

Oil Pollution in Groundwater in Jaffna Region

Summery of the Discussion

Professional Discussion with Stakeholders on "Oil Pollution of Ground Water in the Jaffna Region" organized by Institution of Engineers of Sri Lanka (IESL) and JAFFNA MANAGERS FORUM (JMF) 3rd February (Tuesday)2015 – Euroville Conference Hall –

Sivakumar S S

President Institution of Engineers Sri Lanka Northern Chapter/Head Civil Engineering, University of Jaffna

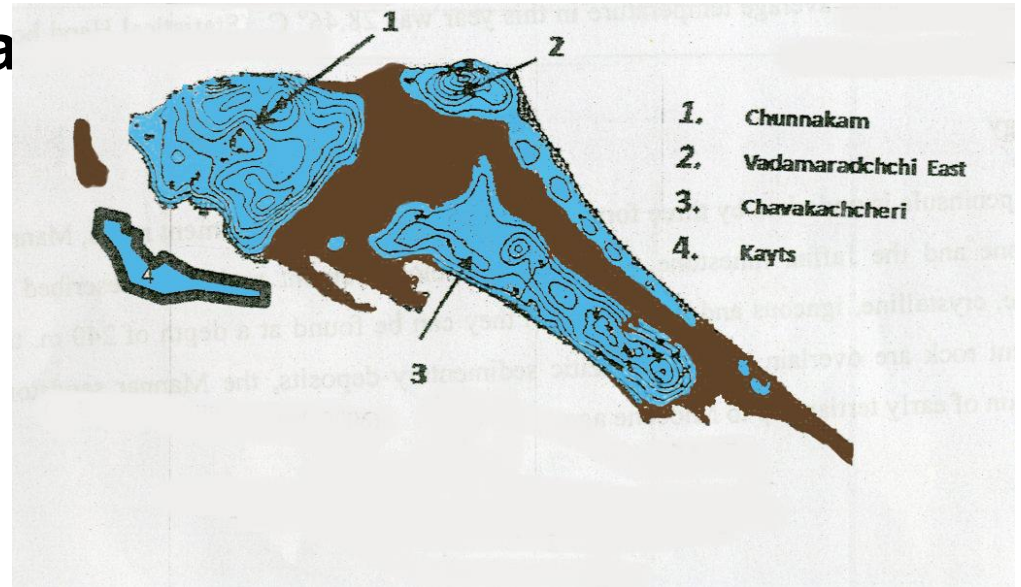
Panel of Professionals - Prof.(Mrs)S Meena, Dr.S.Balakuma, Dr(Eng)S.S.Sivakumar, Eng.S.Sooriyasekaram, Dr(Eng.)K.Vigneswaran, Dr.C.S.Jamunantha



