M/s. BPCL has not been supplied and when the officials were contacted, they said that they have entered into a contract with the CMWSSB for supply of water and they are doing it, but no water supply has been done.

14. When this was pointed out, the learned counsel appearing for the M/s. BPCL submitted that all arrangements have been made and they will ensure that the water supply will be properly done as undertaken by them. The officials of the M/s. BPCL are directed to look into the issue and resolve the same and comply with the direction issued by this Tribunal for supply of water to the people of the locality who have been affected on account of the contamination caused to the ground water in that area.

15. The Central Pollution Control Board as well as the Tamil Nadu Pollution Control Board and the M/s. BPCL are directed to file their further status and compliance report including the steps taken regarding further remediation process that is being suggested by the CPCB and regarding the health study that is directed to be done by the ICMR and submit the reports to this Tribunal on or before 27.08.2021 by e-filing in the form Searchable PDF/OCR Supportable PDF and not in the form of Image PDF along with necessary hardcopies to be produced as per Rules.

16. The Registry is directed to communicate this order to the members of the committee, Central Pollution Control Board, Tamil Nadu Pollution Control Board, BPCL by e-mail immediately for their information and compliance of the direction."

2. The case was originally posted to 27.08.2021 for consideration of further compliance report and progress of the remediation process. Thereafter, the matter has been adjourned from time to time by successive notifications and lastly, it was adjourned to today by notification dated 17.01.2022.

3. We have received the status report submitted by the Project Proponent namely, the 6th Respondent dated 23.08.2021, e-filed on 24.08.2021 which reads as follows:-

**STATUS REPORT FILED BY BHARAT PETROLEUM CORPORATION LIMITED
IN COMPLIANCE OF THE ORDER DATED 27.05.2021 OF THE HON'BLE
NATIONAL GREEN TRIBUNAL.**

The 6th Respondent (Bharat Petroleum Corporation Limited – BPCL) humbly submits as follows:

1. By Order dated 27.05.2021, this Hon'ble Tribunal accepted the recommendations of CPCB in their Reply Affidavit dated 19.06.2020 and directed BPCL:
 - a. to carry out detailed site investigation and risk investigation study to evolve Site Specific Target Levels (SSTLs) for remediation of oil contaminated site at Tondiarpet, Chennai; and
 - b. to augment SVE system by connecting as many wells as possible and by operating both the SVE system simultaneously to optimal extraction rate.

2. Thereafter, CPCB issued letter dated 03.08.2021 whereby BPCL was directed to submit compliance report in respect of following four items (which includes the two items mentioned in paragraph 1 above).
 - a. As per the action plan decided in joint meeting at the highest level held under the chairmanship of Chairman, CPCB at Chennai on March 01, 2019, upon completion of CMRL soil excavation works, M/s.BPCL to submit a Detailed Project Report (DPR) for revised remediation scheme based on re-assessment of site along with the specific target levels (SSTLs) for remediation based on human health risk assessment.
 - b. Installation of Soil Gas Probes to Monitor VOCs in Vadose Zone of Subsoil at 3 locations in affected area, which shall become part of revised remediation scheme.
 - c. Augmentation of SVE system by connecting all available wells to both SVE system and to operate both SVE systems continuously to optimize soil vapor extraction.
 - d. Steps taken to entrust the health impact study to ICMR.

3. In response, by letter dated 06.08.2021, BPCL provided its response to the four items suggested by CPCB. Further, by letter dated 05.08.2021, BPCL submitted the Detailed Project Report (DPR) prepared by BPCL's consultant namely Stratus

Territory Manager (Retail), Chennai
Bharat Petroleum Corporation Ltd.

International Inc. along with the Review of the DPR conducted by Dr. Indumathi M. Nambi, Ph.D., Professor, IIT, Madras, who had earlier reviewed the detailed site assessment report in the year 2015 and had been involved with the Tondiarpet contaminated site since the incident happened in the year 2013.

DIRECTIONS BY CPCB

4. As mentioned above, CPCB by its letter dated 03.08.2021 had suggested four items which includes the two items contained in the Reply Affidavit dated 19.06.2020 filed by CPCB. The four items and BPCL's response to the same as informed to CBCP vide BPCL's letter dated 06.08.2021 are extracted below:

"i. As per the action plan decided in joint meeting at the highest level held under the chairmanship of Chairman, CPCB at Chennai on March 01, 2019, upon completion of CMRL soil excavation works, M/s BPCL to submit a Detailed Project Report (DPR) for revised remediation scheme based on re-assessment of site along with site specific target levels (SSTLs) for remediation based on human health risk assessment.

We have already forwarded the Detailed Project Report (DPR) vetted by IIT, Madras as per reference no.TNP: OPS: 7/CON dated 05.08.2021.

As per the direction of the CPCB and TNPCB, BPCL's consultant Stratus Environmental, Inc. (Stratus), conducted an environmental site investigation between February and March 2021 to reassess the extent of petroleum hydrocarbon impact to soil and groundwater post CMRL excavation activity, and reinstalled monitoring borewells (replacement of wells lost due to CMRL activity) to evaluate the lateral extent of impact to groundwater.

Stratus has prepared a Detailed Project Report (DPR) to present the findings of the site assessment conducted at the Bharat Petroleum Corporation Limited (V. P Koil Street – T.H Main Road) Petroleum Contaminated Site, Tondiarpet, Chennai.

Based on the DPR, Stratus does not recommend a revised remediation scheme for the site. Given the presence of residual petroleum hydrocarbon mass between 25 to 35 feet bgs, Stratus recommended addition of more wells to SVE systems for soil vapor extraction. Stratus recommended connecting newly installed wells 26A, located in the alley, and well MW-25A, located in Devi Polymer property to the SVE-2, and SVE-1 respectively. Stratus in the DPR state that continued operation of SVE and AS would be adequate to remediate the residual mass in soil and groundwater.

ii. Installation of Soil Gas Probes to Monitor VOCs in Vadose zone of Subsoil at 3 locations in affected area, which shall become part of revised remediation scheme.

Given the low concentration in the influent air samples of the SVE system, we do not believe soil gas probes installation would be necessary at this point. However, if CPCB insists, we will direct Stratus to install the soil gas probes.

iii. Augmentation of SVE system by connecting all available wells to both SVE

As per the direction of the CPCB and TNPCB, BPCL's consultant Stratus Environmental Inc.(Stratus), have been focusing on extraction of petroleum hydrocarbon vapours from wells available for remediation activity in and around CMRL work area and in contaminated areas.

SVE SYSTEM OPERATION

Stratus is currently operating two SVE systems to mitigate petroleum hydrocarbon impact on the subsurface near VPK Street and TH Road, Tondiarpet, Chennai. The SVE -1 system consists of 10 HP extraction blower & SVE -2 system consists of a 20 HP Liquid ring vacuum pump used to extract petroleum hydrocarbon vapors from the contaminated area using vapor extraction wells. The extracted vapors are abated in a catalytic oxidizer & thermal oxidizer rated at 250 (CFM) and 500 (CFM) in systems SVE-1 and SVE-2, respectively.

In May 2019, Stratus completed the installation of 2 remediation (SVE-2a, SVE-3a) and 1 air sparge (AS-3a) wells in earmarked locations along T.H main road to compensate for those lost due to CMRL activity (see attached Figure) and these wells are connected to SVE unit-1. In November 2019, Stratus completed the installation of 2 remediation wells (SVE-11, and SVE-12) which are shown on figure 2. Stratus completed the construction activity to connect the remediation wells (SVE - 1, 11, 12 & MW - 2A, 4A) to the SVE unit-2. In March 2021, Stratus completed the installation of 2 remediation wells (MW-25A, and MW-26A) and 1 air sparge well (ASB-1) which are shown in the attached figure. In June 2021, Stratus connected the remediation wells (MW- 26A, ASB-1 & DBAS- 1) to the SVE unit-2.

Stratus began operating the SVE -1 system in May 2016 and SVE-2 beginning 13th January 2020. SVE-1 is operated 24-hours a day and SVE -2 is being operated for 12 hours since 10th June 2020.

SVE unit 1 is connected to remediation wells listed below.

Well ID	Operational status
SVE - 2A, 3A, 4, 5, 7, 8, 9 & MW - 16A	Currently in operation

SVE unit 2 is connected to remediation wells listed below

Well ID	Operational status
MW - 2A, 4A, 26A, SVE- 1, 11, 12	Currently in operation

AIR SPARGING UNIT OPERATION

Air Sparging unit-1 is currently operated at SVE Unit-2 and connected to AS wells listed below.

Well ID	Operational status
AS - 6, ASB - 1	Currently in operation
AS - 2, DBAS - 1	Currently not in operation

We are ready to go ahead with the health impact study at any moment direction to that effect is received from CPCB and TNPCB. As per the minutes of meeting conducted on 23.04.2021 through VC with officials of CPCB, TNPCB and ICMR ,the following is the latest status in this regard.

“ ICMR officials informed that Human Ethics Committee of ICMR has suggested carrying out the health hazard study after the COVID – 19 situation in view of the data collection like blood and urine samples from the affected people in the oil contaminated place at Tondiarpet will not reflect the accurate information.

In the meeting it was concluded that ICMR shall furnish a detailed report obtained from National Institute of Epidemiology containing proposal of health hazard study at affected place of Tondiarpet with information of proposed date of start of the study, time duration along with cost estimation, release of fund for study etc. to CPCB & TNPCB so as to proceed further in this regard as per Hon'ble court order.”

Again as per the letter no. NIE/D/TNPCB/21/15 dated 12th May 2021 addressed to The Member Secretary, TNPCB, ICMR clarified that their Institutional Human Ethics Committee (IHEC) has approved the study in principle and suggested that the initiation of the study may be postponed till COVID 19 pandemic subsides.

We are yet to get any direction in this regard from CPCB & TNPCB or ICMR.”

STATUS OF REMEDIATION ACTIVITIES

5. The executive summary of the assessment studies and remedial activities of petroleum contaminated site from 2015 to 2021 is provided below.

2015 Site Assessment – Key Findings

Residual Hydrocarbon Mass

- Based on the Soil analytical data, Stratus has calculated that approximately, **32,797.61 kg** of residual TPH is still remaining in the soil in 2015.
- Based on the Groundwater analytical data the residual mass of TPH in groundwater is estimated to be approximately **1,380.97 kg** in 2015.
- Cumulatively, **34,178.57 kg** of residual TPH is estimated to be present in soil and groundwater in 2015 at the petroleum contaminated site.

Estimated Mass of TPH present in Soil Surface (2015) (Kg)	Estimated Mass of (TPH) present in Groundwater (2015) (Kg)	Cumulative TPH Mass present in Soil and Groundwater(2015) (Kg)
32,797.61	1,380.97	34,178.57

Remedial Activities

SVE Systems Operation

- The SVE -1 unit has extracted approx. **15,058.05 Kilograms of petroleum hydrocarbons (TPH)**, as of June 2021.
- The SVE -2unit has extracted approx. **1,887.94 Kilograms of petroleum hydrocarbons (TPH)**, as of June 2021.
- Total amount of petroleum hydrocarbon vapor extracted beneath the subsurface soil through SVE 1 & 2 was estimated an amount of **16,945.99 Kilograms** (approximately) as of June 2021.

Estimated Mass of TPH Extracted by SVE-1 (May 2016) – June 2021) (Kg)	Estimated Mass of TPH Extracted by SVE-2 (January 2020) – June 2021) (Kg)	Cumulative Mass of TPH extracted by SVE- 1 & SVE-2(June 2021) (Kg)
15,058.05	1,887.94	16,945.99

Free Product Recovery (Socks Absorbent)

- Free product was not observed or identified in any of the existing or newly installed monitoring wells and borings during the 2021 site assessment. Free product removed through absorbent socks from 2015 - 2021 was calculated to an amount of **69.093 Kg** in the petroleum contaminated site from 2015- 2021.

CMRL Excavation Activity

- TPH mass removed by CMRL activity in the contaminated zone was 4,849.137 Kilograms (approximately) from 2018- 2019.

2021 Site Assessment – Key Findings

Residual Hydrocarbon Mass

- Based on the Soil analytical data, Stratus has calculated that approximately, **1053.93 kg** of residual TPH is still remaining in the soil in March 2021, in comparison to estimated mass of **32,797.61 kg** of TPH in 2015.
- Based on the Groundwater analytical data the residual mass in ground water is estimated to be approximately **2.11kg** in March 2021, compared to **1,380.97 kg** of TPH estimated in 2015.
- Cumulatively, **1,056.043 kg** of residual TPH is estimated to be present in soil and groundwater in March, 2021 at the petroleum contaminated site.

Estimated Mass of TPH present in Soil Surface (2021) (Kg)	Estimated Mass of (TPH) present in Groundwater (2021) (Kg)	Cumulative TPH Mass present in Soil and Groundwater(2021) (Kg)
1,053.93	2.11	1,056.043

Mass Balance Summary of TPH from 2015 – 2021

- Below table summarize the total TPH mass estimated in 2015 assessment, Mass removed by SVE units and absorbent socks, Mass removed by CMRL

Initial TPH Mass (2015) (Kg)	Mass Removed by SVE 1 & 2 (May, 2016-Feb, 2021) (Kg)	Mass Removed by Socks (2015-2020) (Kg)	Mass Removed by CMRL (2018-2019) (Kg)	Mass Removed by SVE units (Unaccounted)/ Natural Attenuation factors (Kg)	TPH Mass Remaining (March, 2021) (Kg)
34,178.57	16,739.58	69.093	4,849.137	11,464.717	1056.043

- The total TPH mass removed till February 2021 is estimated to be 33,122.527Kgs (SVE units -16,739.58 kg, Socks Absorbent - 69.093 kg, unaccounted mass removed by SVE units/ Natural Attenuation factors- 11,464.717 kg and CMRL remediated soil- 4849.137 kg).
- The reduction is calculated to be 96.91% of the total mass estimated in 2015 (34,178.57 kg).

Future Plan of Action

- Installation and commissioning of second air sparge system in SVE Unit - 1.
- Connect AS-4,5,7,3a and SVE-8 (dual purpose) to second air sparge system in SVE Unit -1.
- Connect MW-25A to SVE Unit -1 for soil vapors extraction.
- Stratus will focus on extraction of petroleum hydrocarbon vapors from wells available for remediation activity in and around CMRL work area and in contaminated areas. Stratus will also collect data to evaluate system performance and estimate mass removed.

SUPPLY OF WATER BY BPCL

6. BPCL has been supplying 18,000 ltrs. of water through metro water on a daily basis. This is evidenced from the water supply report of Chennai Metro water for the months of April to July 2021.

HEALTH STUDY BY ICMR

7. In respect of the health study to be conducted by ICMR, by letter dated 12.05.2021, ICMR informed TNPCB that the health study may be postponed till Covid-19 pandemic subsists. Subsequently, by letter dated 12.08.2021, ICMR informed TNPCB that they are ready to proceed with the health study for a total value of Rs.1,12,67,125/- and 90% of the said amount would have to be paid immediately and the balance 10% after submission of the final report. Thereafter, by letter dated 13.08.2021 which was received by BPCL on 16.08.2021, TNPCB directed BPCL to make payment to ICMR through TNPCB in the mode of Demand Draft as mentioned above. BPCL is in the process of making the advance payment of 90% for the health study.

DOCUMENTS

8. The following documents are submitted by BPCL:
 - a) Water Supply Report of Metro Water;
 - b) Detailed Project Report dated 15.04.2021;

- c) Letter dated 01.08.2021 from IIT, Madras to BPCL;
- d) Letter dated 03.8.2021 from CPCB to BPCL;
- e) Letter dated 05.08.2021 from BPCL to TNPCB;
- f) Letter dated 06.08.2021 from BPCL to CPCB;
- g) Letter dated 12.08.2021 with enclosures from ICMR to TNPCB; and
- h) Letter dated 13.08.2021 from TNPCB to BPCL.

4. The Central Pollution Control Board and the Tamil Nadu Pollution Control Board has filed a compliance status report dated 26.08.2021, e-filed on the same date which reads as follows:-

“Compliance Status Report of CPCB and TNPCB in the matter of O. A. No 176 of 2013 (SZ) (Earlier OA No 562 of 2018 (PB)), V. P. Krishnamurthy Vs Union of India & Ors, as per order dated May 27,2021.”

Background:

The Hon'ble National Green Tribunal, Southern Bench, Chennai, in the matter of O. A. No. 176 of 2013 (SZ) (Earlier O. A. No. 562 of 2018); V. P. Krishnamoorthy Vs. Union of India & Ors, passed an order dated 27.05.2021 that:

“8. It is seen from the reply statement that they have given a detailed reason as to why they have to such conclusion in their report regarding the compliance report showing some deficiencies in the SVE system and directing the M/s BPCL to modify the same. Being an expert body on this aspect, we accept the reply submitted by the Central Pollution Control Board in this regards and direct the M/s BPCL to carry out the directions issued by the Central Pollution Control Board as requested for in this reply statement namely, direct the M/s BPCL to carry out detailed site investigation and risk investigation study to evolve Site Specific Target Levels (SSTLs) for remediation of oil contaminated site at Tondiarpet, Chennai and direct the M/s BPCL to augment SVE system by connecting as many well as possible and by operating both SVE system simultaneously to optimal extraction rate.

9. So, M/s BPCL is directed to carry out these directions issued by the Central Pollution Control Board as part of remediation process.

10. The Learned Counsel appearing for the M/s BPCL submitted that they have already complied with the directions as well. If that be the case, the Central Pollution Control Board is directed to inspect these areas with the Tamil Nadu Pollution Control Board and ascertain as to whether the directions issued by them have been complied with or not. If it is not complied with, then they are directed to issue further necessary direction in this regard and submit a detailed report to this Tribunal before the next hearing date.

11. The Tamil Nadu Pollution control Board is also directed to carry out the directions issued by the central Pollution Control Board in their status report which has been mentioned above.

15. The Central Pollution Control Board as well as the Tamil Nadu Pollution Control Board and the M/s BPCL are directed to file their further status and compliance report including the steps taken regarding the health study that is directed to be done by the ICMR and submit the reports to this Tribunal on or before 27.08.2021 by e-filing in the form Searchable PDF/OCR supportable PDF and not in the form of Image PDF along with necessary hardcopies to be produced as per Rules".

A copy of the said order is annexed at **Annexure-I**.

1. Status of Compliance by BPCL w.r.t CPCB directions:

- A. To carry out detailed site investigation and risk assessment study to evolve Site Specific Target Level (SSTLs) for remediation of Oil contaminated site at Tondiarpet, Chennai;**

M/s BPCL submitted the Detailed Site Assessment Report (Post CMRL Excavation) on 06.08.2021, the summary of the assessments are as below;

- i. Three soil borings of depth 70 feet, & dia of 8 inch (one near to the Oil pipe where leakage occurred (hot spot) , second one in peripheral of south side,

third one in peripheral of North-East direction) were installed at the strategic locations adjacent to existing monitoring wells. The soils samples were taken in 5 feet interval, the samples were analysed, the mass reduction in terms of Total Petroleum Hydro Carbon (TPH) in six year span is depicted in **Annexure - 2**. The analysis reports indicates that;

- Low concentrations of Diesel Range Organics (DRO) were reported in almost all samples, the detected concentrations are in the range of 0.08 mg/kg - 144.61 mg/kg.
- Gasoline Range Organics (GRO) were found below detectable limit (0.01 mg/kg) in most of the samples analysed. Low concentrations were reported at few locations, ranging from 0.02 mg/kg to 4.49 mg/kg.
- Low concentrations of Total Petroleum Hydrocarbon (TPH) were reported in almost all samples, the detected concentrations ranged from 0.08 mg/kg to 153.83 mg/kg.
- Higher concentrations of TPH were reported in soil samples collected between 35-36.5 feet bgs in MW-26A (153.83 mg/kg.) located near SVE-3, 10-11.5 feet bgs in Boring-2 (25.09 mg/kg) located near MW-16AB in Devi polymer property, and in ASB-1 (23.02 mg/kg) & (50.58 mg/kg) located near MW-1AB in Vardhraj Perumal Koil Street.
- Benzene, Toulene, ethyl benzene, Xylene, PAH and naphthalene were not reported in any of the soil samples.
- The DRO & TPH Concentrations detected in soil samples collected in February 2021 are significantly lower, compared to the concentrations recorded in 2015 site assessment.

Overall, there is a significant reduction in petroleum hydrocarbon concentrations in soil compared to 2015 data. As per the Ministry of Environment and Forestry (MOEF) document titled Guidance document for assessment and remediation of contaminated sites in India, dated March 2015, screening levels for benzene at 0.5 mg/kg, xylenes at 5 mg/kg, toluene at 3 mg/kg naphthalene at 1 mg/kg and ethylbenzene 5 mg/kg, for a residential neighborhood. For TPH an intervention response level of 5,000 mg/kg. TPH, benzene, xylenes,

ethylbenzene, and naphthalene concentration are low and not exceeded the response levels. At a few areas high DRO and TPH concentrations continue to exist (MW-26A, MW-25AB and ASB-1) between 20

- 55 feet bgs that warrant continuation of remediation.

- ii. *Seven more new wells (5 shallow wells having depth of 25-35 feet and 2 deep wells of 65-75 feet) were installed to compensate the wells abandoned due to CMRL Excavation, all these wells were monitored once in a month, the reduction of contamination is given at Annexure -3.*

The analysis reports of Shallow wells;

- *DRO was not detected in most of the shallow screened monitoring wells. Low concentrations were reported at few wells ranging from 0.08 mg/L to 0.66 mg/L at MW-25A and MW-26A respectively which are adjacent to abandoned wells MW-17A & MW-12A.*
- *TPH was not detected in most of the shallow screened monitoring wells. Low concentrations were reported at few wells ranging from 0.08 mg/L to 0.66 mg/L at MW-25A and MW-26A respectively.*
- *Benzene and naphthalene were not reported in any of the groundwater samples collected. only Xylenes reported in MW-2A with concentration of 76.50 mg/L.*
- *The DRO & TPH Concentrations detected in groundwater samples collected from the existing shallow screened wells and newly installed wells adjacent to the abandoned wells in March 2021 are significantly lower, compared to the DRO & TPH concentrations recorded in 2015 site assessment.*
- *Polycyclic Aromatic hydrocarbons (PAH) were not detected in any of the ground water samples.*

The analysis reports of Deep wells;

- *DRO was not detected in most of the shallow screened monitoring wells. Low concentrations were reported at few wells ranging from 0.10 mg/L to 0.35 mg/L at MW-26B and MW-3B, respectively.*

- TPH was not detected in most of the shallow screened monitoring wells. Low concentrations were reported at few wells ranging from 0.10 mg/L to 0.35 mg/L at MW-26B and MW-3B, respectively.
- Benzene and naphthalene were not reported in any of the groundwater samples collected. Only Xylenes reported in MW-3B with concentration of 22.97 mg/L.
- The DRO & TPH Concentrations detected in groundwater samples collected from the existing deep screened wells and newly installed wells adjacent to the abandoned wells in March 2021 are significantly lower, compared to the DRO & TPH concentrations recorded in 2015 site assessment.

- Polycyclic Aromatic hydrocarbons (PAH) were not detected in any of the ground water samples.