Ground Water in Jaffna Peninsula

Major aquifers in Jaffna

- ❖ Chunnakam,
- ❖ Vadamarachi east,
- ❖ Chavakacheri,
- ❖ Kayts

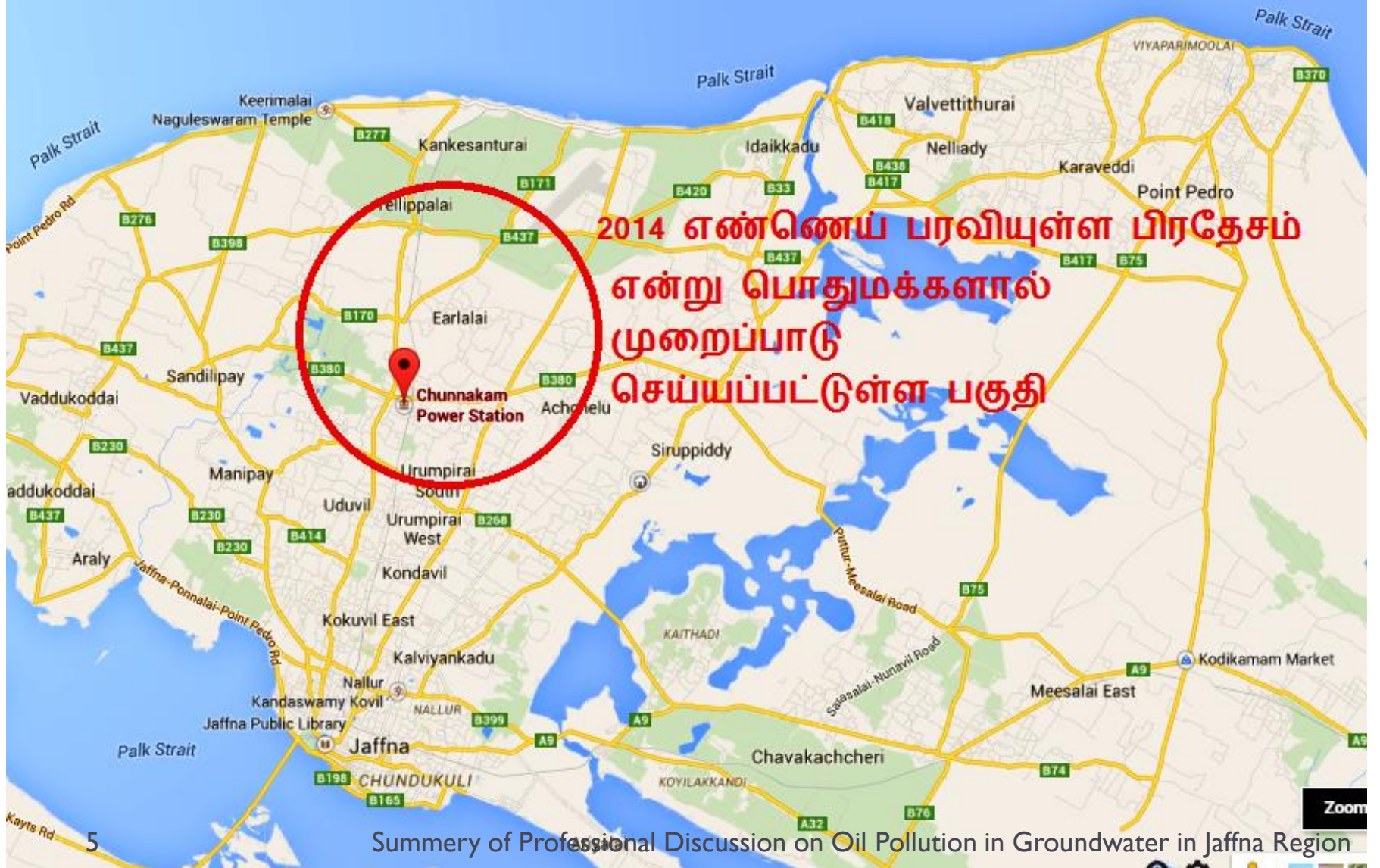


- ❖ Chunnakam aquifer contains the highest capacity of water, the source for 384,000 population.

Chunnakam Tragedy

- ❖ Intensive agriculture area, heavily populated
- ❖ AFTER 2009 (POST WAR) Jaffna has been overloaded with surplus supply of agrochemicals and alcoholic beverages: (exposure to toxic substances)
- ❖ Agrochemical usage is very high
 - ❖ Fertilizers (high in toxic heavy metals, high nitrate)
 - ❖ Pesticides, weedicides over usage
 - ❖ Glyphosate (Round up, chelates heavy metals) over usage
- ▶ Formation of a toxic environment (water, food and beverages) is underway in North.
- ▶ **Further addition of oil hydrocarbons in water and food chain could synergistically act with already existing toxic substances and trigger cascade of reactions leading to**
 - ▶ KIDNEY DISEASE,
 - ▶ CANCER,
 - ▶ BIRTH DEFECTS,
 - ▶ 4 NERVOUS DISORDERS etc...

Reported Polluted Area in 2014



Sources of Pollution and It's Effects

- ❖ The old and one of the new oil fired power stations located at Chunnakam
- ❖ Large quantities of washed lubricant oil from power generating operations discharged directly into the ground over several decades
- ❖ The connectivity of the aquifers makes the pollution to spread extensively with time
- ❖ The seriousness of this pollution lies in the fact that wells are the only drinking water life line for people in this area.
- ❖ It is generally accepted by the medical profession that oil pollution in drinking water can cause kidney failures, cancer of the organs, respiratory track problems and infertility.