Overall, the groundwater analytical data indicates that concentration of petroleum hydrocarbons in groundwater within the shallow and deep-screened monitoring wells has decreased significantly since 2015. As per the Ministry of Environment and Forestry (MOEF) document titled Guidance document for assessment and remediation of contaminated sites in India, dated March 2015, identifies screening levels for, benzene at 0.005 mg/L, xylenes at 0.5 mg/L, toluene at 0.7 mg/L, TPH at 0.5 mg/L and ethylbenzene 0.3 mg/L, for drinking water. TPH, benzene, and ethylbenzene concentrations are not exceeding the screening levels.

iii. Quantification of Residual Hydrocarbon mass in contaminated site;

- Based on the analytical data and TPH Iso concentration contour maps of Soil [0'-50'] feet bgs, the lateral extent of petroleum hydrocarbon impact to soil was calculated.
- Approximately, **1053.93 kg** of residual TPH is estimated to be present in soil in comparison to estimated mass of 32,797.61 kg of TPH in 2015 (Annexure - 4).
- Based on the Groundwater analytical data and TPH Iso concentration

contour maps of groundwater in shallow and deep screened wells (*Annexure -5*) the lateral extent and impact of petroleum hydrocarbon impact to groundwater was calculated.

- Residual mass in groundwater is estimated to be approximately 2.11 kg in March 2021, compared to 1,380.97 kg of TPH estimated in 2015 (*Annexure - 6*).

iv. Mass Balance Summary of TPH during 2015 – 2021

The total mass estimated in 2015 assessment, Mass removed by SVE units and absorbent socks, Mass removed by CMRL activity and unaccounted mass removed by SVE units during the high slug movement into the treatment system till February 2021 and the remaining mass present at site in 2021 are given below;

Initial Mass (2015) (Kg)	Mass Remove dby SVE (2016-2021) (Kg)	Mass Remove dby Socks (2015-2020) (Kg)	Mass Removed by CMRL (2018-2019)(Kg)	Mass Removed by SVE units (Unaccounted)/ Natural Attenuation factors (Kg)	Mass Remaini n g (2021) (Kg)
34,178.57	16,739.58	69.093	4,849.137	11,464.717	1056.043

v. Observations and recommendations of the re assessment study

- Significant reduction in soil and groundwater concentrations is being observed due to remedial efforts and natural attenuation.
- Residual mass continues to be present in the 25 to 35 feet bgs interval that warrants continuation of remediation.
- Although low concentrations of petroleum hydrocarbons are being reported in groundwater samples, not recommend to use of groundwater in private bore wells.
- Higher concentrations of DRO and TPH observed between 25 and 35 feet bgs at a few locations, hence to continue SVE systems to reduce concentration of

petroleum hydrocarbons in soil for a period of at least 6 months.

- *Also to continued operation of the air sparge system located at SVE Unit -2. In addition, study recommends operation of a second air sparge system at SVE Unit-1 and connecting the second AS system to wells AS-3a and SVE-8.*
- *And also recommend to connecting newly installed wells 26A, located in the alley, and MW-25A, located in Devi Polymer property to the SVE-2, and SVE-1 respectively.*

B. To install soil Gas Probes to monitor VOCs in Vadose zone of sub-soil at 3 locations in affected area, which shall become part of revised remediation scheme;

No Soil Gas Probes to monitor VOC in Vadose zone of sub soil is installed, it is informed that " since the low concentration in the influent air samples of the SVE system, installation of soil gas probes may not help in monitoring of VOC."

C. To augment SVE system by connecting as many wells as possible and by operating both the SVE systems simultaneously to optimal extraction rate;

*Presently operating two SVE systems to mitigate petroleum hydrocarbon impact on the subsurface near VPK Street and TH Road, Tondiarpet, Chennai. The SVE -1 system consists of **10 HP extraction blower** & SVE -2 system consists of a **20 HP Liquid ring vacuum pump** used to extract petroleum hydrocarbon vapors from the contaminated area using vapor extraction wells. The extracted vapors are abated in a catalytic oxidizer & thermal oxidizer rated at **250 (CFM)** and **500 (CFM)** in systems SVE-1 and SVE-2, respectively. As per National Green Tribunal (NGT) court order and based on affidavit filed by CPCB on 6th July 2017, the consultant of M/s BPCL (M/s Stratus Environmental INC) obtained permission from CMRL to access the contaminated area under its control. The Stratus began operating the SVE -1 system in May 2016 and SVE-2 beginning **22nd September 2017**. SVE-1 is operated 24-hours a day and SVE -2 is being operated for **12 hours** since **10th June 2020**.*

SVE -1 is connected with 8 wells (MW- 2A, 3A, 4, 5, 7, 8, 9 & MW – 16A) and SVE- 2 is connected with 7 wells (MW – 2A, 4A, 26A, SVE- 1, 11, 12). The Air

sparging unit -1 is started operated at SVE-2 system and connected to 4 Sparging wells (AS – 6, ASB – 1, AS – 2, DBAS – 1). However, in SVE -1, commissioning of air compressor is under progress, it is informed that before August 31, 2021, five air sparging wells (AS-4,5,7,3a and SVE-8) will be connected to SVE -1 system.

SVE Systems –Performance Summary

- SVE system 1 has operated for **34,311 hours** since 20th May 2016 and SVE system 2 operated for **3,581 hours** since 13th January 2020 as of June 2021.
- The SVE -1 unit has extracted approx. **15,058.05 Kilograms of petroleum hydrocarbons**, as of June 2021.
- The SVE -2 unit has extracted approx. **1,887.94 Kilograms of petroleum hydrocarbons** as of June 2021.
- Total amount of petroleum hydrocarbon vapor extracted beneath the subsurface soil through SVE 1 & 2 was estimated an amount of **16,945.99 Kilograms** (Approximately)as of June 2021.

D. To take immediate steps to entrust the health impact study to ICMR;

- As per the follow-up of CPCB, TNPCB convened meeting on 23.04.2021 through Video conference to review the status of award of health study to ICMR. The meeting was attended by the officials of CPCB, TNPCB, ICMR and BPCL. The discussions held and conclusion of meetings are as below;

- M/s BPCL informed that they are coordinating with ICMR to entrust the study of health hazard in the oil contaminated site at Tondiarpet and also informed about they obtained technical & financial approval from corporate office for awarding the project to ICMR.
- ICMR informed that the project proposal was considered by various committees of ICMR and also expressed that the project could not dealt directly with ICMR due to conflict of interest and influence by the funder and requested to arrange payment of cost of study either through TNPCB or CPCB.

- ICMR also expressed the suggestion of Human Ethics committee to carrying out the health hazard study after the COVID -19 Pandemic in view of the data collection like blood and urine samples from the affected people in the oil contaminated site at Tondiarpet will not reflect the correct picture.

- On detailed discussion, CPCB & TNPCB official asked ICMR to furnish detailed project report of National Institute of Epidemiology containing proposal of health hazard study at affected place of Tondiarpet with information on proposed date of commencement of the study. The copy of Minutes meeting is enclosed at **Annexure -7**

o As decided in the meeting, ICMR submitted the proposal vide letter dated May 12, 2021 (**Annexure -8**) to TNPCB and expressed that commencement of study only after subsidence of the COVID -19 Pandemic.

o On further follow up of CPCB, TNPCB organised meeting on 11.08.2021 at TNPCB, H.O., Chennai to review the status of ICMR to take up of project. The meeting was attended by the officials of CPCB, TNPCB, ICMR and BPCL. In the meeting ICMR expressed willingness to start the study on issue of work order by TNPCB along with payment of 90 % of project cost. In the meeting it was convinced that payment will routed through TNPCB either in the form of Cheque or DD drawn by BPCL in the name of ICMR, the minutes of meeting is enclosed as **Annexure .9**.

o Subsequently ICMR expressed vide mail dated August 12, 2021 that **“Since the reported number of COVID 19 cases have been reduced, we wish to undertake the study upon receipt of the funds from TNPCB, funds can be transferred from TNPCB to the account of ICMR-NIE mentioned in the mandate form or through a DD drawn in favour of “The Director, ICMR NIE”, payable at Chennai”**

o As per the ICMR proposal, the duration of the study is 10 months (1 month for preparatory activities, 6 months for field data collection and 3 months for laboratory testing and data analysis) , the study duration starts from the date of

receipt of funds.

- On receipt of proposal, TNPCB directed M/s BPCL vide letter dated 13.08.2021 to issue work order to ICMR along with release of 90% of the total project cost Rs. 1,01, 40413.00 in the mode of DD favour of "The Director, ICMR NIE" payable at Chennai and the same may be delivered to ICMR through O/o TNPCB.

2. Status of Remediation work of Oil contaminated site at Tondiarpet, Chennai

- i) BPCL installed Soil Vapour Extractions (SVE) system to extract mass of Petroleum hydrocarbons from soil and groundwater, 1st SVE was commissioned in May, 2016. The vapours extracted from wells are disposed by incineration incatalytic oxidiser.
- ii) Operation of 1st SVE system got disrupted during the year 2017 due to commencement of Chennai Metro Rail Limited works, which resulted in disconnection of underground pipe network of various monitoring wells, vapour extraction wells and air spraining wells connected to 1st SVE system. As a result, the said SVE system was relocated and re-commissioned between September-October, 2018.
- iii) Due to limited capacity of 1st SVE system, Committee constituted by Hon'ble NGT under Chairman, CPCB directed BPCL to install additional SVE system. Accordingly, BPCL has installed 2nd SVE system in November, 2019 with vapour extraction capacity of 500 cubic feet per minute (cfm). Some of the SVE wells and Air Sparging wells are connected to 2nd SVE system located in the premises of Dal Mill property along V.P.K. Street.
- iv) During joint monitoring by CPCB and TNPCB on August 06, 2021 both SVE systems were found in operation.
- v) 1st SVE system was connected with 8 Soil Vapour Extraction wells ((MW-2A, 3A, 4, 5, 7, 8, 9 & MW - 16A). During monitoring, extraction of petroleum hydrocarbon mass was observed from all 8 wells and operating at 98 - 99 cfm against the designed capacity of 250 cfm.
- vi) At the time of inspection, 2nd SVE system was connected with 7 monitoring wells MW-16A and extraction petroleum hydrocarbon mass was observed from 5

wells only. It was operating at 210-225 cfm against the designed capacity of 500 cfm.

vii) Monitoring team conducted performance of both SVE systems by taking gas samples from inlets and outlets. The performance of both SVE system is given at **Annexure-10**. Study indicates that 1st SVE system was operating at 1/3rd of design capacity with destruction efficiency of 58-59%, whereas 2nd SVE system was operating at 45% capacity with 98% destruction efficiency.

viii) As per records, 1st SVE system has been operating round the clock and soil vapours extracted from 8 wells at a rate of about 27-28 cfm, which is diluted with air to 96-99 cfm. Similarly, SVE -2 was found operated for 11 -12 hrs in a day and soil vapours extracted from 5 wells at a rate of 140 - 155, which is diluted with air to 210 -225 cfm. As per the field data maintained by the operator, the hours of operation, field flow rate, inlet-outlet VOC concentration values, system flow rate and field data of past 18 month for SVE 1 and 11 month for SVE 2 system are given at **Annexure-11**.

ix) Monthly performance data indicates that so far about 16,945.94 kg of Gasoline Range Organics (GRO) has been extracted from soil and groundwater till June 2021 at an average of about 102.72 & 143.38 kg of GRO extracted per month through SVE 1 & 2 respectively. Summary of Monthly performance data of SVE system is given at **Annexure-12**.

x) It was observed that vapours from different wells were extracted without air sparging in SVE 1 system. Field data indicates that the extracted vapours has only GRO which is having lower carbon ranges, however higher carbon range from soil and groundwater can be extracted through SVE system when air sparging is performed. This is evident from the fact that analysis results of groundwater indicate presence of DRO, TPH and THC which are of higher carbon ranges.

3. Water Quality study conducted by CPCB & TNPCB

A team of officials from CPCB and TNPCB carried out groundwater sampling in oil contaminated site at Tondairpet, Chennai on August 06, 2021. Samples were collected from monitoring wells located in and around the impacted area. Observations and findings of the groundwater quality study is given below:

i) At the time of sampling it was noticed that, 7 out of 22 shallow monitoring

wells were abandoned due to Chennai Metro Rail Limited (CMRL) construction works. To replace abandoned wells 5 more new wells were constructed near to abandoned wells. There was no accessibility to collect samples from 5 monitoring wells, hence remaining 15 shallow monitoring wells were monitored.

ii) Out of 10 deep monitoring wells, 2 wells were abandoned due to CMRL works, to replace these, two more constructed to represent abandoned wells. During inspection 3wells were not having access (being junction road and private premises), therefore samples were collected from 7 deep monitoring wells, the details of MWs installed and map showing its location are given at **Annexure-13**.

iii) The analysis report of groundwater samples carried out from monitoring wells on 06.08.2021 is given at **Annexure-14**.

iv) It is observed that, groundwater quality in shallow wells located in outer delineated boundary shows no traces of any petroleum compounds. However, monitoring wells located in core area i.e MW- 2A, 4A, 15A, 16A, 25A and 30 A shows presence of TPH, DRO, THC and TOC.

v) Similarly in Deep monitoring wells located in outer delineated boundary shows no traces of any petroleum compounds, the well located in core area i.e MW 3B& 7B reported the traces of petroleum compounds.

vi) Concentration of Mineral Oil was found within permissible limit of 0.5 mg/L in all monitored wells..

vii) As per the analysis report, no traces of petroleum compounds observed in South and West delineated boundary of contaminated site. However, traces of petroleum compounds were observed in core area as well as in North and South-East direction of outer delineated boundary of contaminated area.

4. Conclusions :

i. M/s BPCL has taken steps to reassessment of contaminated site upon completion of CMRL works by installing new bores and additional monitoring wells, as per the assessment, concentration of petroleum hydrocarbon in soil found reduced significantly compared to 2015 data. As per Guidance document for assessment and remediation of contaminated sites, The concentration of Chemicals of Concern in soil were found less than screening levels (benzene - 0.5 mg/kg, xylenes - 5 mg/kg, toluene - 3 mg/kg, naphthalene - 1 mg/kg, ethylbenzene -5 mg/kg, TPH - 5,000 mg/kg). At a few areas high DRO and TPH

concentrations continue to exist (MW-26A, MW-25AB and ASB-1) between 20 - 55 feet bgs that warrant continuation of remediation. The groundwater analytical data indicates that concentration of petroleum hydrocarbons in groundwater within the shallow and deep-screened monitoring wells has decreased significantly since 2015. As per Guidance document for assessment and remediation of contaminated site. The concentration of Chemicals of Concern in ground water found less than screening levels (benzene at -0.005 mg/L, xylenes - 0.5 mg/L, toluene - 0.7 mg/L TPH - 0.5 mg/L and ethylbenzene - 0.3 mg/L).

ii. As per the Mass balance summary, estimated total mass of petroleum Hydrocarbon was 34,178.57 kg (in 2015), the mass removed through remediation is 16,739.58, through socks - 69.093 kg (floating oil), through CMRL exaction - 4,849.137 kg and natural Attenuation- 11,464.717kg. Mass remaining in soil is 1056.043 kg.

iii. Both SVEs are in operation and wells are connected to both SVE system, the inlet concentration at SVE-1 indicates the significant reduction in South and South-East direction

iv. ICMR submitted the proposal vide letter dated May 12, 2021 to TNPCB and expressed that commencement of study only after subsidence of the COVID - 19 Pandemic. However, in last meeting held on August 11, 2021, ICMR expressed to commence the study on receipt of work order along with payment of 90% of project from TNPCB. Subsequently, ICMR submitted the detailed proposal along with tentative activity chart. As per that, the duration of the study is 10 months (1 month for preparatory activities, 6 months for field data collection and 3 months for laboratory testing and data analysis) , the study duration starts from the date of receipt of funds.

v. TNPCB directed the M/s BPCL vide letter dated August 13, 2021 to issue work order and to release 90% of project cost to ICMR to conduct health hazardous study in Tondiarpet contaminated site.

5. As per the findings of groundwater quality monitoring and the progress in carrying out health study by ICMR, the following are submitted for consideration of Hon'ble Tribunal:

i) May grant about 10 months' time for completion of qualitative

health study in affected area by ICMR with project funding from BPCL by considering the constraint due to COVID – 19 pandemic.

ii) BPCL may optimize operation of 1st SVE system by installing air sparging to improve extraction of Higher Carbon ranges from soil.

iii) BPCL may carry out reference soil & ground water analysis by taking samples (from different depth) from 500 mts away from the contaminated site in upward direction to understand the concentration of Hydro carbon in non-contaminated area and also to fix the target level of remediation.

iv) TNPCB may conduct regular monitoring of ground water as well as performance of SVE systems to ensure the continuous operation of remediation activity.

Hon'ble Tribunal may be pleased to pass appropriate order."

5. The Tamil Nadu Pollution Control Board also filed a report signed by the officer on 13.09.2021, e-filed on 15.09.2021 which reads as follows:-

**"REPORT FILED ON BEHALF OF THE RESPONDENT -
TAMIL NADU POLLUTION CONTROL BOARD"**

I, R. Rajanickam, S/o P.M. Ramasamy, Hindu, aged about 57 years, having office at No.76, Mount Salai, Guindy, Chennai-600 032, do hereby solemnly affirm and sincerely state as follows:

I am the Joint Chief Environmental Engineer, Tamil Nadu Pollution Control Board and I am filing this Report on behalf Tamil Nadu Pollution Control Board and as such I am well acquainted with the facts of the case as per records.

1. It is respectfully submitted that the Hon'ble National Green Tribunal, Southern Bench, Chennai, in the matter of O. A. No. 176 of 2013 (SZ) (Earlier O. A. No. 562 of 2018); V. P. Krishnamoorthy Vs. Union of India & Ors, passed an order dated 27.05.2021 that:

"11. The Tamil Nadu Pollution control Board is also directed to carry out the directions issued by the central Pollution Control Board in their status report which has been mentioned above.

15. *The Central Pollution Control Board as well as the Tamil Nadu Pollution Control Board and the M/s BPCL are directed to file their further status and compliance report including the steps taken regarding the health study that is directed to be done by the ICMR and submit the reports to this Tribunal on or before 27.08.2021 by e-filing in the form Searchable PDF/OCR supportable PDF and not in the form of Image PDF along with necessary hardcopies to be produced as per Rules”.*

2. *It is respectfully submitted that in pursuance to the above order dated 27.5.2021, the said site was inspected by Officials of TNPCB & CPCB on 6.8.2021 and the joint inspection report is enclosed vide Annexure - 1A.*

3. *It is respectfully submitted that TNPCB convened a meeting on 23.04.2021 through video conference to review the status of award of health study to ICMR. The meeting was attended by the officials of CPCB, TNPCB, ICMR and BPCL and minutes of the meeting is enclosed vide Annexure – 2A. . Based on the meeting, ICMR submitted the proposal vide letter dated May 12, 2021 to TNPCB and expressed that commencement of study will be taken up only after subsidence of the COVID -19 Pandemic.*

4. *It is respectfully submitted that TNPCB organized second meeting on 11.08.2021 at TNPCB, Chennai to review the status of progress of the project including health study by ICMR. The meeting was attended by the officials of CPCB, TNPCB, ICMR and BPCL. In the meeting ICMR expressed willingness to start the study on issue of work order by TNPCB along with payment of 90 % of project cost. In the meeting, it was convinced that payment will be routed through TNPCB either in the form of Cheque or DD drawn by BPCL in the name of ICMR and insisted to furnish work plan with cost of the study project. The minutes of meeting is enclosed as Annexure .3A.*

5. *It is respectfully submitted that ICMR has furnished work plan wherein the duration of the study is mentioned 10 months (1 month for preparatory activities, 6 months for field data collection and 3 months for laboratory testing and data analysis) and the health study will be started immediately after the initial payment of 90% of the project cost.*

6. *It is respectfully submitted that TNPCB has communicated M/s BPCL vide letter dated 13.08.2021 to issue work order to ICMR along*

with release of 90% of the total project cost Rs. 1,01, 40413.00 in the mode of DD favour of "The Director, ICMR NIE" payable at Chennai.

Under the above circumstances, it is humbly prayed that this Hon'ble National Green Tribunal (Southern Zone) may be pleased to take this Report on record and pass such further or other orders as this Hon'ble Tribunal may deem fit and proper in the facts and circumstances of this case and thus render justice."

6. It is seen from the compliance status report submitted by the Central Pollution Control Board and Tamil Nadu Pollution Control Board that though there was lot of improvements happened due to continues remediation process that has been undertaken by M/s. BPCL, but certain other things also will have to be carried out and they have given certain directions in this regard. Though they have mentioned in the status report that to install the Soil Gas Probes to monitor VOC in Vadose Zone of sub soil at 3 locations in affected area, which shall become part of revised remediation scheme, it was not installed. Further, they have mentioned that they have received a reply from M/s. BPCL that since the low concentration in the influent air samples of the SVE system, installation of soil gas probes may not help in monitoring the VOC. But they have not expressed their opinion as to whether that will have to be installed or not. If they have are not in agreement with the submissions made by M/s. BPCL, then they will have to express their opinion about the same, as M/s. BPCL has

mentioned in their compliance report that if such a direction is given by the CPCB, they are ready to abide by the same as well.

7. So, the Central Pollution Control Board (CPCB) has to take a call on this issue and give necessary directions to M/s. BPCL in this regard.

8. It is also mentioned in the report that certain works have been undertaken by them regarding the augmentation of the SVE system by connecting as many wells as possible and by operating both the SVE Systems simultaneously to optimal extraction rate and reply to that stating that it was undertaken to be completed before 31st August, 2021. But nothing has been mentioned as to whether the same has been complied with and the usage is at optimal level as required by them. Further, in the conclusion portion of the report, certain recommendations have been given and the same will have to be carried out by M/s. BPCL in this regard.

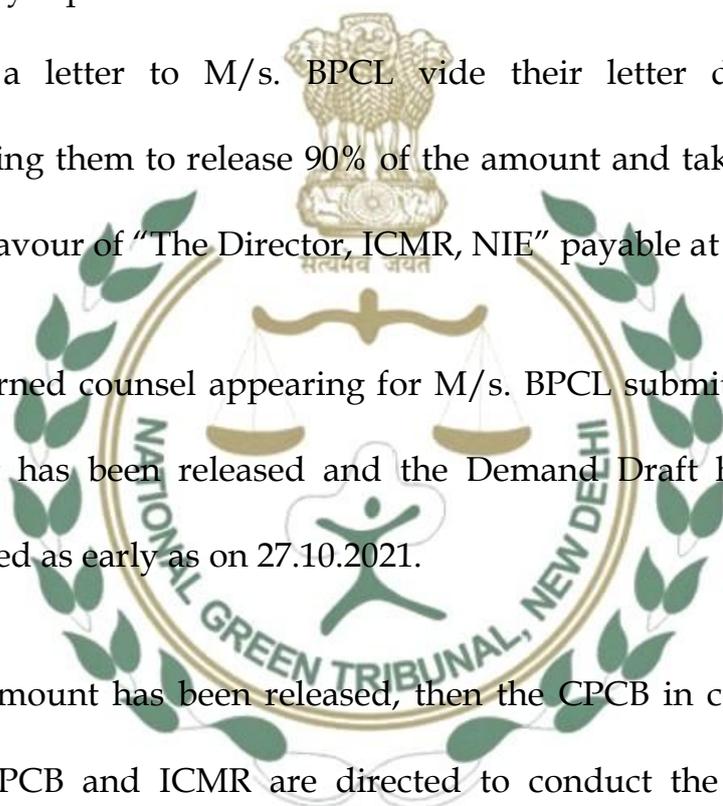
9. The Central Pollution Control Board and the Tamil Nadu Pollution Control Board have to monitor the same as to whether the entire remediation process has been completed and whether that is sufficient to remove the damage caused to the soil and water and if there are any further steps to be taken in spite of compliance of the earlier recommendations, they are also directed to recommend the further

remediation, if any, required in this regard, so that M/s. BPCL can carry out the same and make the entire area pollution free as before.