At Chunnakam Power Station site there are 3 generations of power stations

First Generation

The first generation power stations, believed to be all diesel oil powered, were installed and operated by CEB. In this category is also included nearly 25 No. 1 MW capacity Agrico diesel oil powered generators, which operated right up to December 2012.

Washed lubricant oil from these first generation power stations discharged into the ground over decades is largely responsible for the oil pollution we are experiencing now. This however requires verification from maintenance records and through interrogations

Chunnakam

First Generation of Power Station

- ▶ **They were installed and operated without any environmental compliance.** There is no more fresh pollution emanating from these power stations because they have all been de-commissioned a few years ago. During the war one or more diesel oil storage tanks were bomb damaged and the diesel oil from these tanks had also gone into the ground. But the damage had been done already by discharging washed oil into the ground over several decades as stated in the preamble.

Chunnakam

Second Generation of Power Station

Second generation power station: Circa 2009, Singapore based private company installed the Northern Power generating station (16MW later upgraded to 25MW we believe) and began selling power to CEB.

- ▶ **This power station was a BOI approved** project and although implemented with an environmental protection license, until recently discharged washed oil directly into the ground continuing to pollute the underground aquifers.
- ▶ **Quite recently, approximately 5 months ago**, they have installed a series of underground concrete tanks to separate the oil from water, we believe not through treatment processes but only through decanting process, which is not satisfactory

Chunnakam

Second Generation of Power Station

- ▶ **The structural integrity and water proofing and oil proofing efficiency** of these decanting tanks appear to be in doubt. We did not have access to the design and drawings for these tanks. The disposal arrangements need to be investigated for compliance.
- ▶ **As far as we know the Northern power station is fuelled by Heavy Fuel Oil with high Sulphur impurity.** It should be noted that there is no stack to discharge the burnt residual fuel oil, which is a serious non-compliance of safety regulations. The environmental protection arrangements were not incorporated into at the design and installation stage but have been added in a piecemeal fashion when problems began to emerge at the insistence of Central Environmental Agency, Public Health Inspectors and MOH.

Chunnakam

Third Generation of Power Station

- ▶ **The third generation power station**, Uthiru Janani is a State owned power station, installed in January 2013, immediately after decommissioning the Agrico generators, was given conditional environmental approval and also environmental protection license.
- ▶ This is a state of the art power station generating 24 MW, also fired by Heavy Fuel Oil, preheated by steam to reduce its viscosity from 180 to 24 units.

Chunnakam

Third Generation of Power Station

- ▶ It has incorporated state of the art treatment processes to remove the oil from the washed oil effluent from power generation operations. In order to discharge the burnt fuel oil residual tar emissions, a 35 m tall stack is provided complying with current international regulations.
- ▶ Monitoring of effluent water quality and emission standards are being undertaken at the required intervals
- ▶ Clean water is discharged via well constructed concrete channels into open ground.
- ▶ However the stagnant clean water in the open channels and the ground are an ideal breeding ground for dengue producing mosquitoes.

GS divisions Affected as at December 2014

- ❖ J196, Chunnakam Town South -3167 families
- ❖ J197, Chunnakam Town East -1247 families
- ❖ J267, Uduvil area (outside Chunnakam) - not available
- ❖ J203, Earlalai South - 3450 families
- ❖ Crisis measures have been put into operation to deliver drinking water to affected families, but this number is increasing, which indicates that the oil pollution is spreading. Currently barrels, located at strategic positions, are filled with drinking water by water browsers

Investigations

- ▶ Testing of water by the Water Board is in progress now. Since tests commenced, it is reported that 80% of the wells tested are heavily contaminated to unacceptably high levels, even 140 times the maximum permitted by WHO.
- ▶ A well in J196 used by NWSD to supply drinking water to Kanthoradai area is heavily polluted. The water supply to Kantharodai is now cut off for safety reasons!
- ▶ According to Central Environmental Agency, the increase in oil pollution in Chunnakam, north of the power station complex, is clearly highlighted in Google mapping as ever enlarging black patches from the time it started occurring, concurring with what is observed with available data.

Report of the Analysis of Status of Ground Water by Water Supply and Drainage Board



The report(the link to download is given below) about the analysis of status of ground water by Water Supply and Drainage Board in 2013/2014 gives the true position at that time. Now more damage seems to have taken place. ...

- ▶ https://www.facebook.com/ajax/messaging/attachment.php?attach_id=864474806929306&mid=mid.1423683795738%3A752bb563a7c3af6e76&ext=1423799562&hash=AQBMcEZHRsxUafxSOerDZI4YAY0VwAuysvMUJZAb5aq9v6FI&pnref=story

Results of the Analysis

❖ **A preliminary study survey** to find the contamination was done by National Water Supply and Drainage Board, Jaffna. This analysis was done in 150 wells. 70% are in domestic used and 30% are agricultural used. 81% of wells within 200m have oil and grease contamination of more than 1mg/l and 74% of well in the distance of 200-500m have oil and grease concentration more than 1mg/l. 50% of wells more than 500m have oil and grease concentration more than 1mg/l.

❖ **The pattern of oil spread is more towards North.** But the area affected is around 2km diameter in distance. When the water pumped out more, the oil concentration observed is also more.

❖ **The analysis of heavy metal yield that** 10% of the wells have contamination of Pb above normal limit and 12% of wells have chromium above normal limit.

Results of the Analysis

Oil & grease concentration was analyzed in 150 locations, dug wells were analyzed in bottom and top of the water layer, and tube wells water were analyzed in a single point. The total analysis is 226. 116 out of 150 wells were having oil and grease contaminations.

Distance	% of the wells exceeding 1mg/l
Within 200 m from CPS	81
200 m - 500 m from CPS	74
> 500 m from CPS	51

Table 3.2 Contamination level vs. distance

Analysis of the status of groundwater quality
which was contaminated with waste oil in the

Chunnakam area, Jaffna

November 2013 - September, 2014

September, 2014

Regional Laboratory,

National Water Supply & Drainage Board,

Jaffna.

Type of Heavy metal	Maximum value	Minimum value	No of analyzed locations	Pollution %
Lead (Pb)	0.168	> 0.000	50	10
Chromium (Cr)	0.002	> 0.000	20	12
Arsenic (As)	> 0.000	> 0.000	10	0

Table 3.6 Heavy metal concentration

150 wells were analyzed, in which 109 (73%) wells have shown the oil level above standard, 07 (4%) wells were under the limit and 34 wells (23%) were not contaminated with oil and grease.