10. It is also seen from the report that the ICMR has quantified the amount required for the study as Rs.1,01,40,413/- and 90% of the amount will have to be released in advance and the balance 10% can be paid after the study report was submitted. The State Pollution Control Board had issued a letter to M/s. BPCL vide their letter dated 13.08.2021, requesting them to release 90% of the amount and take in the mode of DD in favour of "The Director, ICMR, NIE" payable at Chennai.

11. The learned counsel appearing for M/s. BPCL submitted that the said amount has been released and the Demand Draft has been sent as requested as early as on 27.10.2021.

12. If the amount has been released, then the CPCB in coordination with the TNPCB and ICMR are directed to conduct the health study as directed and obtain the report and if any further remediation is required on the basis of the health study conducted, that also will have to be suggested by them to be carried out by M/s. BPCL to remedy the situation fully.



13. It is also seen from the reports that the ICMR required 10 months time for this purpose. The amount has been released as early as on 27.10.2021 and almost three months have lapsed after the release of the amount. Considering the circumstances, we feel that six months time can be granted to the ICMR to complete the study and the CPCB to file a further compliance report and further recommendations, if any, required in this regard, after a period of six months.

14. The learned counsel Mr. A. Yogeshwaran appearing for the applicant in O.A. No.176/2013 (SZ) submitted that though the report of the CPCB shows the removal of Petroleum Hydro Carbon, they have not given the detailed report regarding the mass balance summary and what are the further remedial measures required for remediating the same. The CPCB is also directed to mention these aspects as well in the report to be filed.

15. The TNPCB is also directed to file an independent report regarding the improvements in that area, after completion of the remediation work that has been undertaken by M/s. BPCL.

16. M/s. BPCL is also directed to file a further progress cum compliance report regarding the remediation work undertaken by them and if any

to be undertaken by them on the basis of the observations made by the CPCB in their report dated 26.08.2021.

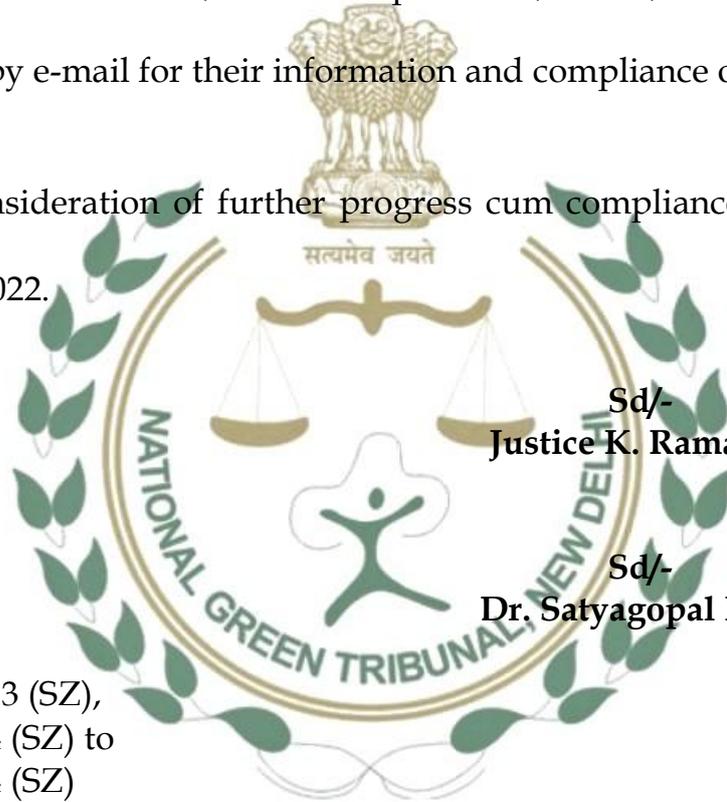
17. Mr. Kandhan Doraisamy, the learned counsel appearing of the applicant in some of the cases submitted that M/s. BPCL has not supplied the quantity of water undertaken by them for the last six months. But this was denied by the learned counsel appearing for M/s. BPCL and they relied on the monthly supply chart produced by them along with their compliance report. It is very difficult for the Tribunal to monitor all those things. The Tribunal can only direct the M/s. BPCL to comply with the direction of supply of water and if there is any complaint regarding the non-supply, they will have to sort it out with the persons to whom the contract for supply has been entrusted by them.

18. M/s. BPCL is directed to ascertain from the CMWSSB regarding the complaint of non-supply of water made by the learned counsel Mr. Kandhan Doraisamy who is appearing for the applicant in some of the cases and if there is any gap, then they are directed to settle the same with them and see that the supply of water as directed by this Tribunal to the persons affected in that area is not disturbed.

19. They are directed to submit their respective reports to this Tribunal on or before 18.08.2022 by e-filing in the form of Searchable PDF/OCR Supportable PDF and not in the form of Image PDF along with necessary hardcopies to be produced as per Rules.

20. The Registry is directed to communicate this order to the members of the Joint Committee, official respondents, CPCB, NEERI, TNPCB and ICMR by e-mail for their information and compliance of directions.

21. For consideration of further progress cum compliance report, post on 18.08.2022.



Sd/-
Justice K. Ramakrishnan, JM

Sd/-
Dr. Satyagopal Korlapati, EM

O.A. No.176/2013 (SZ),
O.A. No.34/2014 (SZ) to
O.A. No.42/2014 (SZ)
10th February, 2022. Mn.

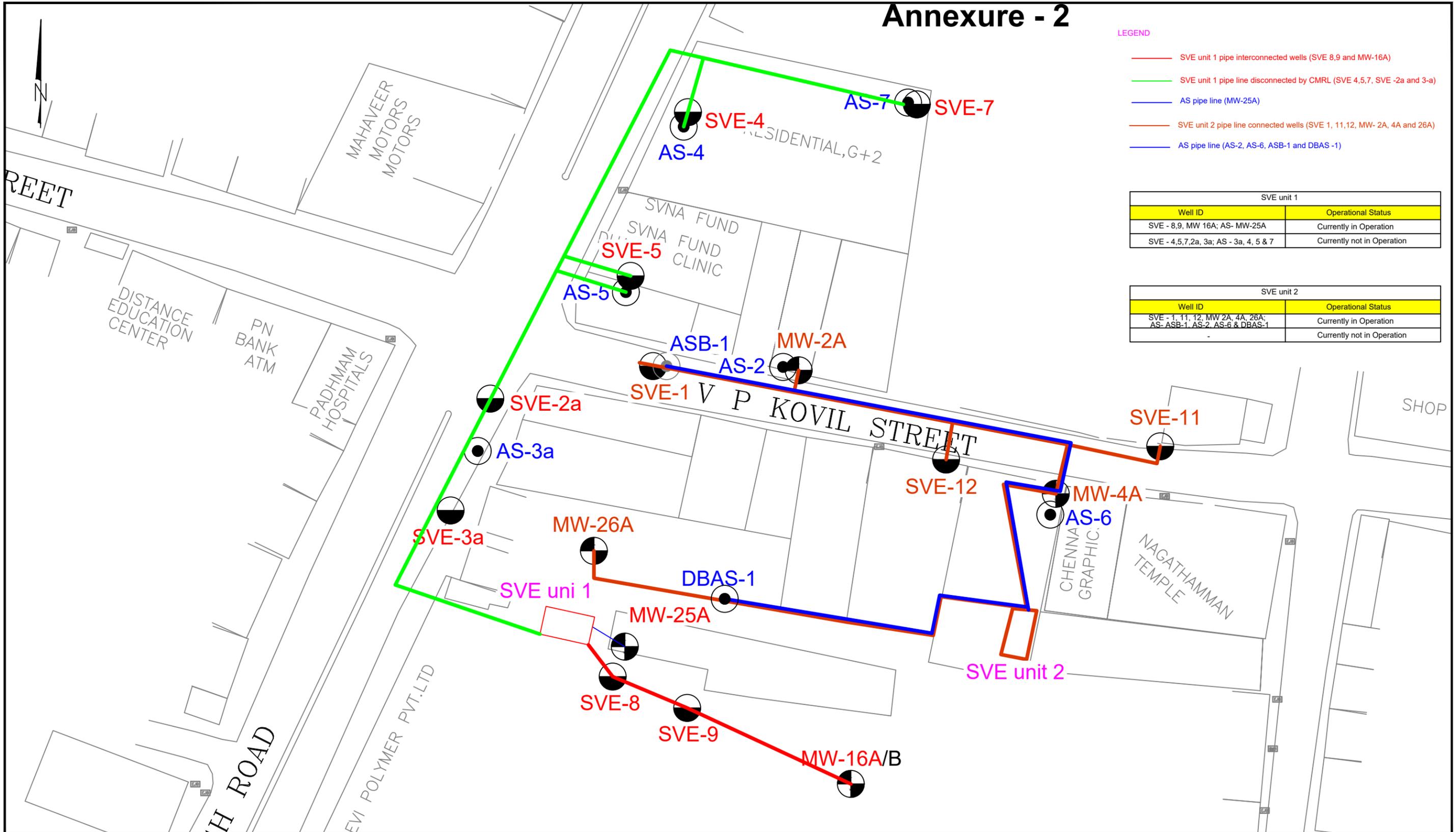
Annexure - 2

LEGEND

- SVE unit 1 pipe interconnected wells (SVE 8,9 and MW-16A)
- SVE unit 1 pipe line disconnected by CMRL (SVE 4,5,7, SVE -2a and 3-a)
- AS pipe line (MW-25A)
- SVE unit 2 pipe line connected wells (SVE 1, 11,12, MW- 2A, 4A and 26A)
- AS pipe line (AS-2, AS-6, ASB-1 and DBAS -1)

SVE unit 1	
Well ID	Operational Status
SVE - 8,9, MW 16A; AS- MW-25A	Currently in Operation
SVE - 4,5,7,2a, 3a; AS - 3a, 4, 5 & 7	Currently not in Operation

SVE unit 2	
Well ID	Operational Status
SVE - 1, 11, 12, MW 2A, 4A, 26A; AS- ASB-1, AS-2, AS-6 & DBAS-1	Currently in Operation
-	Currently not in Operation



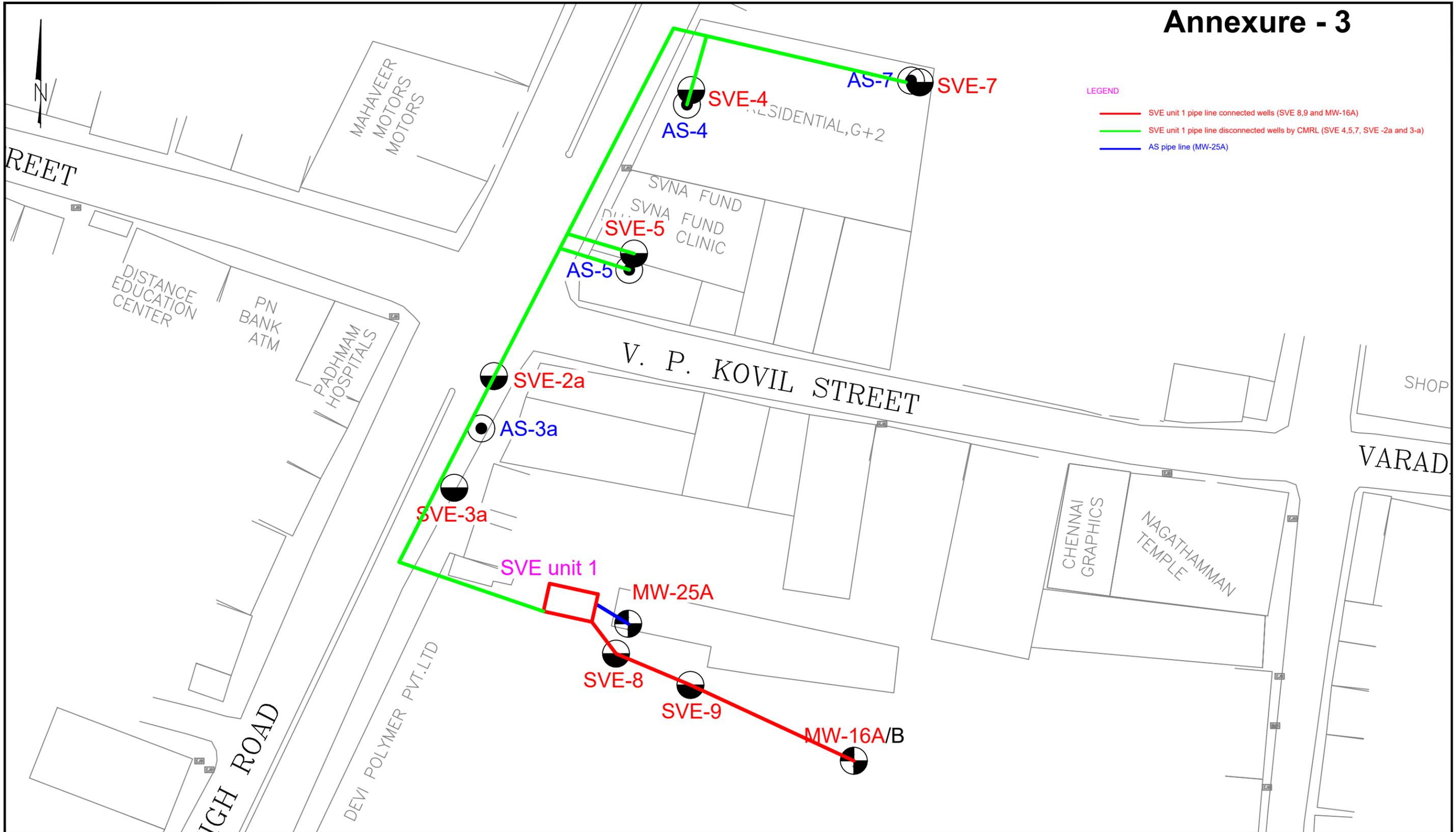
PATH NAME: Tondiarpet
 DRAFTER INITIALS: Senthilkumar S
 DATE LAST REVISED: March 10, 2021
 FILENAME: BPCL Tondiarpet - SVE UNITS



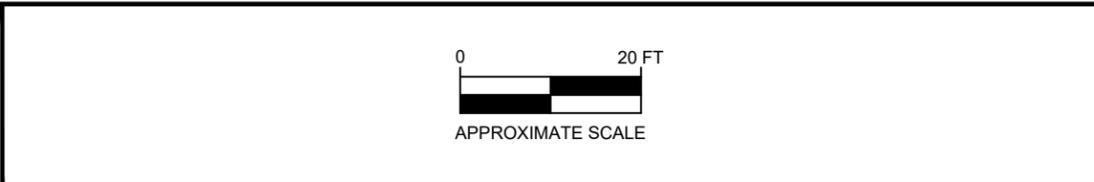
BHARAT PETROLEUM CORP. LTD.
 VPK STREET
 TONDIARPET, CHENNAI
 SVE UNIT PIPE LINE

FIGURE
3
 PROJECT NO.
 400-01-03

Annexure - 3



PATH NAME: Tondiarpet
 DRAFTER INITIALS: Senthilkumar S
 DATE LAST REVISED: March 10, 2021
 FILENAME: BPCL Tondiarpet SVE UNIT 1



BHARAT PETROLEUM CORP. LTD.
 VPK STREET
 TONDIARPET, CHENNAI
 SVE UNIT 1 PIPE LINE

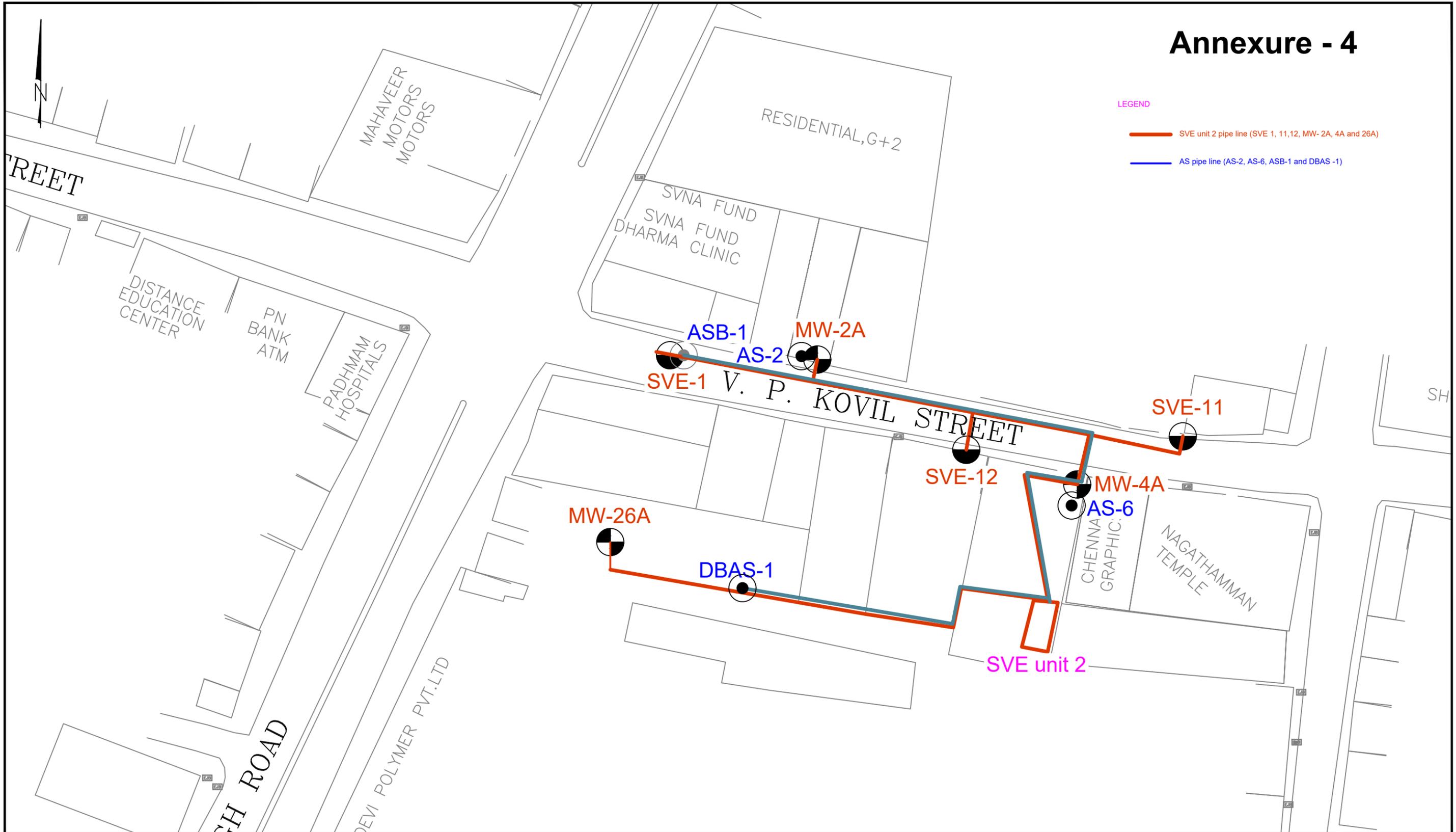
FIGURE
1
 PROJECT NO.
 400-01-03

Annexure - 4

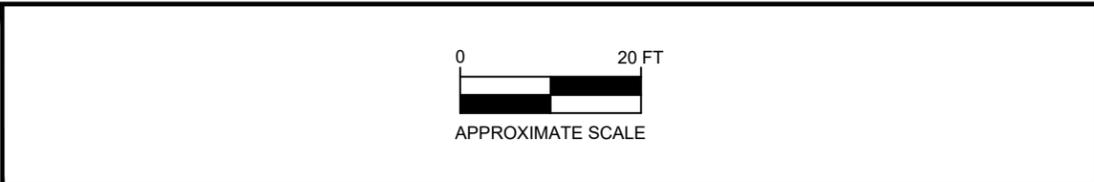
LEGEND

— SVE unit 2 pipe line (SVE 1, 11,12, MW- 2A, 4A and 26A)

— AS pipe line (AS-2, AS-6, ASB-1 and DBAS -1)



PATH NAME: Tondiarpet
 DRAFTER INITIALS: Senthilkumar S
 DATE LAST REVISED: March 10, 2021
 FILENAME: BPCL Tondiarpet SVE UNIT 2



BHARAT PETROLEUM CORP. LTD.
 VPK STREET
 TONDIARPET, CHENNAI
 SVE UNIT 2 PIPE LINE

FIGURE
 2
 PROJECT NO.
 400-01-03

Annexure - 5

The monthly performance data of SVE 1 system submitted by M/s BPCL

Date	Cumulative Time Elapsed in hr	SVE System flow rate in CFM	Influent concentration in mg/m ³			Effluent concentrations in mg/m ³			Destruction Efficiency in %	Mass Extraction rate	Cumulative Mass Extracted
			DRO	GRO	TPH	DRO	GRO	TPH		GRO in kg/hr	GRO in kg
20.05.16	13.2	91	814.64	<2.5	23038.24	186.012	<2.5	4607.65	77	0.13	1.66
25.05.16	49.2	84	22215.33	<2.5	72.855	0.123			100		
04.06.16 *	126	94	1.23	0.037	<1.0	0.322	<2.5	<1.0	74		
06.06.16	150.3	79	0.617	NA	NA	0.0417	NA	NA	93		
16.06.16	271.5	92	NA	NA	NA	NA	NA	NA	99		
18.07.16	704.8	80	3462.4	1075.8	3462.4	829.2	0	829.2	76	0.47	
30.07.16	842.7	96									198.40
31.08.16	1267.75	94.58	715.5	1185.33	715.5	BDL	BDL	BDL	100	0.12	295.87
26.09.16	1591.05	96.23	BDL	1258	BDL	BDL	BDL	BDL	100	0.21	381.14

24.10.16	1991.05	96.24	0	5701.3	0	0	0	0	100	0.93	553.49
28.11.16	2439.05	95.71	0	9880	0	0	0	0	100	1.61	1273.26
27.12.16	2743.05	96.71	0	13027.2	0	0	0	0	100	2.14	1923.98
28.01.17	3195.35	97.77	0	16660	0	0	0	0	100	2.77	3175.69
24.02.17	3531.35	97.85	0	11710.4	0	0	0	0	100	1.95	3829.83
30.03.17	4004.35	97.45	0	6319.57	0	0	0	0	100	1.05	4324.75
29.04.17	4484.35	97.64	BDL	16939.00	BDL	BDL	BDL	BDL	100	2.81	5673.57
30.05.17	4980.35	98.00	BDL	2102.01	BDL	BDL	BDL	BDL	100	0.35	5847.16
28.06.17	5444.35	98.00	BDL	7236.00	BDL	BDL	BDL	BDL	100	1.20	6406.20
25.07.17	5876.35	98.00	BDL	7870.11	BDL	BDL	BDL	BDL	100	1.31	6972.30
28.08.17	6414.35	99.00	BDL	6330.14	BDL	BDL	BDL	BDL	100	1.06	7545.13
27.09.17	6942.35	98.29	BDL	5443.83	BDL	BDL	BDL	BDL	100	0.91	8025.14
27.10.17	7662.35	98.51	BDL	5589.40	BDL	BDL	BDL	BDL	100	0.94	8698.75
27.11.17	8158.35	98.33	BDL	3490.21	BDL	BDL	BDL	BDL	100	0.58	8987.97
27.12.17	8785.35	97.90	BDL	4822.86	BDL	BDL	BDL	BDL	100	0.80	9490.95
31.01.18	9511.35	97.40	BDL	3765.70	BDL	BDL	BDL	BDL	100	0.62	9943.37
28.02.18	10015.35	97.40	BDL	1389.70	BDL	BDL	BDL	BDL	100	0.23	10059.27