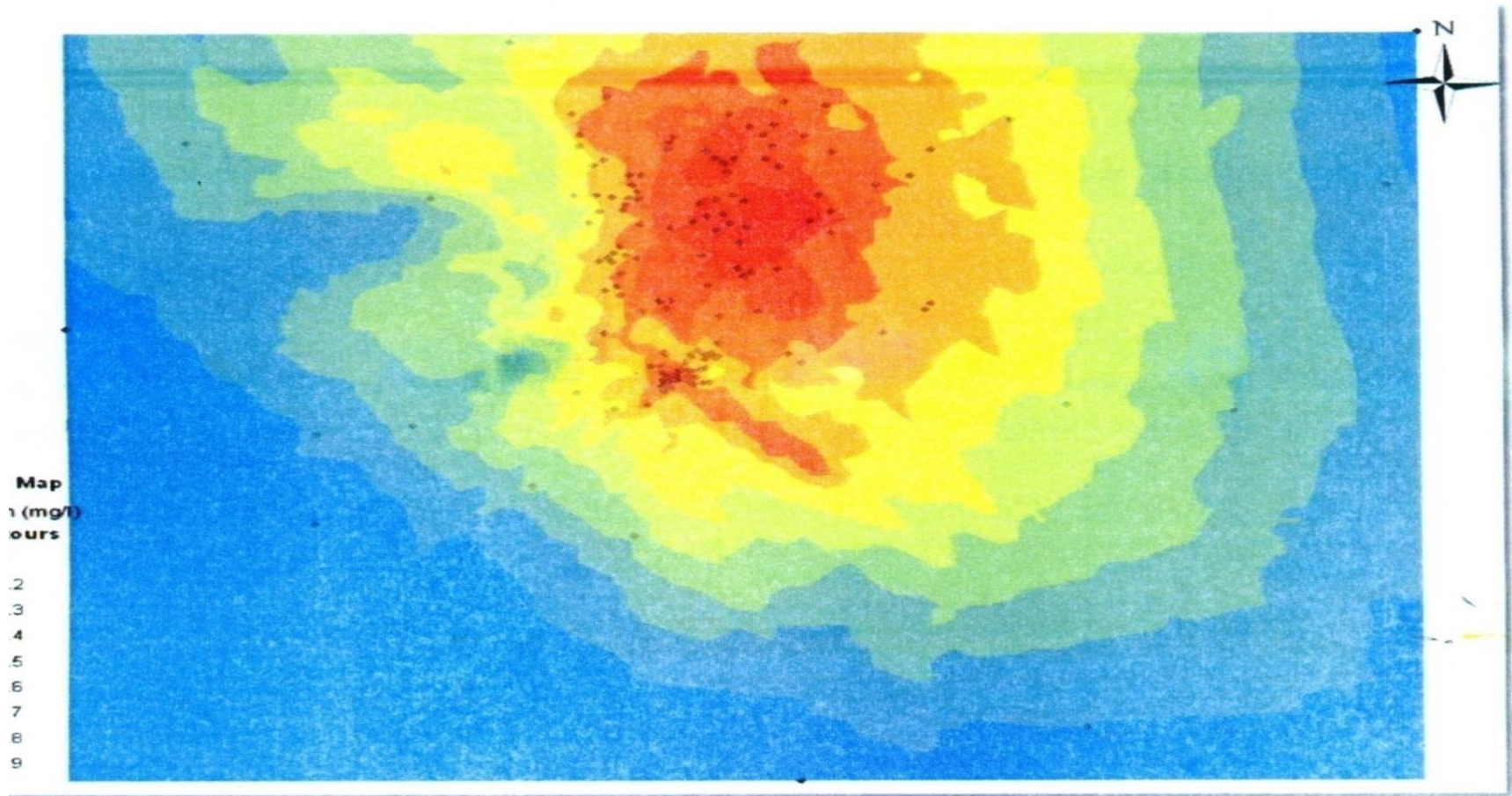


Figure 3. 8 spatial distributions of oil concentration of Analyzed wells

Oil Removal Technologies

- **Physical & Mechanical methods**
 - **Skimmer, Micro, Ultra & Membrane filtration**
- **Biological methods**
 - **Use of microorganisms**
- **Chemical treatments**
 - **Coagulation & flocculation, Electrocoagulation**
- **Coalescence**
 - **Use of granular or fibrous filter material**
- **Adsorption**
 - **Utilises sorbents**

Adsorption & Coalescence

- **No additional chemicals are required to demulsify oil in water**
- **High removal efficiency of COD**
- **Porous structures in natural fibrous oil sorbents permit oil attachment and entrapment**
- **Oil adsorption performance is measured by**
 - **Oil removal efficiency (% removal)**
 - **Sorption capacity (mass of oil sorbed per gram sorbent)**

Oil Removal by Adsorption

- ❖ **Attraction of oil to the surface of a sorbent**
- ❖ **In this process,**
 - ❖ **oil molecules diffuse into the sorbent surface**
 - ❖ **oil gets entrapped into the sorbent structure by capillary action**
 - ❖ **oil droplets agglomerate in porous and rough structures of the sorbent**
- ❖ **Preferred technology due to its simplicity and relatively lower processing cost**

Natural Oil Sorbents

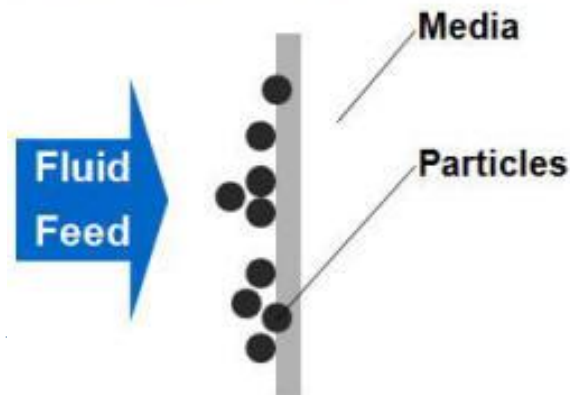
- ❖ **Can be organic (from plant and animal residues) or inorganic (from minerals) sorbents**
- ❖ **Organic fibrous sorbents,**
 - ❖ **have relatively higher sorption capacity**
 - ❖ **are environmental friendly and cost effective**
 - ❖ **possibility of sorbent collection, higher oil recovery and relatively easy disposal**
- ❖ **Common examples: sugarcane bagasse, rice husk, barley straw, cotton grass, wood residues, etc.**
- ❖ **Suffer high water uptake due to low hydrophobicity**