27.03.18	10653.35	97.40	BDL	127.60	BDL	BDL	BDL	BDL	100	0.02	10072.75
27.04.18	11384.35	97.60	BDL	334.92	BDL	BDL	BDL	BDL	100	0.05	10109.30
30.05.18	12163.35	97.60	BDL	1223.51	BDL	BDL	BDL	BDL	100	0.20	10265.10
28.06.18	12844.35	97.80	BDL	654.75	BDL	BDL	BDL	BDL	100	0.11	10339.19
31.07.18	13625.35	97.90	BDL	2257.00	BDL	BDL	BDL	BDL	100	0.38	10635.97
29.08.18	14307.35	97.52	BDL	1980.67	BDL	BDL	BDL	BDL	100	0.33	10861.03
15.09.18	14715.35	97.61	BDL	1837.67	BDL	BDL	BDL	BDL	100	0.31	10987.51
30.11.18	15555.35	97.49	BDL	2036.34	BDL	BDL	BDL	BDL	100	0.34	11273.11
31.12.18	16299.35	97.10	BDL	1547.33	BDL	BDL	BDL	BDL	100	0.26	11466.55
31.01.19	17043.35	97.58	BDL	2354.00	BDL	BDL	BDL	BDL	100	0.39	11756.71
28.02.19	17715.35	98.18	BDL	760.00	BDL	BDL	BDL	BDL	100	0.13	11844.07
31.03.19	18459.35	97.77	BDL	1303.33	BDL	BDL	BDL	BDL	100	0.22	12007.75
30.04.19	19179.35	97.83	BDL	890.00	BDL	BDL	BDL	BDL	100	0.15	12115.75
31.05.19	19923.35	97.55	BDL	656.75	BDL	BDL	BDL	BDL	100	0.11	12197.59
30.06.19	20643.35	98.13	BDL	1848.25	BDL	BDL	BDL	BDL	100	0.31	12420.79
31.07.19	21382.35	97.94	BDL	1213.00	BDL	BDL	BDL	BDL	100	0.20	12570.07
31.08.19	22038.35	97.82	BDL	986.25	BDL	BDL	BDL	BDL	100	0.16	12677.61

30.09.19	22730.35	98.40	BDL	1296.00	BDL	BDL	BDL	BDL	100	0.22	12827.57
31.10.19	23457.35	97.58	BDL	1459.72	BDL	BDL	BDL	BDL	100	0.24	13003.50
30.11.19	24170.35	97.73	BDL	2045.14	BDL	BDL	BDL	BDL	100	0.34	13245.92
30.12.19	24908.35	98.29	BDL	1226.80	BDL	BDL	BDL	BDL	100	0.20	13396.52
31.01.20	25573.35	98.16	BDL	270.51	BDL	BDL	BDL	BDL	100	0.05	13429.77
29.02.20	26229.35	98.02	BDL	528.00	BDL	BDL	BDL	BDL	100	0.08	13487.54
31.03.20	26779.35	98.30	BDL	1384.96	BDL	BDL	BDL	BDL	100	0.20	13597.54
30.04.20	26853.35	98.30	BDL	1384.96	BDL	BDL	BDL	BDL	100	0.20	13613.94
31.05.20	27069.35	98.30	BDL	1384.96	BDL	BDL	BDL	BDL	100	0.20	13655.54
30.06.20	27622.35	98.36	BDL	342.00	BDL	BDL	BDL	BDL	100	0.06	13687.54
31.07.20	28259.35	98.37	BDL	160.16	BDL	BDL	BDL	BDL	100	0.03	13704.62
31.08.20	28838.00	98.40	BDL	3038.00	BDL	BDL	366.29	BDL	87.9	0.51	13998.56
30.09.20	29465.00	98.38	BDL	3320.33	BDL	BDL	BDL	BDL	100	0.56	14346.58
31.10.20	30107.00	98.35	BDL	1859.90	BDL	BDL	BDL	BDL	100	0.31	14546.13
30.12.20	30508.00	98.41	BDL	1442.96	BDL	BDL	BDL	BDL	100	0.24	14642.89
31.12.20	31101.00	98.33	BDL	1550.57	BDL	BDL	14.89	BDL	99.0	0.26	14796.52
30.01.21	31671.00	98.29	BDL	716.06	BDL	BDL	BDL	BDL	100	0.12	14864.69

27.02.21	32238.00	98.33	BDL	1209.83	BDL	BDL	BDL	BDL	100	0.20	14979.31
31.03.21	32876.00	98.39	BDL	133.20	BDL	BDL	BDL	BDL	100	0.02	14993.51
31.05.21	33954.00	98.39	BDL	195.56	BDL	BDL	BDL	BDL	100	0.03	15028.76
30.06.21	34311.00	98.39	BDL	490.72	BDL	BDL	BDL	BDL	100	0.08	15058.05
31.07.21	34934.00	98.35	BDL	416.24	BDL	BDL	BDL	BDL	100	0.07	15101.39
31.08.21	35554.00	98.32	BDL	166.00	BDL	BDL	BDL	BDL	100	0.03	15118.58
30.09.21	36153.00	98.32	BDL	189.57	BDL	BDL	BDL	BDL	100	0.03	15137.55
30.10.21	36725.00	98.32	BDL	281.01	BDL	BDL	BDL	BDL	100	0.05	15164.41
31.12.21	37720.00	98.37	BDL	0.00	BDL	BDL	BDL	BDL	100	0.00	15164.41
31.01.22	38246.00	98.34	BDL	0.00	BDL	BDL	BDL	BDL	100	0.00	15164.41
28.02.22	38822.00	98.30	BDL	0.00	BDL	BDL	BDL	BDL	100	0.00	15164.41
31.03.22	39467.00	98.29	BDL	0.00	BDL	BDL	BDL	BDL	100	0.00	15164.41
30.04.22	40039.00	98.29	BDL	0.00	BDL	BDL	BDL	BDL	100	0.00	15164.41
31.05.22	40638.00	98.31	BDL	0.00	BDL	BDL	BDL	BDL	100	0.00	15164.41
30.06.22	41252.00	98.34	BDL	0.00	BDL	BDL	BDL	BDL	100	0.00	15164.41

The monthly performance data of SVE 2 system submitted by M/s BPCL												
Date	Operational hours	Flow Rate	Influent Concentrations			Effluent Concentrations			Destruction Efficiency	Mass Extraction Rate	Mass Extracted	Cumulative Mass Extracted
			DRO	GRO	TPH	DRO	GRO	TPH				
	Hours	CFM	mg/m ³	mg/m ³	mg/m ³	mg/m ³	mg/m ³	mg/m ³	%	Kgs/hr	Kgs/month	Kilograms
29.02.20	82.00	258.30	BDL	1061.60	BDL	BDL	BDL	BDL	100	0.50	41.00	28.87
30.06.20	293.00	220.56	BDL	1737.30	BDL	BDL	BDL	BDL	100	0.65	137.15	166.37
31.07.20	576.00	205.00	BDL	7114.87	BDL	BDL	826.88	BDL	88	2.48	701.84	876.07
31.08.20	880.00	219.00	BDL	2371.60	BDL	BDL	438.77	BDL	81	0.88	268.30	1135.37
30.09.20	1176.00	223.80	BDL	2348.38	BDL	BDL	BDL	BDL	100	0.89	264.35	1399.71
31.10.20	1478.00	218.89	BDL	894.30	BDL	BDL	14.77	BDL	98	0.33	100.45	1500.17
30.11.20	1695.00	228.16	BDL	885.95	BDL	BDL	12.47	BDL	99	0.34	74.54	1574.70
31.12.20	1995.00	217.50	BDL	475.54	BDL	BDL	4.84	BDL	99	0.18	52.73	1627.43
30.01.21	2278.00	218.96	BDL	518.56	BDL	BDL	BDL	BDL	100	0.19	54.60	1682.03

27.02.21	2555.00	219.17	BDL	758.47	BDL	BDL	BDL	BDL	100	0.28	78.24	1760.27
31.03.21	2864.00	218.70	BDL	629.65	BDL	BDL	BDL	BDL	100	0.23	72.30	1832.58
31.06.21	3395.00	218.89	BDL	22.74	BDL	BDL	BDL	BDL	100	0.01	4.49	1837.07
30.06.21	3581.00	217.81	BDL	739.00	BDL	BDL	BDL	BDL	100	0.27	50.87	1887.94
31.07.21	3893.00	218.08	BDL	417.12	BDL	BDL	BDL	BDL	100	0.15	48.23	1936.17
31.08.21	4205.00	218.48	BDL	291.20	BDL	BDL	BDL	BDL	100	0.11	33.73	1969.90
30.09.21	4505.00	218.20	BDL	618.00	BDL	BDL	BDL	BDL	100	0.23	68.74	2038.64
30.10.21	4733.00	218.42	BDL	483.35	BDL	BDL	0.69	BDL	100	0.18	40.90	2079.54
31.05.22	5029.00	217.20	BDL	929.86	BDL	BDL	BDL	BDL	100	0.84	101.58	2181.12
30.06.22	5341.00	219.81	BDL	0.00	BDL	BDL	BDL	BDL	100	0.00	0.00	2181.12

Note: BDL - Below detectable limit

*SVE was under repair, Carbon adsorption system was in operation

NA- Lab analysis reports are not available

Table 1 - Hydrocarbon Recovery Summary
 Bharat Petroleum Corporation Ltd.VPK Street, Tondiarpet, Chennai

Well ID	Year	Number of Socks used	Removed Mass (g)	Cumulative Mass removed (g)	Mass removed 2015 - 2019
6/15 VPK Street	2015	6	3747.5	3747.50	7844.30
	2016	1	738.5	4486.00	
	2017	2	608	5094.00	
	2018	4	1656	6750.00	
	2019	1	1094.3	7844.30	
Alley 3 and 4	2015	11	9,526.5	9526.50	17574.80
	2016	4	4786	14312.50	
	2017	2	726.8	15039.30	
	2018	4	1676	16715.30	
	2019	2	859.5	17574.80	
MW-3A	2015	2	2,026.0	2026.00	6138.70
	2016	2	1247	3273.00	
	2017	2	743.7	4016.70	
	2018	4	1403.7	5420.40	
	2019	2	718.3	6138.70	
MW-16A	2015	0	0.0	0.00	2175.60
	2016	1	660	660.00	
	2017	2	584.4	1244.40	
	2018	3	556.8	1801.20	
	2019	3	374.4	2175.60	
Murugan store	2017	1	520.8	520.80	2515.10
	2018	3	1264.5	1785.30	
	2019	2	729.8	2515.10	
5/20 VPK Street	2015	10	9,405.0	9405.00	18480.00
	2016	8	6929	16334.00	
	2017	2	2146	18480.00	
MW-8A	2015	2	400.5	400.50	1132.50
	2016	2	322	722.50	
	2017	1	410	1132.50	
MW-4A	2015	0	0.0	0.00	610.00
	2016	1	610	610.00	
MW-17A	2015	0	0.0	0.00	489.00
	2016	1	489	489.00	
SVE-5	2015	1	1,027.0	1027.00	2345.00
	2016	2	1318	2345.00	
MW-6A	2015	0	0.0	0.00	248.00
	2016	1	248	248.00	

Table 1 - Hydrocarbon Recovery Summary
 Bharat Petroleum Corporation Ltd.VPK Street, Tondiarpet, Chennai

MW-9A	2015	0	0.0	0.00	528.50
	2016	0	528.5	528.50	
SVE-1	2015	4	3,945.0	3945.00	4505.00
	2016	1	560	4505.00	
Ashok welding shop	2016	0	0.0	0.00	173.00
	2017	1	173	173.00	
MW-2A	2017	1	246.0	246.00	814.80
	2018	1	568.8	814.80	
MW-1A	2016	4	1993	1993.00	3518.20
	2017	3	991.2	2984.20	
	2018	1	250.6	3234.80	
	2019	1	283.4	3518.20	

Explanation:

g = grams

Total grams removed =

69,092.50 grams

Total number of socks removed

112

Adsorbent material - SoakEase™-brand socks

Annexure - 7

Based on our estimate in the CMRL excavation area (surface to 50 ft depth), approximately **20,46,570.94 cubic meters (m³)** of soil was excavated from the contaminated site along T.H main road between M.M Theatre and junction of V.P.K Street-T.H main road during the period from 24th February 2018, to 31st December, 2019. It is our understanding that the excavated soil was transported to Tiruneermalai and Cut & Cover- Area 2, Nandanam, Chennai. Stratus identified the methodology presented below to estimate the mass of petroleum hydrocarbons removed due to CMRL excavation of soil within the contaminated area. It should be noted that based on the data generated in 2015, not all of the area excavated by CMRL was within the contaminated zone. It should also be noted that periodic samples collected from the excavation based on PID readings resulted in BDL values. Therefore, an empirical methodology based on our company's experience with similar projects was adopted.

The formula used to calculate CMRL excavation mass removed is,

$$\text{CMRL Mass Removal} = \text{Initial Mass within the CMRL excavation Area} - \text{Mass Removed by SVE operation during 2016 to 2018 and Natural Attenuation}$$

Initial Mass in the CMRL excavation area was estimated using 2015 detailed site assessment soil data (**12,595.162 kg**). During November 2017, Stratus drilled and collected soil samples in the CMRL area before excavation to estimate the mass removed by SVE unit in the excavated area. The soil analytical data was compared with 2015 soil analytical data and the difference was used to identify the mass removed by SVE unit between 2016 and 2018. The data comparison shows the reduction in petroleum hydrocarbons in soil to be greater than 90%. Given the limited radius of influence of the vapor extraction wells installed in the street (installed where access was issued), Stratus used the average reduction of 51.5% in the entire CMRL exaction area due to soil vapor extraction. Below is the comparison of TPH analytical data of soil from 2015 and 2018. Soil analytical data from MW-17AB was compared with analytical data from boring B1 (boring drilled for soil samples before CMRL excavation).

Well ID	MW-17AB	B1	% Reduction
Year	2015	2017	
Depth 10 ft	305	0.4	-99.79692
20 ft	344.7	0.7	-96.875
30 ft	155.45	0.35	-99.8358
40 ft	49	1876	3728.5714
50 ft	160.8	14.3	-91.10697

In addition, Stratus considered the natural degradation factor (microbial) of hydrocarbons. The degradation rate is dictated by site-specific environmental factors and contaminant characteristics, so it is highly variable^{1,2}. In general, degradation at a site once the source is removed is estimated to be 40 to 50% in first two years. Given our site conditions, Stratus conservatively assumed 10% of mass reduction by natural attenuation/degradation. Based on the above assumptions Stratus estimated the

1 - Microbial Degradation of Petroleum Hydrocarbon Contaminants: An Overview Nilanjana Das and Preethy Chandran Environmental Biotechnology Division, School of Biosciences and Technology, VIT University, Vellore, Tamil Nadu 632014, India

2 - Degradation Rates for Petroleum Hydrocarbons Undergoing Bioventing at the Meso-Scale, [Alamgir A. Khan](#), & [Richard G. Zytner](#)

mass of CMRL removal by soil excavation in the contaminated site. A simple calculation is present below,

Cumulative Mass in Contaminated Zone of CMRL Excavation Area (2015) in KG	Cumulative TPH Mass removed by Remedial Activity of SVE Unit (2016-2018) in KG	Cumulative TPH Mass removed by Natural attenuation factors (2015-2018) in KG	Cumulative TPH Mass Removed by CMRL (2018-2019) in KG
12595.16	6486.51	1259.52	4,849.137

A detailed table is attached with this document.

Table 7: TPH Mass Removed by SVE Unit, Natural Attenuation Factors and CMRL Activity in Contaminated Zone of CMRL Excavated Area (2021)

Basis	Area ID	Area sq.ft	Thickness (ft)	Soil Volume (cu.ft)	Soil Density (Kg/cu.ft)	Soil Mass (Kg)	Avg.TPH Conc. in soil (2015) (mg/kg)	CummulativeTPH Mass in Contaminated Zone of CMRL Excavation Area (2015) (kg)	Reduction in Avg. TPH Conc. In soil due to remediation by SVE Units from the period 2015-2018 (%)	Reduction in Avg. TPH Conc. due to unaccounted TPH mass removed by Natural attenuation factors from 2015-2018 (%)	Avg. TPH Conc. In soil (2018) (mg/kg)	Cummulative TPH Mass removed by Remedial Activity of SVE Unit (2016-2018) (Kg)	Cummulative TPH Mass removed by Natural attenuation factors (2015-2018) (Kg)	Cummulative TPH Mass Removed by CMRL (2018-2019) (Kg)
Figure-21 0' - 10'	A	11,692.06	10	1,16,920.59	43.04	50,32,262.19	317.56	1598.055			122.261	822.998	159.806	615.251
	B	3,177.60	10	31,776.00	43.04	13,67,639.04	11.10	15.181			4.274	7.818	1.518	5.845
	C1	16,816.29	10	1,68,162.90	43.04	72,37,731.22	0.30	2.171	51.50	10.00	0.116	1.118	0.217	0.836
	C2	7,059.68	10	70,596.80	43.04	30,38,486.27	0.10	0.304			0.039	0.156	0.030	0.117
	C3	2,415.60	10	24,156.00	43.04	10,39,674.24	0.10	0.104			0.039	0.054	0.010	0.040
Mass of TPH present in 0 - 10 feet bgs								1615.815	Mass of TPH removed by SVE/ Natutal Attenuation Factors/ CMRL Activity from 0 - 10 feet bgs			832.145	161.582	622.089
Figure -22 10' - 20'	A	2,811.93	10	28119.3	43.04	12,10,254.67	1667.15	2017.676			641.853	1039.103	201.768	776.805
	B1	10,313.94	10	103139.4	43.04	44,39,119.78	354.28	1572.669			136.396	809.925	157.267	605.478
	B2	4,196.43	10	41964.3	43.04	18,06,143.47	141.00	254.666	51.50	10.00	54.285	131.153	25.467	98.046
	C1	7,449.19	10	74491.9	43.04	32,06,131.38	4.45	14.267			1.713	7.348	1.427	5.493
	C2	5,514.10	10	55141.01	43.04	23,73,269.07	1.10	2.611			0.424	1.344	0.261	1.005
D	10,503.50	10	105035.01	43.04	45,20,706.83	0.10	0.452			0.039	0.233	0.045	0.174	
Mass of TPH present in 10 - 20 feet bgs								3862.341	Mass of TPH removed by SVE/ Natutal Attenuation Factors/ CMRL Activity from 10 - 20 feet bgs			1989.106	386.234	1,487.001
Figure -23 20'-30'	A1	18,661.51	10	186615.1	43.04	80,31,913.90	375.16	3013.237			144.436	1551.817	301.324	1,160.096
	A2	4,225.06	10	42250.6	43.04	18,18,465.82	137.00	249.130	51.50	10.00	52.745	128.302	24.913	95.915
	B	8,520.12	10	85201.23	43.04	36,67,060.94	32.45	118.996			12.493	61.283	11.900	45.814
	C	9,754.27	10	97542.7	43.04	41,98,237.81	0.10	0.420			0.039	0.216	0.042	0.162
Mass of TPH present in 20 - 30 feet bgs								3381.783	Mass of TPH removed by SVE/ Natutal Attenuation Factors/ CMRL Activity from 20 - 30 feet bgs			1741.618	338.178	1,301.986
Figure-24 30'-40'	A	2,490.91	10	24909.1	43.04	10,72,087.66	1344.50	1441.422			517.633	742.332	144.142	554.947
	B1	1,643.08	10	16430.84	43.04	7,07,183.35	260.10	183.938			100.139	94.728	18.394	70.816
	B2	2,310.47	10	23104.73	43.04	9,94,427.58	116.00	115.354			44.660	59.407	11.535	44.411
	B3	4,196.43	10	41964.3	43.04	18,06,143.47	149.50	270.018	51.50	10.00	57.558	139.060	27.002	103.957
	C	6,522.16	10	65221.6	43.04	28,07,137.66	28.99	81.379			11.161	41.910	8.138	31.331
	D	7,936.19	10	79361.9	43.04	34,15,736.18	4.45	15.200			1.713	7.828	1.520	5.852
E	15,546.11	10	155461.12	43.04	66,91,046.60	0.30	2.007			0.116	1.034	0.201	0.773	
Mass of TPH present in 30 - 40 feet bgs								2109.319	Mass of TPH removed by SVE/ Natutal Attenuation Factors/ CMRL Activity from 30 - 40 feet bgs			1086.299	210.932	812.088
Figure-25 40' - 50'	A	2,869.46	10	28694.61	33.98	9,75,042.85	1438.20	1402.31			553.707	722.188	140.231	539.888
	B	4,196.43	10	41964.3	33.98	14,25,946.91	156.00	222.45	51.50	10.00	60.060	114.561	22.245	85.642
	C1	19,190.00	10	191900	33.98	65,20,762.00	0.10	0.65			0.039	0.336	0.065	0.251
	C2	14,644.56	10	146445.6	33.98	49,76,221.49	0.10	0.50			0.039	0.256	0.050	0.192
Mass of TPH present in 40 - 50 feet bgs								1625.90	Mass of TPH removed by SVE/ Natutal Attenuation Factors/ CMRL Activity from 40 - 50 feet bgs			837.341	162.590	625.973
Cumulative TPH Mass in contaminated Zone of CMRL Excavated Area (2015)								12595.162						
Cumulative TPH Mass Removed by Remedial Activity of SVE Unit in the Contaminated Zone of CMRL Excavated Area (2016-2018)											6486.508			
Cumulative TPH Mass Removed by Natural Attenuation Factors in the Contaminated Zone of CMRL Excavated Area (2015-2018)												1259.516		
Cumulative TPH Mass Removed by CMRL Activity in the Contaminated Zone of CMRL Excavated Area (2018-2019)													4,849.137	

Notes:

- The average concentration is assumed to be uniform across the chosen depth of soil profile
 - The % Reduction in the average concentration of Soil profile at specific depths from period 2015 to 2018 is estimated using the analytical data of soil borings advanced from 2017-2021, SVE hydrocarbon mass removal rate from 2015-2018 and Unaccounted SVE TPH mass removal / natural attenuation factors.
 - Soil density is assumed to be 43.04 Kg/ft³ for sand, 33.98 Kg/ft³ for clay (Argonne National Lab, Environmental Science Division, Table 2.1, <http://web.ead.anl.gov/resrad/datacoll/soildens.htm>).
 - Soil Mass = Soil Density * Soil Volume
 - TPH Mass (Kilograms) = Soil Mass (Kilograms) * Average Concentration (Avg Conc) (milligrams*10⁻⁶/Kilogram)
- 1 - Microbial Degradation of Petroleum Hydrocarbon Contaminants: An Overview Nilanjana Das and Preethy Chandran Environmental Biotechnology Division, School of Biosciences and Technology, VIT University, Vellore, Tamil Nadu 632014, India
2 - Degradation Rates for Petroleum Hydrocarbons Undergoing Bioventing at the Meso-Scale. Alamgir A. Khan, & Richard G. Zytner

Annexure - 8**Note for mass removed by SVE units (unaccounted)/Natural attenuation factors (kg):**

Stratus conducted a detailed assessment and estimated the remaining mass of petroleum hydrocarbon in the soil and groundwater in Feb 2021. Based on the investigation Stratus prepared a Mass Balance summary which details the mass removed by SVE units, mass removed by Socks, mass removed by CMRL excavation, and the remaining mass in the soil (estimated using the soil analytical data) and groundwater (estimated using water analytical data). The difference of summation of all the mass removed by Stratus & CMRL with initial mass was 11,464.717 kg which we concluded to be removed by SVE units and Natural degradation.

Initial mass –	Mass removed by SVE units + Socks + CMRL + (estimated remaining mass-Feb 2021)	=	Mass removed by SVE units (unaccounted) /Natural attenuation factors (kg)
34,178.57	22,713.853	=	11,464.717

Stratus observed that both SVE units has been ran under high slug (high concentration) movement of petroleum hydrocarbon during initial starting hours on everyday operation of the system and gradually reduces (Most common in the rainy seasons). Stratus collects air samples only once in a month and estimates the mass removed in the entire month using that one-time air sample analytical data. This high slug movement contributes to mass removed, given that this is not accounted for, Stratus assigned a portion of the remaining mass to this. In addition, natural degradation of petroleum hydrocarbons occurs and therefore some mass was assigned for this as well.

**Table 10: Mass Balance Summary of Total Petroleum Hydrocarbon (TPH) from 2015 - 2022
BPCL Tondiarpet Oil Contamination Site
Tondiarpet, Chennai**

S.No	Site Assessment - 2015		Total Petroleum Hydrocarbon (TPH) Mass removed in Soil & Groundwater through the Activities of SVE Units, CMRL Excavations, Free Floating product removal through Socks Absorbent from 2015-2021		TPH Mass Removed through SVE Remedial Efforts and Natural Attenuation Factors from 2015-2021 but not accounted by SVE Mass Removal Calculation		Site Assessment - Feb 2021 Mass Estimate		Mass Remaining June 2022
	Task/ Work Activity	Initial TPH Mass in 2015 (Kilograms)	Work Activity	Accounted TPH Mass Removed (Kilograms)	Work Activity	Unaccounted TPH Mass Removed (Kilograms)	Task/ Work Activity	TPH Mass (Kilograms)	TPH Mass Present (Kilograms)
1	Quantified Estimated Mass of Total Petroleum Hydrocarbon (TPH) present in Soil Surface (0'-50') Bgs (2015)	32,797.60	SVE -1 Unit Cumulative TPH Mass Extracted (May 2016 - June 2022)	15,164.410	TPH Mass Extracted by SVE Unit-1 and SVE Unit-2 / Natural Attenuation Factors but not accounted by SVE Mass removal Calculations (May 2016 - Feb 2021)	11,464.717	Quantified Estimated Mass of Total Petroleum Hydrocarbon (TPH) Present in Soil Surface (0'-50') Bgs	1,053.933	
2	Quantified Estimated Mass of Total Petroleum Hydrocarbon (TPH) present in Groundwater (2015)	1,380.97	SVE -2 Unit Cumulative TPH Mass Extracted (Feb 2020 - June 2022)	2,181.120			Quantified Estimated Mass of Total Petroleum Hydrocarbon (TPH) Present in Groundwater	2.110	
3			Free Phase Floating Product removed through Absorbent Socks (2015-2020)	69.093					
4			Cumulative Mass of TPH Removed by CMRL Activity in the Contaminated Zone of CMRL Excavated Area (2018 - 2019)	4,849.137					
	Cumulative Estimated Mass of Total Petroleum Hydrocarbon (TPH) present in Soil Surface (0'-50') Bgs and Groundwater (2015)	34,178.57	Quantified Estimated Mass of Total Petroleum Hydrocarbon (TPH) Mass removed by SVE Units / Absorbent Socks/ CMRL Activity in Soil Surface (0'-50') Bgs and Groundwater from 2015-2021	22,263.760	TPH Mass Extracted by SVE Unit-1 and SVE Unit-2 / Natural Attenuation Factors but not accounted by SVE Mass removal Calculations (May 2016 - Feb 2021)	11,464.717	Cumulative Estimated Mass of Total Petroleum Hydrocarbon (TPH) present in Soil Surface (0'-50') Bgs and Groundwater (Feb-2021)	1,056.043	450.093

Note for remaining mass - 2022

Below table summarize the total mass estimated in 2015 assessment, Mass removed by SVE units and absorbent socks, Mass removed by CMRL activity and unaccounted mass removed by SVE units during the high slug movement into the treatment system till June 2022 and the remaining mass present at site in 2022.

<i>Initial Mass (2015) (Kg)</i>	<i>Mass Removed by SVE (2016-2022) (Kg)</i>	<i>Mass Removed by Socks (2015-2020) (Kg)</i>	<i>Mass Removed by CMRL (2018-2019) (Kg)</i>	<i>Mass Removed by SVE units (Unaccounted)/ Natural Attenuation factors (Kg)</i>	<i>Mass Remaining (May 2022) (Kg)</i>
34,178.57	17,345.53	69.093	4,849.137	11,464.717	450.093

Remaining mass was estimated 450.093kg in soil and groundwater.

2021 Estimated TPH mass in groundwater – 2.11kg

2021 Estimated TPH mass in Soil – 1053.93kg

Mass removed between 2021 – 2022 was 605.94kg using SVE units.

Remaining Mass could be approximately 450.093kg in soil and groundwater.

Sample ID	Date Collected	VOC (mg/kg)	TPH (mg/kg)	GRO (mg/L)	DRO (mg/kg)	BTEX (mg/kg)	PAH (mg/kg)	TOC %	Oil and grease (mg/L)	Mineral oil (mg/L)
<u>Soil</u>										
GLENS										
RMW-1AB 5ft	31-May-22	BLQ (LOQ 0.02)	BLQ (LOQ 0.1)	BLQ (LOQ 0.1)	BLQ (LOQ 0.02)	BLQ (LOQ 0.02)	BLQ (LOQ 0.05)	BDL (DL 0.2)	BDL (DL 10)	BDL (DL 5.0)
RMW-1AB 10ft	31-May-22	BLQ (LOQ 0.02)	BLQ (LOQ 0.1)	BLQ (LOQ 0.1)	BLQ (LOQ 0.02)	BLQ (LOQ 0.02)	BLQ (LOQ 0.05)	BDL (DL 0.2)	BDL (DL 10)	BDL (DL 5.0)
RMW-1AB 20ft	31-May-22	BLQ (LOQ 0.02)	BLQ (LOQ 0.1)	BLQ (LOQ 0.1)	BLQ (LOQ 0.02)	BLQ (LOQ 0.02)	BLQ (LOQ 0.05)	BDL (DL 0.2)	BDL (DL 10)	BDL (DL 5.0)
RMW-1AB 30ft	31-May-22	BLQ (LOQ 0.02)	BLQ (LOQ 0.1)	BLQ (LOQ 0.1)	BLQ (LOQ 0.02)	BLQ (LOQ 0.02)	BLQ (LOQ 0.05)	BDL (DL 0.2)	BDL (DL 10)	BDL (DL 5.0)
RMW-1AB 40ft	31-May-22	BLQ (LOQ 0.02)	BLQ (LOQ 0.1)	BLQ (LOQ 0.1)	BLQ (LOQ 0.02)	BLQ (LOQ 0.02)	BLQ (LOQ 0.05)	BDL (DL 0.2)	BDL (DL 10)	BDL (DL 5.0)
RMW-1AB 50ft	31-May-22	BLQ (LOQ 0.02)	BLQ (LOQ 0.1)	BLQ (LOQ 0.1)	BLQ (LOQ 0.02)	BLQ (LOQ 0.02)	BLQ (LOQ 0.05)	0.42	BDL (DL 10)	BDL (DL 5.0)
RMW-1AB 70ft	31-May-22	BLQ (LOQ 0.02)	BLQ (LOQ 0.1)	BLQ (LOQ 0.1)	BLQ (LOQ 0.02)	BLQ (LOQ 0.02)	BLQ (LOQ 0.05)	BDL (DL 0.2)	BDL (DL 10)	BDL (DL 5.0)
RMW-1AB 80ft	31-May-22	BLQ (LOQ 0.02)	BLQ (LOQ 0.1)	BLQ (LOQ 0.1)	BLQ (LOQ 0.02)	BLQ (LOQ 0.02)	BLQ (LOQ 0.05)	BDL (DL 0.2)	BDL (DL 10)	BDL (DL 5.0)
RMW-2AB 5ft	04-Jun-22	BLQ (LOQ 0.02)	BLQ (LOQ 0.1)	BLQ (LOQ 0.1)	BLQ (LOQ 0.02)	BLQ (LOQ 0.02)	BLQ (LOQ 0.05)	BDL (DL 0.2)	BDL (DL 10)	BDL (DL 5.0)
RMW-2AB 10ft	04-Jun-22	BLQ (LOQ 0.02)	BLQ (LOQ 0.1)	BLQ (LOQ 0.1)	BLQ (LOQ 0.02)	BLQ (LOQ 0.02)	BLQ (LOQ 0.05)	BDL (DL 0.2)	BDL (DL 10)	BDL (DL 5.0)
RMW-2AB 15ft	04-Jun-22	BLQ (LOQ 0.02)	BLQ (LOQ 0.1)	BLQ (LOQ 0.1)	BLQ (LOQ 0.02)	BLQ (LOQ 0.02)	BLQ (LOQ 0.05)	BDL (DL 0.2)	BDL (DL 10)	BDL (DL 5.0)
RMW-2AB 25ft	04-Jun-22	BLQ (LOQ 0.02)	BLQ (LOQ 0.1)	BLQ (LOQ 0.1)	BLQ (LOQ 0.02)	BLQ (LOQ 0.02)	BLQ (LOQ 0.05)	BDL (DL 0.2)	BDL (DL 10)	BDL (DL 5.0)
RMW-2AB 30ft	04-Jun-22	BLQ (LOQ 0.02)	BLQ (LOQ 0.1)	BLQ (LOQ 0.1)	BLQ (LOQ 0.02)	BLQ (LOQ 0.02)	BLQ (LOQ 0.05)	BDL (DL 0.2)	BDL (DL 10)	BDL (DL 5.0)
RMW-2AB 45ft	04-Jun-22	BLQ (LOQ 0.02)	BLQ (LOQ 0.1)	BLQ (LOQ 0.1)	BLQ (LOQ 0.02)	BLQ (LOQ 0.02)	BLQ (LOQ 0.05)	BDL (DL 0.2)	BDL (DL 10)	BDL (DL 5.0)
RMW-2AB 55ft	04-Jun-22	BLQ (LOQ 0.02)	BLQ (LOQ 0.1)	BLQ (LOQ 0.1)	BLQ (LOQ 0.02)	BLQ (LOQ 0.02)	BLQ (LOQ 0.05)	BDL (DL 0.2)	BDL (DL 10)	BDL (DL 5.0)
RMW-2AB 65ft	04-Jun-22	BLQ (LOQ 0.02)	BLQ (LOQ 0.1)	BLQ (LOQ 0.1)	BLQ (LOQ 0.02)	BLQ (LOQ 0.02)	BLQ (LOQ 0.05)	BDL (DL 0.2)	BDL (DL 10)	BDL (DL 5.0)
RMW-3AB 10ft	07-Jun-22	BLQ (LOQ 0.02)	BLQ (LOQ 0.1)	BLQ (LOQ 0.1)	BLQ (LOQ 0.02)	BLQ (LOQ 0.02)	BLQ (LOQ 0.05)	BDL (DL 0.2)	BDL (DL 10)	BDL (DL 5.0)
RMW-3AB 15ft	07-Jun-22	BLQ (LOQ 0.02)	BLQ (LOQ 0.1)	BLQ (LOQ 0.1)	BLQ (LOQ 0.02)	BLQ (LOQ 0.02)	BLQ (LOQ 0.05)	BDL (DL 0.2)	BDL (DL 10)	BDL (DL 5.0)
RMW-3AB 20ft	07-Jun-22	BLQ (LOQ 0.02)	BLQ (LOQ 0.1)	BLQ (LOQ 0.1)	BLQ (LOQ 0.02)	BLQ (LOQ 0.02)	BLQ (LOQ 0.05)	BDL (DL 0.2)	BDL (DL 10)	BDL (DL 5.0)
RMW-3AB 25ft	07-Jun-22	BLQ (LOQ 0.02)	BLQ (LOQ 0.1)	BLQ (LOQ 0.1)	BLQ (LOQ 0.02)	BLQ (LOQ 0.02)	BLQ (LOQ 0.05)	BDL (DL 0.2)	BDL (DL 10)	BDL (DL 5.0)
RMW-3AB 30ft	07-Jun-22	BLQ (LOQ 0.02)	BLQ (LOQ 0.1)	BLQ (LOQ 0.1)	BLQ (LOQ 0.02)	BLQ (LOQ 0.02)	BLQ (LOQ 0.05)	BDL (DL 0.2)	BDL (DL 10)	BDL (DL 5.0)
RMW-3AB 55ft	07-Jun-22	BLQ (LOQ 0.02)	BLQ (LOQ 0.1)	BLQ (LOQ 0.1)	BLQ (LOQ 0.02)	BLQ (LOQ 0.02)	BLQ (LOQ 0.05)	BDL (DL 0.2)	BDL (DL 10)	BDL (DL 5.0)
RMW-3AB 60ft	07-Jun-22	BLQ (LOQ 0.02)	BLQ (LOQ 0.1)	BLQ (LOQ 0.1)	BLQ (LOQ 0.02)	BLQ (LOQ 0.02)	BLQ (LOQ 0.05)	BDL (DL 0.2)	BDL (DL 10)	BDL (DL 5.0)
RMW-3AB 65ft	07-Jun-22	BLQ (LOQ 0.02)	BLQ (LOQ 0.1)	BLQ (LOQ 0.1)	BLQ (LOQ 0.02)	BLQ (LOQ 0.02)	BLQ (LOQ 0.05)	BDL (DL 0.2)	BDL (DL 10)	BDL (DL 5.0)

Legend/Notes:

VOC - Volatile Organic carbon GL/EN-INS/SOP/33
 GRO = gasoline-range organics by GL/EN-INS/SOP/33
 DRO = diesel-range organics by GL/EN-INS/SOP/39
 TOC = total organic carbon by Walkley & Black Method
 BTEX compounds by USEPA Method 5035A
 naphthalene by EPA Method 8100.
 µg/kg= micrograms/kilogram
 mg/kg = milligrams/kilogram

ND- Not Detected
 BDL-Below Limit of Quantification

Analytical Laboratories:

1. Samples analyzed by GLENS Labs, Chennai.

Table 4 - Reference Study Groundwater Analytical Data Summary (Fuel Compounds)

Bharat Petroleum Corporation, Ltd.

Tondiarpet, Chennai

Sample ID	Date Collected	VOC (mg/L)	DRO (mg/L)	GRO (mg/L)	TPH(mg/L)	PAH (mg/L)	TOC %	Benzene (µg/L)	Toluene (µg/L)	Ethylbenzene (µg/L)	Total Xylenes (µg/L)	Naphthalene (µg/L)	Oil and grease (mg/L)	Mineral oil (mg/L)
<u>Shallow Monitoring Wells</u>														
GLENS														
RMW-1A	04-Jul-22	0.51	0.50	0.45	0.84	BLQ (LOQ 0.05)	9.60	118.00	BLQ (LOQ10.0)	38.20	106.00	19.00	BDL (DL 4.0)	BDL (DL 0.1)
RMW-1A (Duplicate)	04-Jul-22	0.64	0.42	0.55	0.78	BLQ (LOQ 0.05)	22.40	BLQ (LOQ 10.0)	BLQ (LOQ 10.0)	131.00	360.00	37.00	BDL (DL 4.0)	BDL (DL 0.1)
RMW-2A	04-Jul-22	0.89	0.44	0.78	0.83	BLQ (LOQ 0.05)	6.40	BLQ (LOQ 10.0)	BLQ (LOQ 10.0)	190.00	490.00	50.00	BDL (DL 4.0)	BDL (DL 0.1)
RMW-3A	04-Jul-22	0.81	0.50	0.69	0.95	BLQ (LOQ 0.05)	25.60	BLQ (LOQ 10.0)	BLQ (LOQ 10.0)	154.00	430.00	42.00	BDL (DL 4.0)	BDL (DL 0.1)
<u>Deep-Screened Monitoirng Wells</u>														
RMW-1B	04-Jul-22	BLQ (LOQ 0.01)	BLQ (LOQ 0.01)	BLQ (LOQ 0.01)	BLQ (LOQ 0.1)	BLQ (LOQ 0.05)	64.00	BLQ (LOQ 10.0)	BLQ (LOQ 10.0)	BLQ (LOQ 10.0)	BLQ (LOQ 10.0)	BLQ (LOQ 10.0)	BDL (DL 4.0)	BDL (DL 0.1)
RMW-2B	04-Jul-22	0.78	0.57	0.68	1.06	BLQ (LOQ 0.05)	32.10	BLQ (LOQ 10.0)	BLQ (LOQ 10.0)	162.00	440.00	41.00	BDL (DL 4.0)	BDL (DL 0.1)
RMW-3B	04-Jul-22	0.60	0.45	0.56	0.84	BLQ (LOQ 0.05)	38.50	BLQ (LOQ 10.0)	BLQ (LOQ 10.0)	149.00	340.00	39.00	BDL (DL 4.0)	BDL (DL 0.1)
Trip Blank	04-Jul-22	BLQ (LOQ 0.01)	BLQ (LOQ 0.01)	BLQ (LOQ 0.01)	BLQ (LOQ 0.1)	BLQ (LOQ 0.05)	BDL (DL 2.0)	BLQ (LOQ 10.0)	BLQ (LOQ 10.0)	BLQ (LOQ 10.0)	BLQ (LOQ 10.0)	BLQ (LOQ 10.0)	BDL (DL 4.0)	BDL (DL 0.1)
<u>Legend/Notes:</u>														
VOC - Volatile Organic carbon GL/EN-INS/SOP/33														
GRO = gasoline-range organics by GL/EN-INS/SOP/33														
DRO = diesel-range organics by GL/EN-INS/SOP/39														
TOC = total organic carbon by Walkley & Black Method														
BTEX compounds by USEPA Method 5035A														
naphthalene by EPA Method 8100.														
µg/L = micrograms/liter														
mg/L = milligrams/liter														
ND- Not Detected														
BDL-Below Limit of Quantification														
<u>Analytical Laboratories:</u>														
1. Samples analyzed by GLENS Labs, Chennai.														

Annexure-10

SVE 1- Field data pertains to system flow rate and its concentration of past 32 month

Month & Year	Average time of operation per day (hrs/day)	No. of wells used for extraction in a day	Field inlet (without dilution)		System Inlet (inlet to SVE system, after dilution)	
			Flow in cfm	Concentration in ppm (using PID)	Flow in cfm	Concentration in ppm (using PID)
Oct 2019	23(31 d)	5	28-28.6	341-409	96-99	220-278
Nov 2019	23(30 d)	5	28.1-28.6	332-389	96-99	211-257
Dec 2019	24(31 d)	5	28-28.6	316-379	97-99	214-247
Jan 2020	24(28 d)	5	28-28.70	160-213	97-99	101-163
Feb 2020	23(29 d)	5	27.10-28.70	123.25-229.50	97-99	49-159
Mar 2020	24(23 d)	5	28-29	206-274	97-99	49-73
April 2020	9(9 d)	5	27.40-29	229-284	97-98.90	54-69
May 2020	11(26 d)	5	27.80-29	206-284	97-99	49-73
Jun 2020	21(26 d)	5	27.80-29	359-455	97-99	159-249
July 2020	23(27 d)	5	28.10-29.10	384-437	97.80-98.90	189-238
Aug 2020	22(26 d)	5	0.00-28.70	0.00-435	0.00-98.70	0.00-242
Sep 2020	23(26 d)	8	28.20-28.60	380-405	98.20-98.60	212-235
Oct 2020	24(27 d)	8	28.20-28.50	230-245	98.20-98.50	176-185
Nov 2020	20(23 d)	8	0.00-28.50	230-245	98.20-98.50	0.00-184
Dec 2020	20(26 d)	8	28.30-28.60	183-196	98.10-98.50	138-145
Jan 2021	24(24 d)	8	28.30-28.50	180-192	98.10-98.40	140-146
Feb 2021	24(24 d)	8	28.10-28.60	176-209	98.10-98.50	137-170
Mar 2021	24(27 d)	8	28.10-28.60	80-186	98.10-98.50	44-117
April 2021	24(22 d)	8	28.10-28.60	312-378	98.10-98.60	159-189
May 2021	24(23 d)	8	28.10-28.70	289-367	98.10-98.60	159-189
June 2021	24(15d)	8	28.10-28.60	115-289	98.10-98.60	93-155
July 2021	23(26 d)	8	28.10-28.60	61-116	98.00-98.60	32.00-95.00
Aug 2021	23 (26 d)	8	28.10-28.60	11.00-60.00	98.00-98.60	10.00-32.00
Sept 2021	24 (25 d)	8	28.10-28.60	11.00-60.00	98.00-98.50	10.00-32.00

Oct 2021	24 (24 d)	8	28.10-28.60	45.00-225.00	98.00-98.50	25.00-185.00
Dec 2021	24 (23 d)	8	28.20-28.60	4.00-14.00	98.20-98.50	3.00-12.00
Jan 2022	24 (22 d)	8	28.30-28.40	0.10-0.40	98.20-98.50	0.10-0.30
Feb 2022	24 (24 d)	8	28.20-28.40	0.10-0.30	98.20-98.50	0.10-0.10
Mar 2022	27 (24 d)	8	28.20-28.40	0.10-0.30	98.20-98.50	0.10-0.10
April 2022	24 (24 d)	8	28.20-28.40	0.10-0.30	98.20-98.40	0.10-0.10
May 2022	24 (25 d)	8	28.20-28.40	0.10-0.30	98.20-98.40	0.10-0.10
June 2022	24 (26 d)	3	28.20-28.40	0.10-0.30	98.30-98.40	0.10-0.10
SVE SYSTEM – 2						
Feb 2020	3(18 d)	1	0.00-290	0.00-379.66	0.00-340	0.00-390
Jun 2020	12(18 d)	1	105-165	320-435	190-250	196-298
July 2020	10(27 d)	1	0.00-165	0.00-428	0.00-235	0.00-272
Aug 2020	12(26 d)	1	140-160	340-412	210-225	222-258
Sep 2020	11(26 d)	5	140-155	0.00-399	210-399	220-235
Oct 2020	11(27 d)	5	140-155	205-225	210-230	285-315
Nov 2020	11(23 d)	5	0.00-155	0.00-212	230-230	0.00-315
Dec 2020	12(26 d)	5	140-155	172-205	225.15-231.30	275-315
Jan 2021	12(24 d)	5	140-155	180-195	210-225	278-293
Feb 2021	12(24 d)	5	140-155	180-215	210-225	278-295
Mar 2021	11(27 d)	5	140-155	115-189	210-225	203-290
April 2021	12 (22 d)	5	140-155	55.00-79.00	210-225	89.00-121
May 2021	11 (23 d)	5	140-155	51.00-68.00	210-225	89.00-114
June 2021	12 (16 d)	5	140-155	72.00-140.00	210-225	125-310
July 2021	12 (26 d)	5	140-155	118-135	210-225	275-308