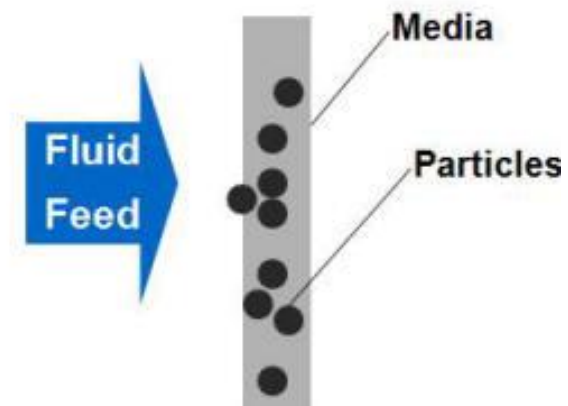
Oil Removal by Coalescence

- ❖ **Two separation mechanisms**
 - ❖ **Separation through Surface Filtration**
 - ❖ **Coalescence through Depth Filter**
- ❖ **In surface filter, oil loads only on the surface of media**
- ❖ **In depth filter, oil penetrates through the depth of the media**

Surface Filtration



Depth Filtration



Depth Filtration

- ❖ **Gives relatively better removal of lighter emulsions (<100 μm) than adsorption**
- ❖ **In this process,**
 - ❖ **smaller oil droplets are first transported into the filter and attached to the fibre surfaces**
 - ❖ **followed by agglomeration and transport of larger droplets on the fibre**
 - ❖ **removal of oil droplets from the filter as oil residence time is prolonged**
- ❖ **Enables formation of larger oil droplets and increase oil -water separation**

Summary of Oil Removal Technologies

- ❖ **Recommended technologies for oil removal are adsorption and depth filtration**
- ❖ **Adsorption shows,**
 - ❖ **good oil removal efficiency, simple operation & low processing cost**
 - ❖ **labour intensive & poor removal of fine emulsions (<100 µm)**
- ❖ **Depth filtration shows,**
 - ❖ **good oil removal efficiency, simple operation & low initial and operating cost**
 - ❖ **slow oil removal process & efficiency depends on the quality of filter bed media**

The 3 types of Bioremediation to Clean Oil Contamination of Groundwater

Biostimulation

The first type of bioremediation is biostimulation; nutrients in a gas or liquid form are added to soil or water where there is a need to remove contaminants. The bacteria are already there they are just stimulated to encourage growth and activity. Essentially the bacteria turn the harmful substances into CO_2 .