Aug 2021	12 (26 d)	5	140-155	70.00-121	210-225	145-258
Sept 2021	12 (25 d)	5	140-155	50.00-70.00	210-225	120-140
Oct 2021	12 (19 d)	5	140-155	55.00-235	210-225	125-340
May 2022	12 (25 d)	6	140-155	46.00-59.00	210-225	40.00-52.00
June 2022	12 (26 d)	6	135-150	3.00-47.00	215-220	2.00-45.00

Annexure -11

Performance of Soil Vapour Extraction (SVE) system

Performance of 1 st SVE system by taking samples from inlet & outlet						
Absorbent used ----Tenax + Carbopack						
Parameter	Unit	Field inlet			SVE System inlet (dilution with air)	SVE outlet
		MW 16 A & SVE 8, 9				
TVOC	ppm	4.8			3.6	0.6
VOC	mg/m ³	1.49			1.5	0.54
BTEX	mg/m ³	0.77			0.45	0.16
GRO	mg/m ³	1.23			1.11	0.32
DRO	mg/m ³	1.68			1.1	BLQ(LOQ: 0.1)
TPH	mg/m ³	2.14			1.22	BLQ(LOQ: 0.1)

Performance of 2 nd SVE system by taking samples from inlet & outlet						
Absorbent used ----Tenax + Carbopack						
Parameter	Unit	Field inlet			SVE System inlet (dilution with air)	SVE outlet
		MW 2A, SVE 1 & SVE 12	MW 4A & SVE 11	MW 26 A		
TVOV	ppm	1.9	2.1	3.9	1.8	BDL(DL:0.1)
VOC	mg/m ³	1.08	1.02	2.09	1.32	BLQ(LOQ: 0.1)
BTEX	mg/m ³	0.61	0.47	1.2	0.9	BLQ(LOQ: 0.1)
GRO	mg/m ³	1.04	0.95	1.96	1.38	BLQ(LOQ: 0.1)
DRO	mg/m ³	0.55	0.84	1.73	0.42	BLQ(LOQ: 0.1)
TPH	mg/m ³	0.49	0.56	1.51	0.42	BLQ(LOQ: 0.1)

8	Mineral oil (mg/L)	BDL (DL: 0.1)	BDL (DL: 0.1)	BDL (DL: 0.1)	BDL (DL: 0.1)	BDL (DL: 0.1)	BDL (DL: 0.1)	BDL (DL: 0.1)	BDL (DL: 0.1)	BDL (DL: 0.1)	BDL (DL: 0.1)	BDL (DL: 0.1)	BDL (DL: 0.1)	BDL (DL: 0.1)	BDL (DL: 0.1)	BDL (DL: 0.1)
9	BTEX (mg/L)	0.41	0.34	BLQ (LOQ: 0.01)	0.70	0.69	BLQ (LOQ: 0.01)	BLQ (LOQ: 0.01)	BLQ (LOQ: 0.01)	BLQ (LOQ: 0.01)	0.70	BLQ (LOQ: 0.01)	BLQ (LOQ: 0.01)	BLQ (LOQ: 0.01)	BLQ (LOQ: 0.01)	BLQ (LOQ: 0.01)
10	Odour experienced in the field	Light smell	Light smell	Sewage smell	Mild smell	Mild smell	Light smell	Very Light smell	Light sewage smell	No smell	Light smell	No smell	Smell observed	Smell observed	No small	Light smell

Table 2: Results of Analysis of Deep wells

S. No	Parameter & Units	Deep wells monitoring and Detectable limits						
		MW – 25 B	MW – 16 B	MW – 3 B	MW – 26 B	MW – 5 B	MW- 23 B	MW – 7 B
1	TPH (mg/L)	BLQ (LOQ:0.1)	BLQ (LOQ:0.1)	0.71	BLQ (LOQ:0.1)	BLQ (LOQ:0.1)	BLQ (LOQ:0.1)	0.93
2	VOC (mg/L)	BLQ (LOQ:0.01)	BLQ (LOQ:0.01)	0.80	BLQ (LOQ:0.01)	BLQ (LOQ:0.01)	BLQ (LOQ:0.01)	0.87
3	DRO (mg/L)	BLQ (LOQ:0.1)	BLQ (LOQ:0.1)	0.27	BLQ (LOQ:0.1)	BLQ (LOQ:0.1)	BLQ (LOQ:0.1)	0.31

4	GRO (mg/L)	BLQ (LOQ:0.01)	BLQ (LOQ:0.01)	0.37	BLQ (LOQ:0.01)	BLQ (LOQ:0.01)	BLQ (LOQ:0.01)	0.80
5	Total Hydrocarbon (mg/L)	BLQ (LOQ:0.1)	BLQ (LOQ:0.1)	0.71	BLQ (LOQ:0.1)	BLQ (LOQ:0.1)	BLQ (LOQ:0.1)	0.93
6	TOC (mg/L)	48.1	25.6	17.6	8.0	22.4	8.0	32.1
7	Oil & Grease (mg/L)	BDL (DL:4.0)	BDL (DL:4.0)	BDL (DL:4.0)	BDL (DL:4.0)	BDL (DL:4.0)	BDL (DL:4.0)	BDL (DL:4.0)
8	Mineral oil (mg/L)	BDL (DL:0.1)	BDL (DL:0.1)	BDL (DL:0.1)	BDL (DL:0.1)	BDL (DL:0.1)	BDL (DL:0.1)	BDL (DL:0.1)
9	BTEX (mg/L)	BLQ (LOQ:0.01)	BLQ (LOQ:0.01)	0.33	BLQ (LOQ:0.01)	BLQ (LOQ:0.01)	BLQ (LOQ:0.01)	0.46
10	Odour experienced in the field	Light smell	No smell	Sewage smell	No smell	Very light smell	No smell	Smell observed

Note:

BDL – Below detectable limit, DC – Detectable limit

BLQ – Below limit of quantification

LOQ – Limit of quantification

Table 3: Results of analysis of Residence located near to Agasthya Theatre

S. No	Parameters & Units	Nearby House wells monitoring & Detectable limits	
		House No. 233/9	House No. 233/10
1	TPH (mg/L)	0.95	0.77
2	VOC (mg/L)	0.96	1.08
3	DRO (mg/L)	0.32	0.29
4	GRO (mg/L)	0.96	1.08
5	Total Hydrocarbon (mg/L)	0.95	0.77
6	TOC (mg/L)	12.8	3.2
7	Oil & Grease (mg/L)	BDL(DL:4.0)	BDL(DL:4.0)
8	Mineral Oil (mg/L)	BDL(DL:0.1)	BDL(DL:0.1)
9	BTEX (mg/L)	0.74	0.81
10	Odour experienced in the field	Smell observed	Smell observed

Table 4: Results of Analysis of Reference Monitoring (Shallow)Wells

S. No	Parameters & Units	Reference monitoring A wells and Detectable limits		
		RMW 1 A	RMW 2 A	RMW 3 A
1	TPH (mg/L)	0.71	0.88	0.95
2	VOC (mg/L)	1.05	0.97	0.88
3	DRO (mg/L)	0.63	0.77	0.63
4	GRO (mg/L)	1.05	0.95	0.88
5	Total Hydrocarbon (mg/L)	0.71	0.88	0.95
6	TOC (mg/L)	16	6.4	14.5

7	Oil & Grease (mg/L)	BDL(DL:4.0)	BDL(DL:4.0)	BDL(DL:4.0)
8	Mineral Oil (mg/L)	BDL(DL:0.1)	BDL(DL:0.1)	BDL(DL:0.1)
9	BTEX (mg/L)	0.72	0.68	0.63
10	Odour experienced in the field	No smell	Light smell observed	Light smell

Table 5: Results of Analysis of Reference Monitoring (Deep)Wells

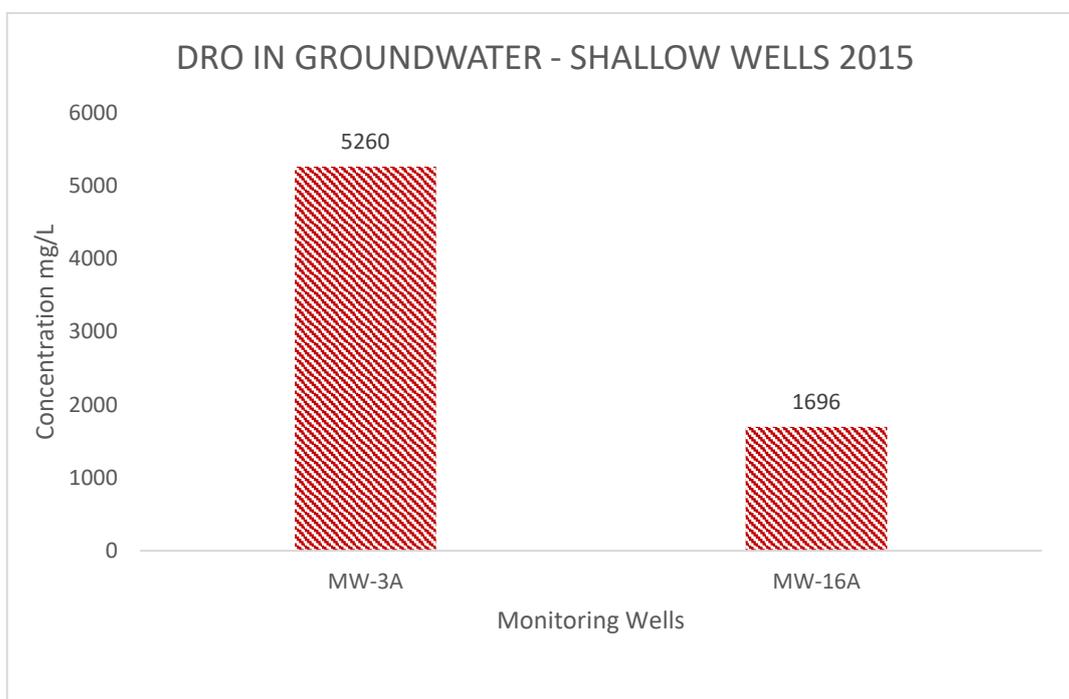
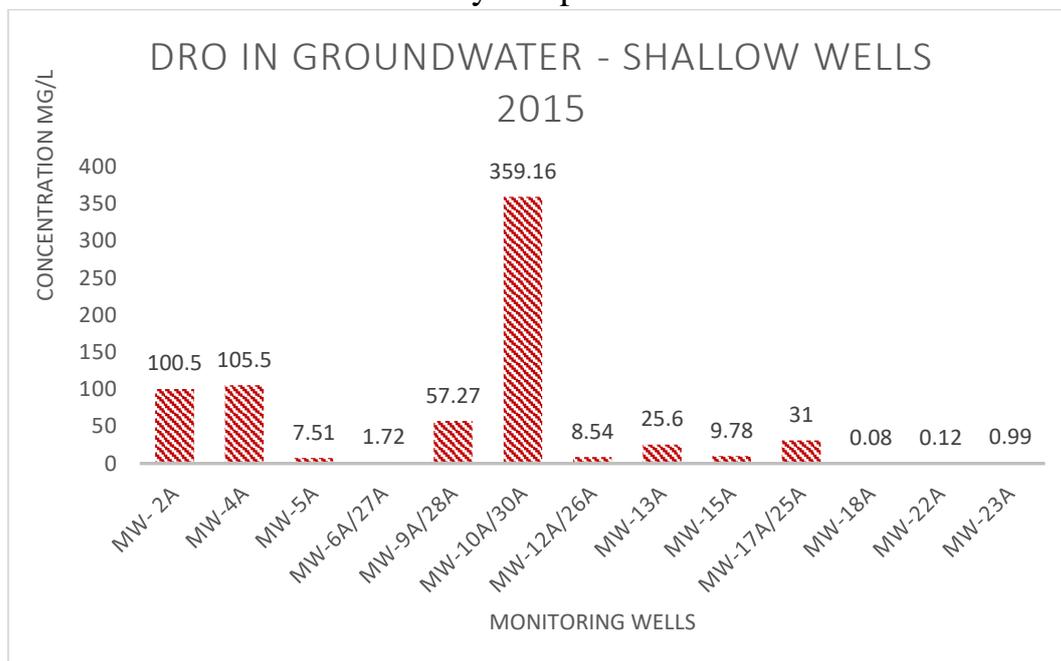
S. No	Parameters & Units	Reference monitoring B wells and Detectable limits		
		RMW 1 B	RMW 2 B	RMW 3 B
1	TPH (mg/L)	BLQ(LOQ:0.1)	0.78	0.82
2	VOC (mg/L)	BLQ(LOQ:0.01)	0.83	0.76
3	DRO (mg/L)	BLQ(LOQ:0.1)	0.68	0.74
4	GRO (mg/L)	BLQ(LOQ:0.01)	0.83	0.76
5	Total Hydrocarbon (mg/L)	BLQ(LOQ:0.1)	0.78	0.82
6	TOC (mg/L)	38.5	14.4	20.8
7	Oil & Grease (mg/L)	BDL(DL:4.0)	BDL(DL:4.0)	BDL(DL:4.0)
8	Mineral Oil (mg/L)	BDL(DL:0.1)	BDL(DL:0.1)	BDL(DL:0.1)
9	BTEX (mg/L)	BLQ(LOQ:0.01)	0.5	0.53
10	Odour experienced in the field	Mild smell	No smell	No smell

Table 6: BPCL Tank Sample

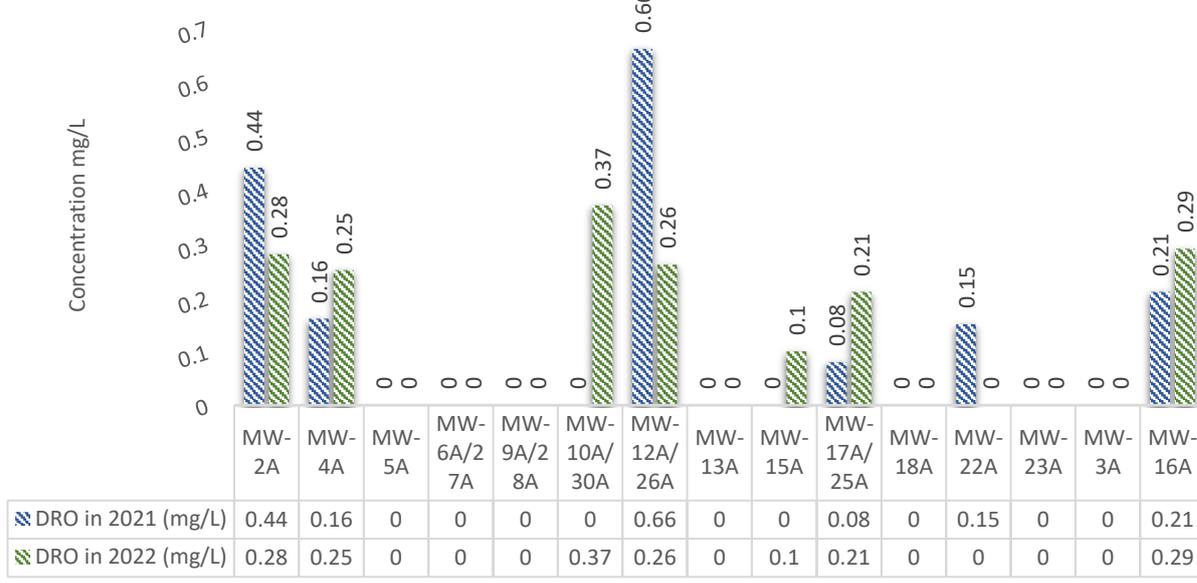
S. No	Parameters & Units	BPCL Tank sample monitoring & Detectable limits	
		Tank 22 Inlet	Tank 22 Outlet
1	TPH (mg/L)	1.14	BLQ(LOQ:0.1)
2	VOC (mg/L)	0.83	BLQ(LOQ:0.01)
3	DRO (mg/L)	0.38	BLQ(LOQ:0.1)
4	GRO (mg/L)	0.83	BLQ(LOQ:0.01)
5	Total Hydrocarbon (mg/L)	1.14	BLQ(LOQ:0.1)
6	TOC (mg/L)	9.7	BDL(DL:2.0)
7	Oil & Grease (mg/L)	BDL(DL:4.0)	BDL(DL:4.0)
8	Mineral Oil (mg/L)	BDL(DL:0.1)	BDL(DL:0.1)
9	BTEX (mg/L)	0.63	BDL(DL:0.01)

Annexure – 14

The mass reduction in terms of DRO, TPH and TOC in Ground water for seven-year span

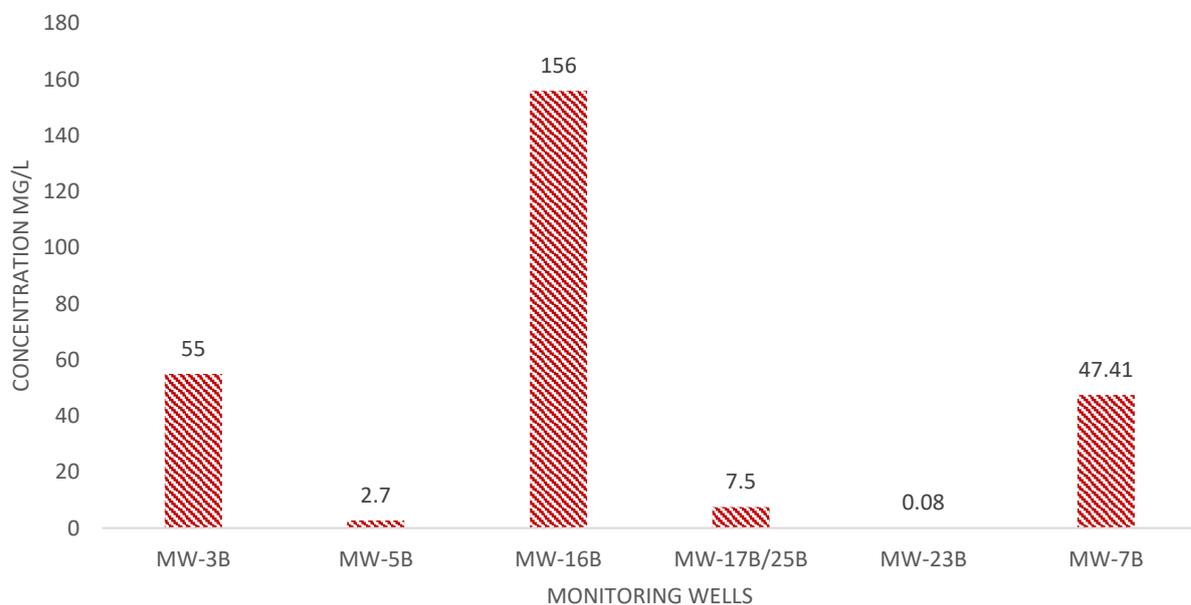


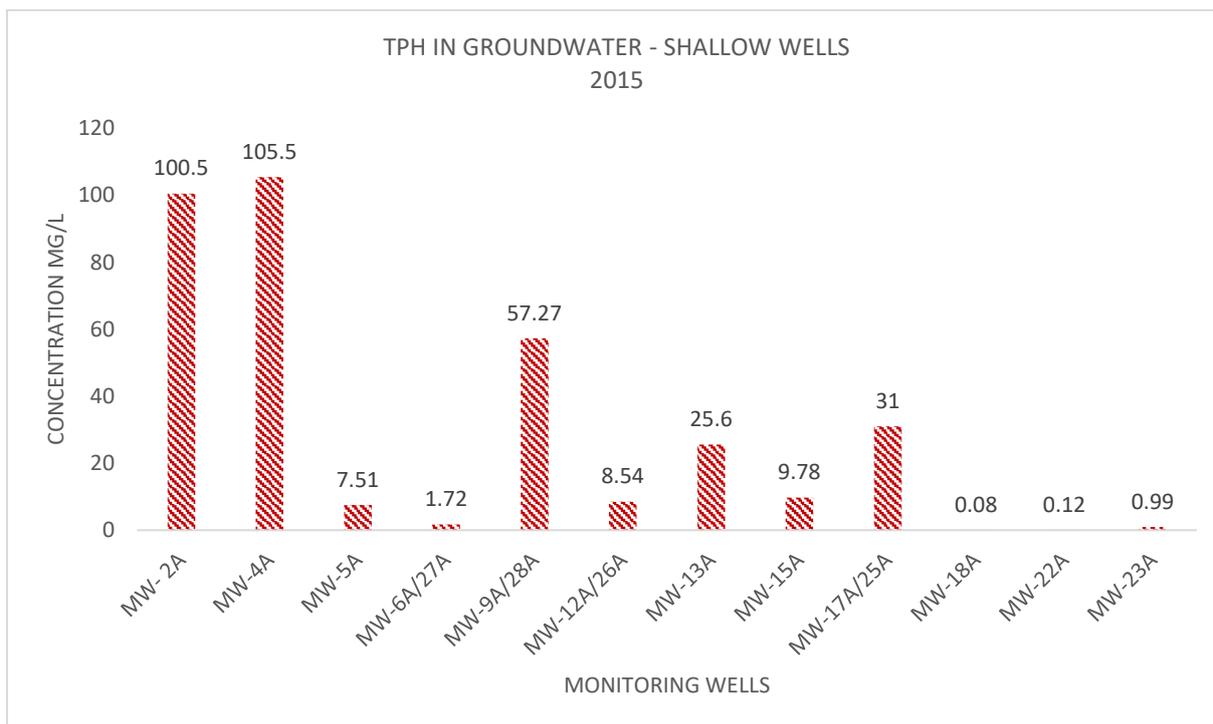
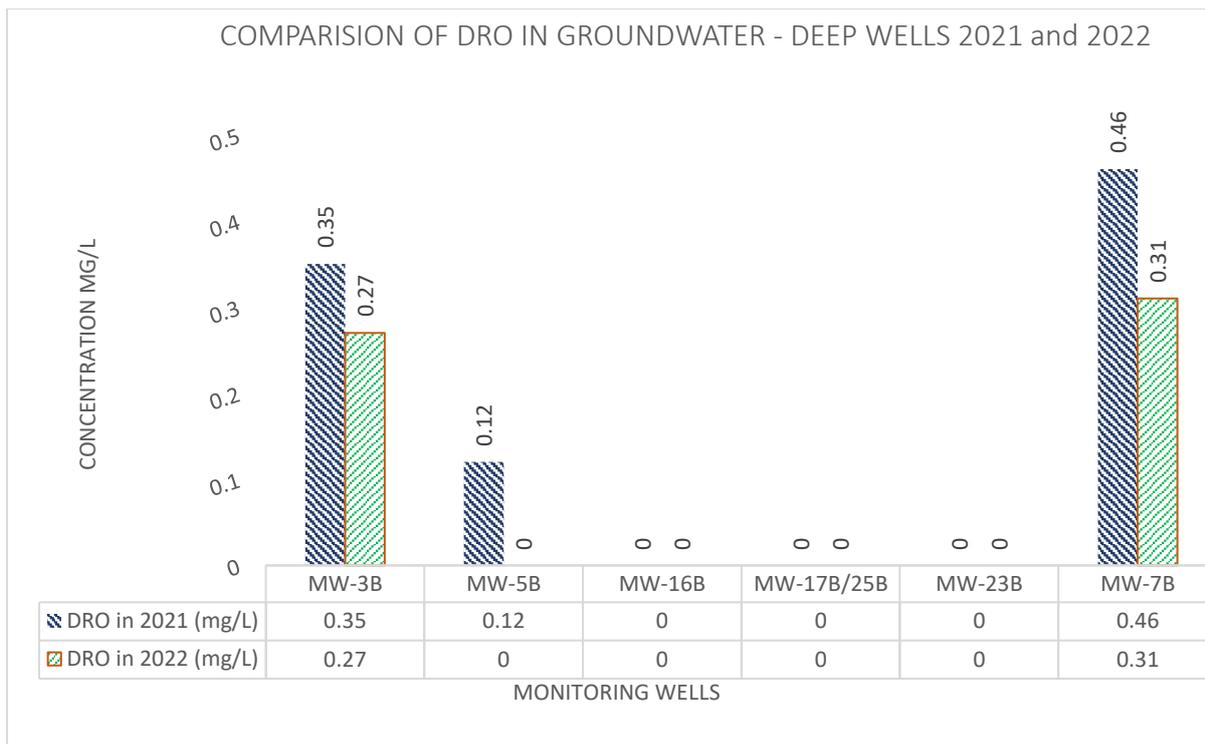
COMPARISION OF DRO IN GROUNDWATER - SHALLOW WELLS 2021 and 2022

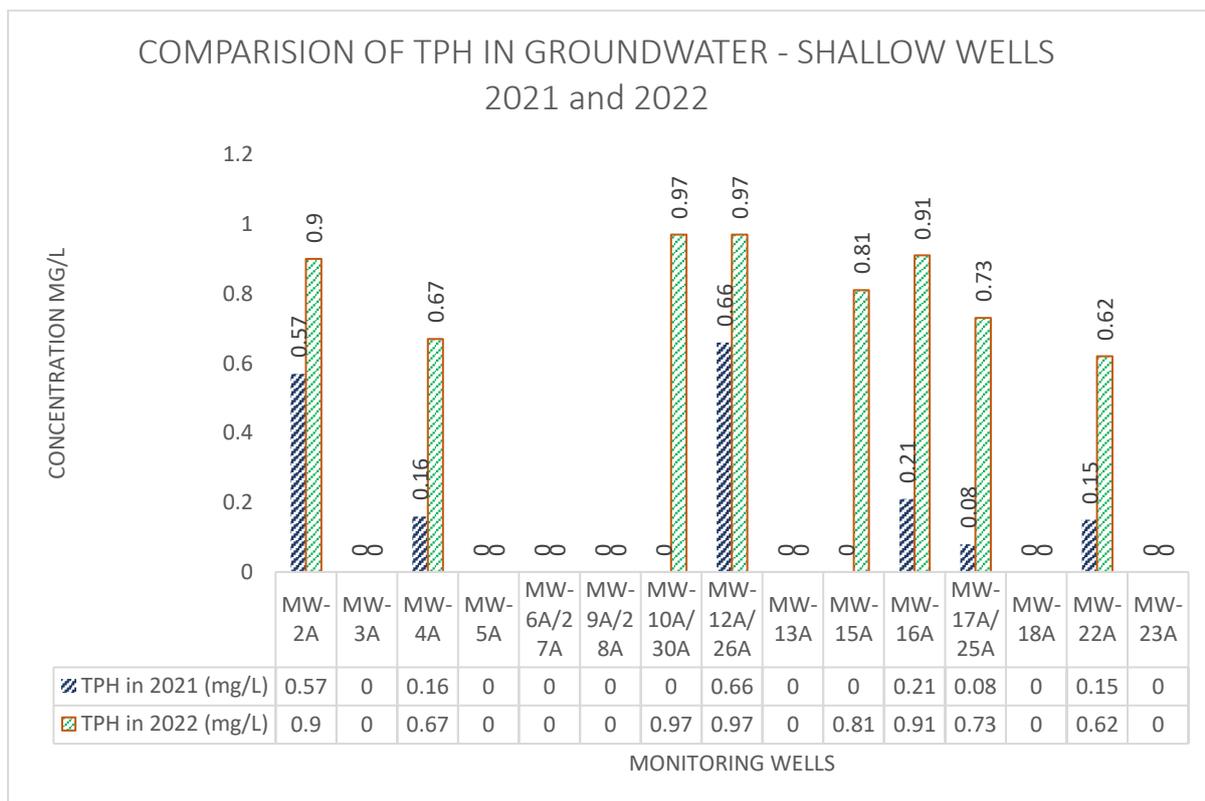
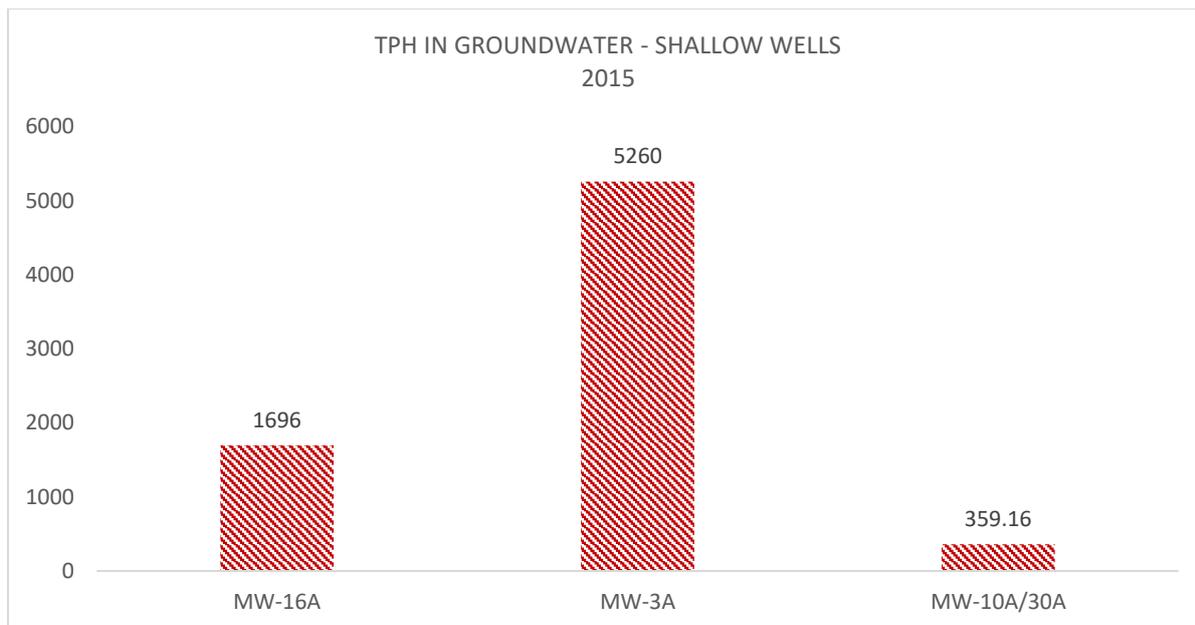


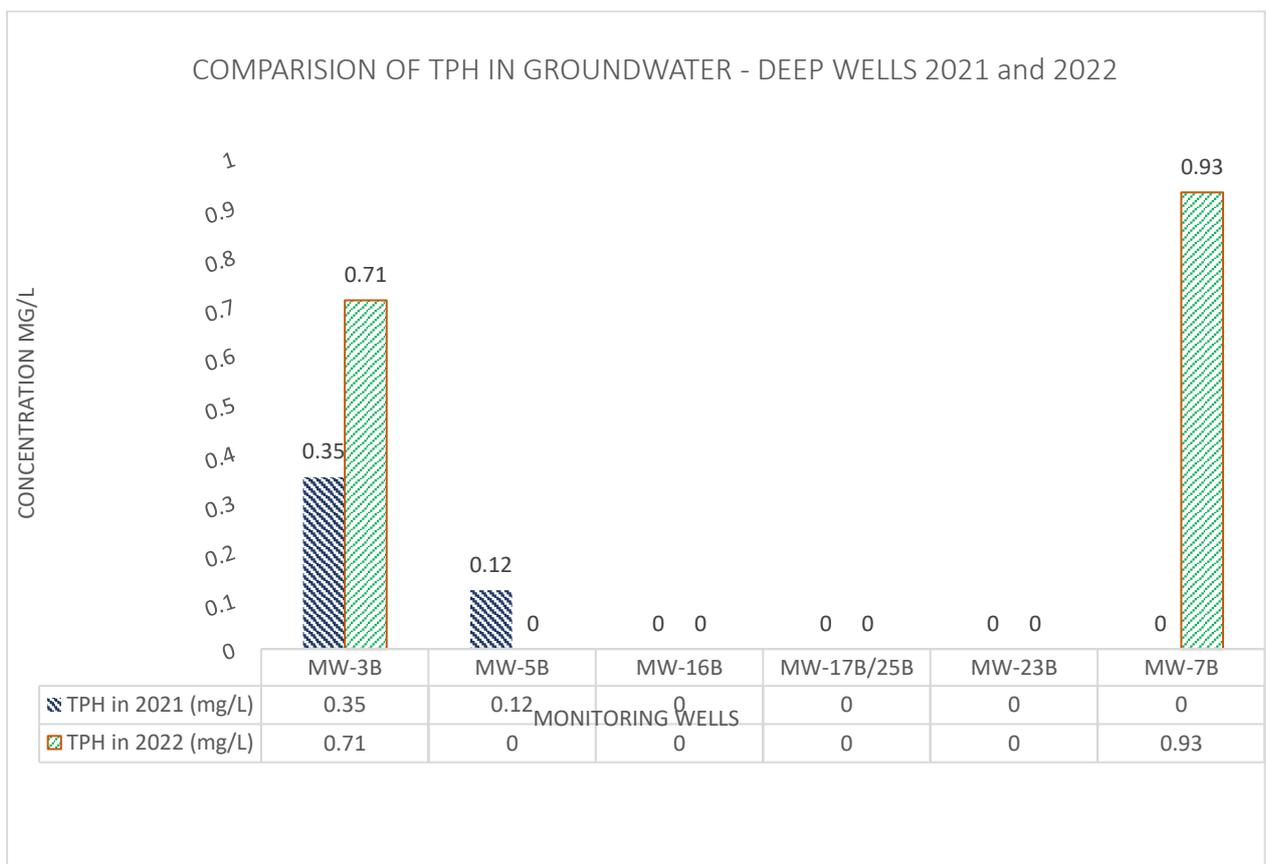
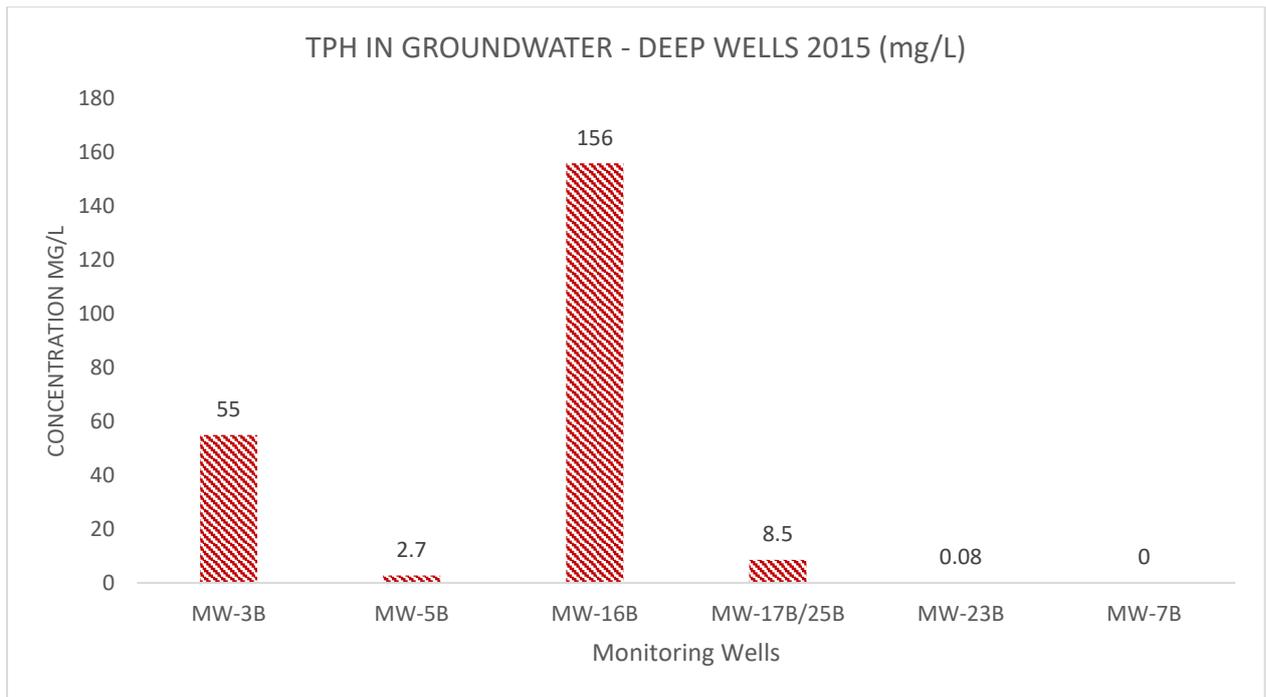
Monitoring Wells

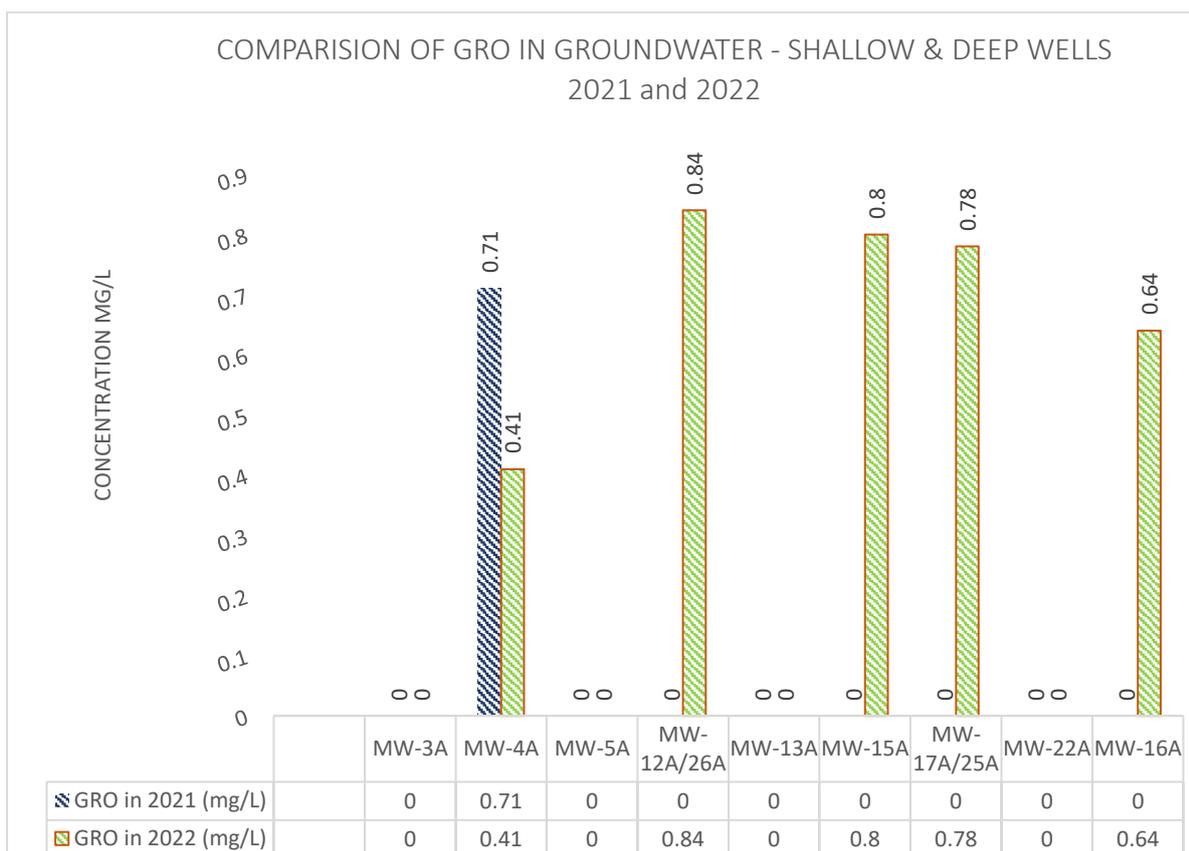
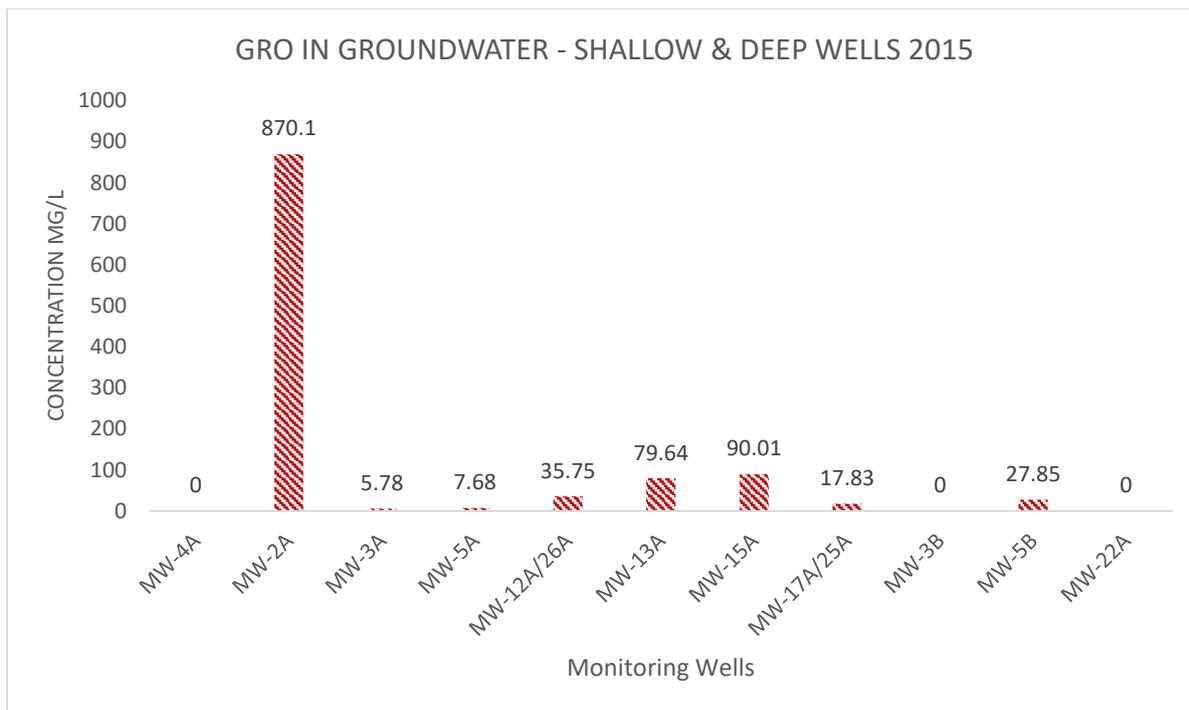
DRO IN GROUNDWATER - DEEP WELLS 2015



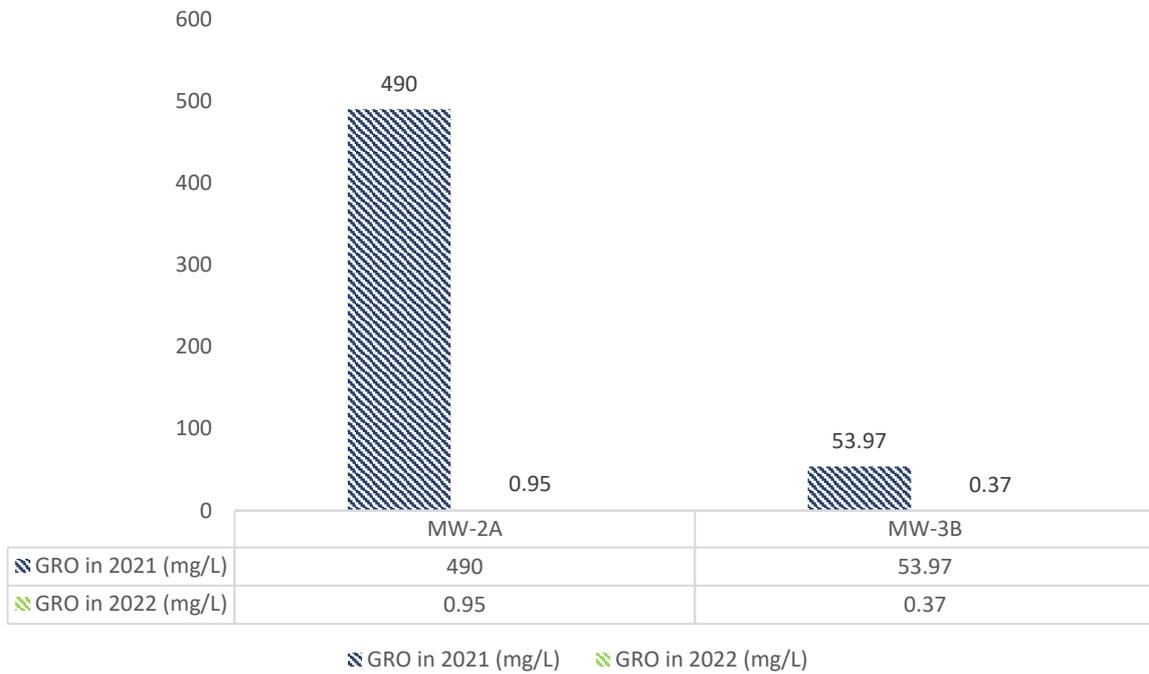








COMPARISION OF GRO IN GROUNDWATER - SHALLOW & DEEP WELLS 2021 and 2022





चेन्नै टेरिटरी
न. 35, वैद्यनाथन स्ट्रीट, डा.पे.सं. 1152,
तंण्डैयारपेट, चेन्नै-600 081. तार : इन्स्टलकेट
दूरभाष : 25952381, 25952384, 25951158, 25953884
दूरभाष : 25951288, 25228129 टेलिफैक्स : 044-25956949

CHENNAI TERRITORY
No.35, Vaidyanathan Street, Post Box No. 1152,
Tondiarpet, Chennai-600 081. Grams : INSTALKEET
Phone : 25952381, 25952384, 25951158, 25953884
Phone : 25951288, 25228129 TeleFax : 044-25956949

Annexure - 15

Dt. 28.10.2021

REF: TNP: TNPCB: 2021-22

To,

The Member Secretary,
Tamilnadu Pollution Control Board,
No.76, Mount Salai,
Guindy,
Chennai-600032



Respected Sir,

SUB: Remediation of oil contaminated site at Tondiarpet, Chennai (TN): : Hon'ble NGT Court Case No. OA No. 562/2013: To conduct health study in the vicinity of Oil contaminated site by ICMR – Submission of Demand Draft of payment – req.

Ref. (1) TNPCB letter no. T2/TNPCB/F.0173/HWM/NGT-176/2013 (SZ)/2021 dated 13.08.2021

This has reference to your letter mentioned under reference (1). As directed by you, we hereby submit the 90% of total budget for health study vide SBI DD no. 615500 dated 27.10.2021 drawn in favour of THE DIRECTOR, ICMR NIE for Rs. 92, 81,055.50 (Rupees Ninety two lakhs Eighty one thousand fifty five and paise fifty only) after deducting the applicable TDS.

We request you to kindly forward a receipt for the amount remitted and also to start the health study through ICMR at the earliest.

Thanking you.