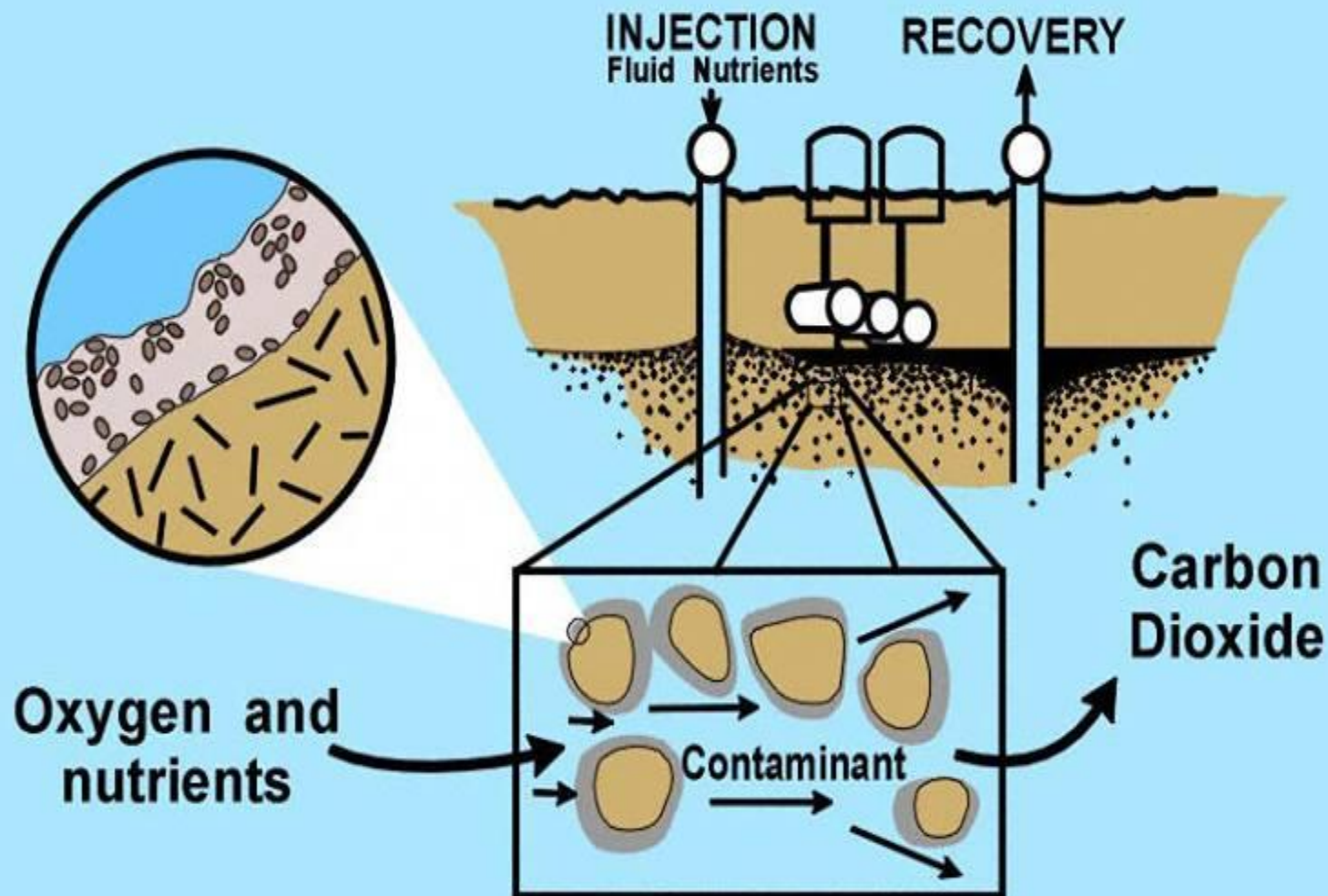
Bio augmentation

The second type of bioremediation is bio augmentation, where microorganisms are added to the soil to help remove contaminants. It is more commonly used in contaminants in the original site, and is more successful. It is not very helpful in sites of contamination rather than the original site because it is difficult to control the site conditions.

Intrinsic bioremediation

The third type of bioremediation is when it happens naturally in the contaminated area, such as a petroleum site like an old gas station. There is no other knowledge of it happening naturally in any other type of contaminated site.

Bioremediation



Response in Social media on Bioremediation

- ▶ Subramaniam Anandarajah Even though the words and description appears very attractive and given in the form that people will believe. The activity injection is not required. if the content in the place where the oil is added is removed and water pumped out from that location continuously for some times it is enough. when the water become good at that location the water in the other wells could be pumped out and cleaned. just before the next rainy season if the water in the wells are evacuated . it would be sufficient. if will become ok.
- ▶ The problem is glorified and the entire population is made to shiver by telling that they are going to get cancer. then suggesting injection of nutrients is the earning concern of some people.
- ▶ Sri Pragash Sir, I can send you a sample of oil&heavy metal absorbent for your testing purposes. it is a biodegradable organic material.

Panel Presentations



Discussion



Conclusions and Recommendations

- ❖ Without attempting to apportion blame to anybody for past omissions and mistakes, we wish to concentrate our energies to immediately take the necessary measures first to stop the continuing contamination and then to explore methods to get rid of the oil already gone into the ground and the aquifers and thereby restore the water quality in the affected wells. The following measures are proposed:
- ❖ Appoint a specialist consultant to investigate and advise on the most economic and effective method to restore the water quality in the affected wells.

Conclusions and Recommendations ctd..

- ❖ With immediate effect, Northern Power shall a) construct a 35 m tall chimney stack to discharge burnt emissions b) provide the design and construction details of the underground washed oil tanks and separated oil and water tanks for our Engineer's perusal c) install filtration process instead of decantation process to remove all oil from washed oil effluent d) provide well constructed concrete channels to divert clean water into underground storage tanks e) construct underground clean water harvesting tanks to store clean water for irrigation purposes f) carry out water tests and emission tests at approved intervals and submit results to the Environmental Protection Agency.

Conclusions and Recommendations ctd..

- ❖ Subject to security and other considerations, provide access to PHI's, MOH and Environmental Protection Agency officers to carry out their monitoring duties. If an open and transparent approach was adopted in the first place we could have worked co-operatively and avoided the present disastrous situation and the prohibitively high costs involved now.
- ❖ While the cost of all the above mentioned measures required to comply with the health and safety standards and possibly for the work incurred for the restoration of water quality in the wells will be met by CEB and Northern Power, other sources of funds will be needed to continue the emergency measures to provide drinking water in the interim. Emergency fund allocation is therefore necessary to deal with the situation.

Conclusions and Recommendations ctd..

- ❖ The good work initiated so far must be continued from where it came to a standstill due to change of government i.e the Environment Ministry and Northern Provincial Council must continue to provide leadership, resources and expert advise for the clean up. There is no need to waste time redoing what has already been done.
- ❖ Northern Power has not been open and transparent and has not provided honest answers to basic questions asked of them. The environmental violations of the past has created an extremely difficult problem to solve. Scientists and Engineers need honest and accurate information from the CEB of past practices by all the power generating companies and also from the recent offender (Northern Power) in order to be able to properly assess the situation and to provide scientific solution to arrest further pollution and to treat the already polluted soil and ground water. Hiding available clues in this instance is a crime against humanity. A court order to Northern Power and CEB may become necessary to make all the factual data available. A lot of forensic work will be required, especially in view of a lack of openness and transparency.

Conclusions and Recommendations ctd..

- ▶ The work of specialists must begin immediately without any further bureaucratic delays.
- ▶ Another note of a rather serious nature is also appropriate here. Two weeks ago a mason told one of the panel expert that his mate was doing construction work at this site recently. He claims to have observed a bore hole dug in the middle of an oil kulam at this site to make the oil disappear deep into the ground. Whether it is speculation or truth needs to be found out through forensic work. we suspect there was a great deal of cover up, needing ruthless but impartial investigation.

Conclusions and Recommendations ctd..

Northern Provincial Council should take the following immediate action without any further delay

- ❖ Release a statement with it's stand on this burning issue
- ❖ Supply safe domestic water to all affected people
- ❖ Immediately deploy proper legally acceptable institutions to start collecting water sample and map out the contamination spreading pattern (for this purpose procure one Ground Penetrating Radar)
- ❖ Prepare short and long term plan to overcome this problem and prevent any future damage
- ❖ Prepare statute on Environmental pollution subject in concurrent with 13th amendment to constitution.

Thank You

நீருக்கான எமது உரிமையை
பாதுகாப்போம்.
இன, மத, மொழி கடந்து
ஒன்றிணைவோம்.

**Clean Water is Basic Human
Right**



#WaterCrisis

Event No: 06/2014-15

 **INSTITUTION OF ENGINEERS, SRI LANKA**
NORTHERN PROVINCIAL CHAPTER
IESL - NPC

**Professional Discussion among Stakeholders
on**

**Oil Pollution of Ground Water
in the Jaffna Region**

On
Tuesday, 3rd of February, 2015, from 9.00 a.m. to 12.30 p.m.
At
Euroville Conference Hall, Nallur

Jointly organized with
Jaffna Managers Forum (JMF)

Admission free **All Are Welcome**

For more information contact :

Dr (Eng).S.S.Sivakumar -0772508730 **Eng.T.Rajagobu** **- 0773172093**
Mr.V.Niranjana - 077 304 3206