Yours faithfully,

For Bharat Petroleum Corporation Ltd

Chief Installation Manager

Encl. SBI DD no. 615500 dated 27.10.2021
CC : The Regional Director, CPCB, Chennai
CC : Chairman, CPCB, Delhi.
CC : DEE, TNPCB, Arumbakkam, Chennai.

रजिस्टर्ड ऑफिस : भारत भवन, 4 & 6, करीमभाय रोड, बेलार्ड इस्टेट, पोर्ट बोक्षक, 688, मुंबई- 400 001.
तार : कोरोपेट, फेक्स : 261 6793, फोन : 2261 8281, 2261 8061

Registered Office : Bharat Bhavan, 4 & 6, Currimbhoy Road, Ballard Estate, P.B. No.688, Mumbai -400 001.
Grams : KEROPET, Fax : 261 6793, Phones : 2261 8281, 2261 8061

जारी करी जारी
Issuing Branch: ANNA NAGAR (WEST), CHENNAI
कॉड क्र. / CODE No: 03870
Tel No. 044-49571316

Key: YEFBAP
Sr. No: 31384

Page No. 86
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मांग द्राफ्ट
DEMAND DRAFT

मार्ग जानेपर THE DIRECTOR, ICMR NIE *****

या उनके आ
OR TO

ON DEMAND PAY

रुपये RUPEES

Ninety Two Lakh Eighty One Thousand Fifty Five and Paise Fifty Only

अदा करे ₹ 9281055.50

IOI 000523615500
Name of Applicant

Key: YEFBAP Sr. No: 31384
BHARAT PETROLEUM CORPORATION L

AMOUNT BELOW 9281056(8/7) मूल्य प्राप्त / VALUE RECEIVED



भारतीय स्टेट बैंक

STATE BANK OF INDIA

अदाकर्ता शाखा / DRAWEE BRANCH: GOPC, CHENNAI

कॉड क्र. / CODE No: 10385

Jagannath

प्राधिकृत हस्ताक्षरकर्ता
AUTHORISED SIGNATURE

S. Anand
BRANCH MANAGER

कम्प्यूटर द्वारा मुद्रित होने पर ही वैध
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केवल 3 महीने के लिए वैध
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₹ 1,50,000/- एवं अधिक के लिखत दो अधिकारियों द्वारा हस्ताक्षरित होने पर ही वैध है
INSTRUMENTS FOR ₹ 1,50,000/- & ABOVE ARE NOT VALID UNLESS SIGNED BY TWO OFFICERS

S. ANAND
CR No.A-3

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Preliminary Report

Annexure - 16

Period of report: 23/02/2022 to 29/07/2022

Collaborating institutions: IIT-Madras, Madras Medical College-Chennai,
ICMR-NIE –Chennai, ICMR-NIOH-ROHC(S)-Bangalore, ICMR-NIREH-Bhopal.

Outsourcing partner: ICMR-NIRT, Chennai - Blood sample analysis (Initial Period)
Sipra Labs, Hyderabad – Blood and Urine sample analysis

Objectives:

- To assess the health impact of the population exposed to oil pipeline-leak in Tondiarpet area and unexposed population in Royapuram area in Chennai.
- To collect the current environmental petroleum exposure data in both study areas and collect historical environmental data at the exposed area.

Study design: Cross-sectional study

Study population: Residents (aged 5 years and above)

- Tondiarpet (exposed to oil pipeline leak)
- Royapuram (unexposed to oil pipeline leak)

Sample size: 3,335 individuals each in exposed and unexposed areas

- Include all the eligible individuals residing within 200 m² radius from the oil leakage point.
- The population density of Chennai is 26,553/KM² (2011 census)
- The approximate number of population residing in 200 m² radius is 3,335.

Sampling:

- Recruit all the residents in the exposed & unexposed areas
- Maximum two attempts for recruitment

Data collection:

- Trained staff nurses, field workers & lab technicians collected the data
- Structured questionnaire being used to collect data using Android-based ODK app in Tabs
- Collected socio-demographic details, duration of stay, occupation, self-reported co-morbidities
- Venous blood (5ml) & urine (50 ml) in a sub-sample of study population (both exposed and unexposed area)
- Lung function – spirometry
- Heart Rate Variability

Preliminary Results

Timelines for data collection:

Task (Data Collection)	Unexposed Area (Royapuram)	Exposed Area (Tondiarpet)
Started	23/02/2022	02/05/2022
Completed	29/04/2022	Expected date of completion 15/08/2022

Data compilation and cleaning are ongoing.

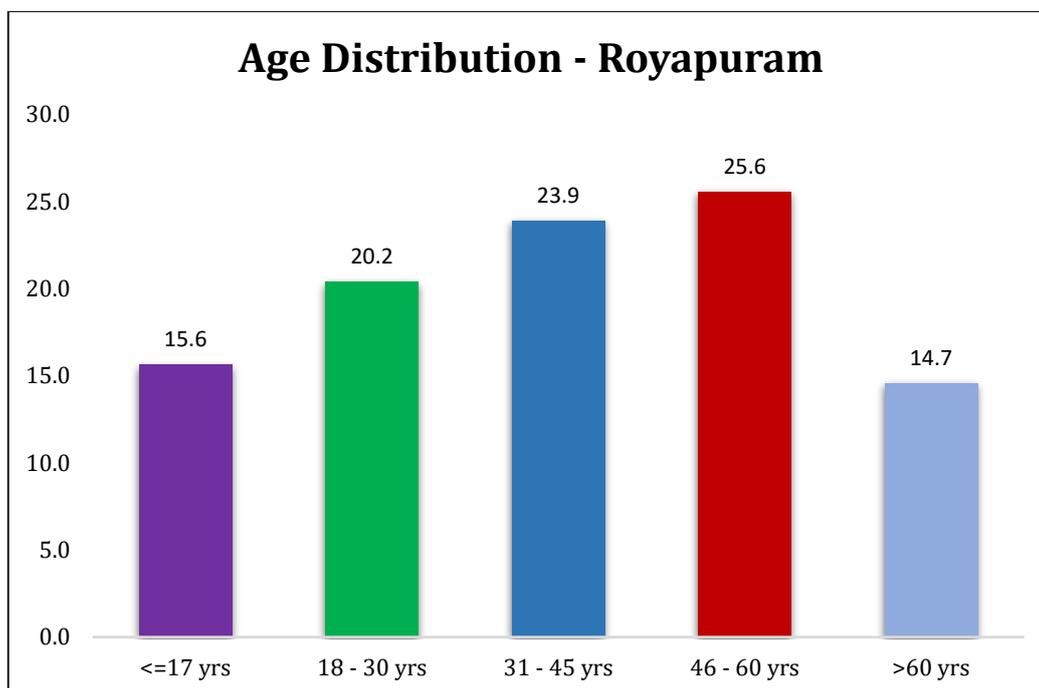
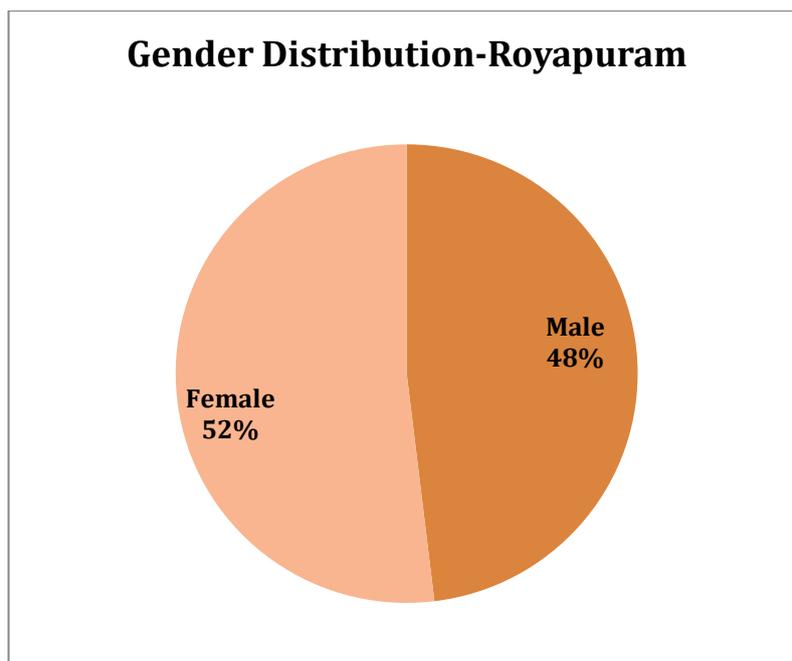
I. Unexposed area - Royapuram

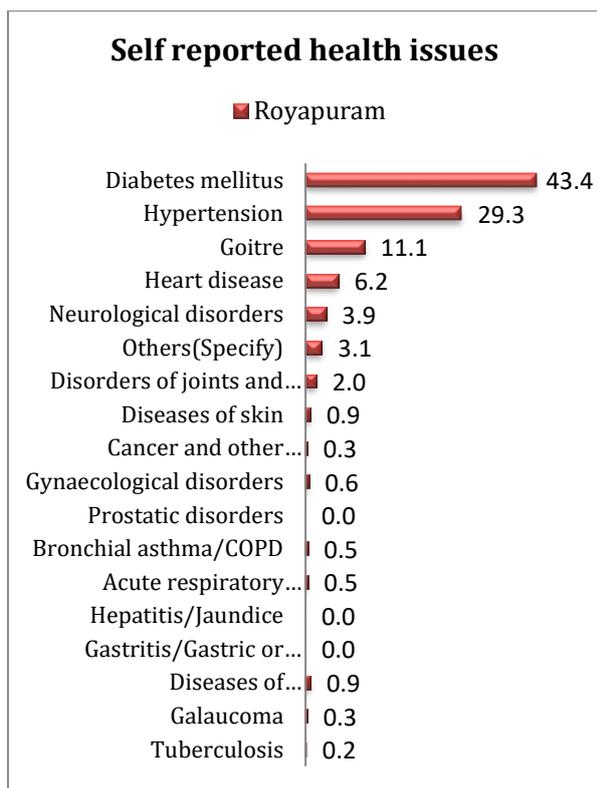
S.no	Description	Randomly Selected households for clinical evaluation and biological testing	Other population for clinical evaluation
1	Total approached Households	450	924
2	Consented Households	342	608
3	Door locked/Refused	108	316
		Selected individuals	
4	Consented individuals	336	2476
5	Refused/ Non competent	06	385

Sample Collection among Selected individuals: (n= 336)

S.no	Investigations	≥18 years (n=312)	<18 years (n=24)
1	HRV Test	257	NA
2	Spirometry	264	NA
3	Blood Samples	256	22
4	Urine Samples	259	22

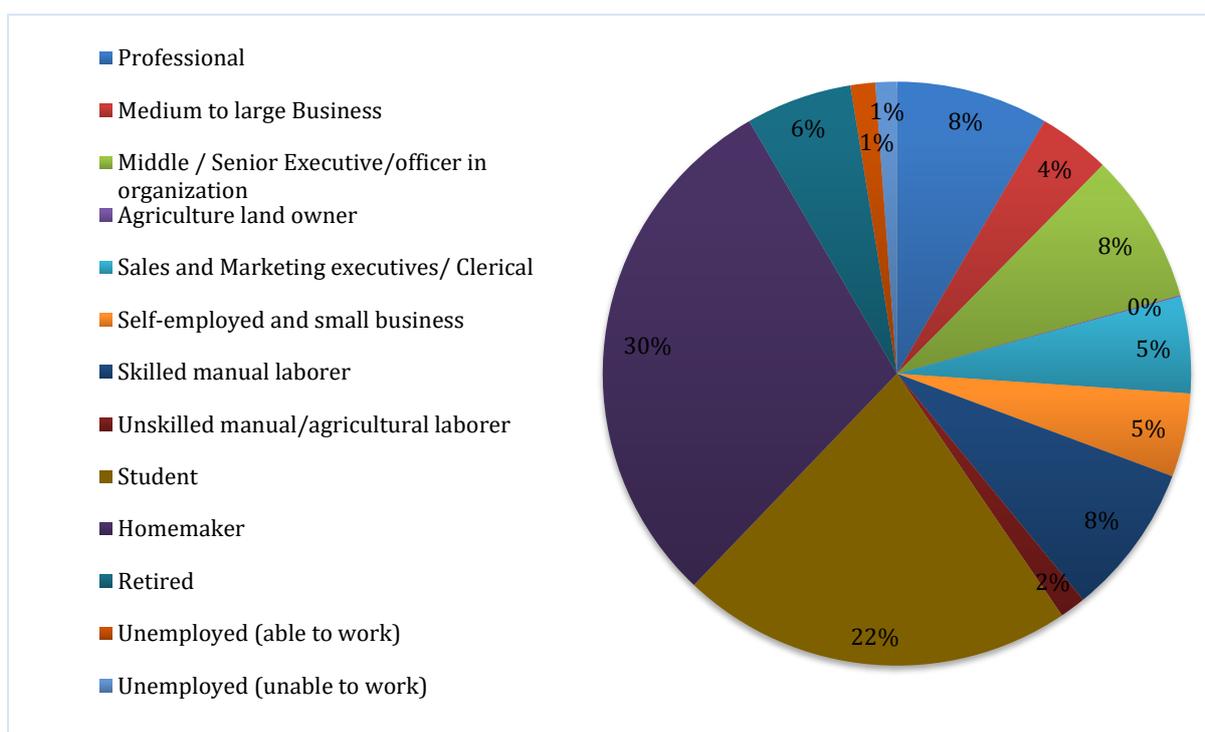
NA – Not applicable





Description of risk factors	Frequency
Blood Pressure \geq 18 Years	
Normal	18.8%
Prehypertension	45.8%
Stage 1 Hypertension	21.7%
Stage 2 Hypertension	13.7%
Staying years [median (IQR)]	18 (7-32)
Married	60.4 %
How many hours do you stay away in a day [median (IQR)]	8 (0-9)
Currently do you have any ailment	23.8%

Occupational Status (Royapuram)

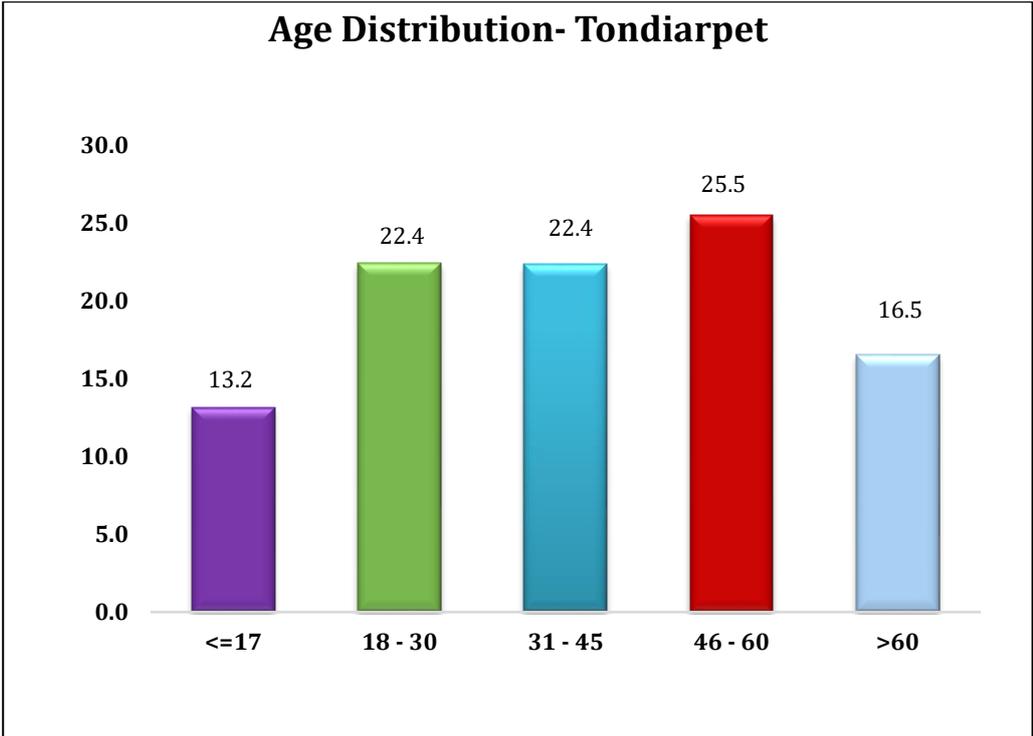
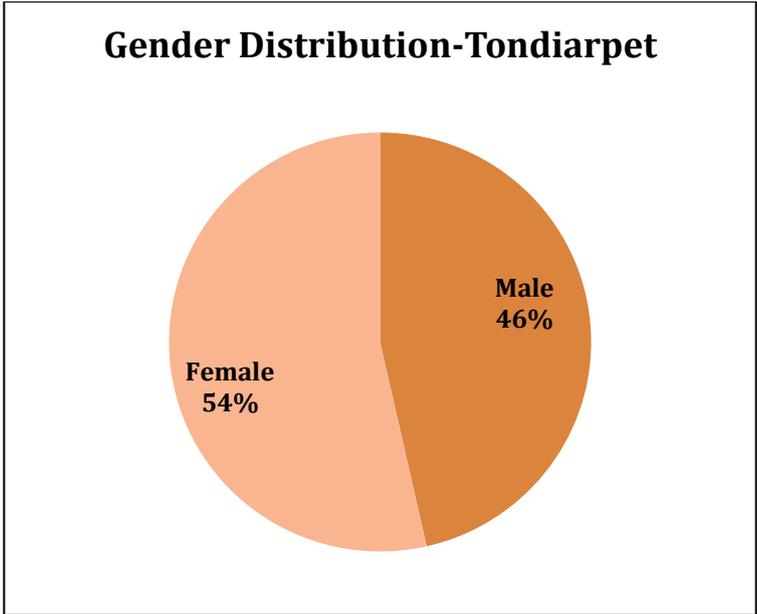


II. Exposed Area - Tondiarpet (Mopping activities ongoing)

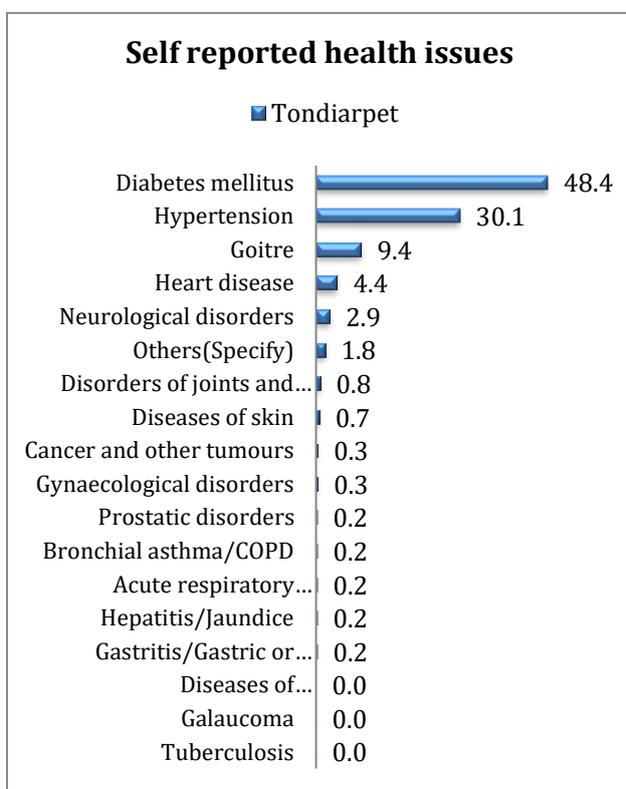
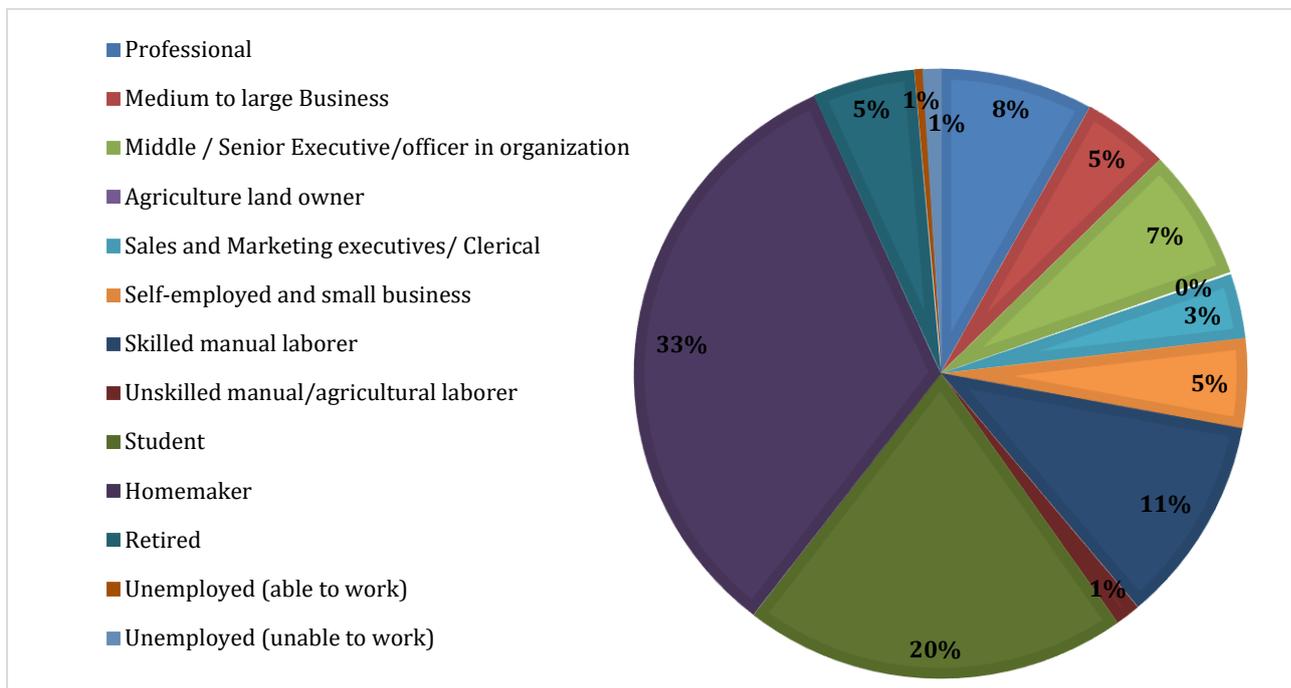
S.no	Description	Randomly Selected households for clinical evaluation and biological testing	Other population for clinical evaluation
1	Total approached Households	450	670
2	Consented Households	355	501
3	Door locked/Refused	95	169
		Selected individuals	
4	Consented individuals	297	2090
5	Refused/ Non competent	58	408

Sample collection among selected individuals: n=297

S.no	Sample Type	Number	Not Eligible/Refused
1	HRV Testing	260	37
2	Spirometry	266	31
3	Blood Samples	281	16
4	Urine Samples	278	19



Occupational Status-Tondiarpet



Description of risk factors	Frequency
Blood Pressure \geq 18 Years	
Normal	22.6%
Prehypertension	45.5%
Stage 1 Hypertension	21.9%
Stage 2 Hypertension	10.1%
Staying years [median (IQR)]	17 (7-30)
Married	61.5%
How many hours do you stay away in a day [median (IQR)]	6(0-8)
Currently do you have any ailment	24.9%

On- going activities:

1. Lab report generation and distribution to participants who provided biological samples in Tondiarpet and Royapuram area.
2. Attempting visit to hospitals in Tondiarpet and Royapuram area to extract morbidity data since 2010.
3. CA-125 marker test- Lab identification processes.
4. Data compilation and analysis.