REPORT

OF

EXPERT TECHNICAL COMMITTEE

[Constituted by the Government of Tamil Nadu vide G.O. (MS). NO. 79 Industries (MMA 1) Department Dated 30.06.2014 with respect to Coalbed Methane Project proposed in Mannargudi Block of Thiruvarur and Thanjavur Districts]

JULY 2015

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EXECUTIVE SUMMARY

M/s. Great Eastern Energy Corporation Limited (GEECL) Gurgaon, Haryana is a private sector company in the field of Coalbed Methane (CBM) exploration near Asansol in the Burdwan district of West Bengal. They proposed for initiating CBM exploration activities in Mannargudi block of Thiruvarur and Thanjavur districts of Tamil Nadu. The Government of India, Ministry of Petroleum and Natural Gas has awarded methane block in Tamil Nadu (No. MG-CBM-2008/IV) to GEECL for exploration and production of coalbed methane in the IV round of coalbed methane policy (CBM-IV) over an area of 691 sq.km (effective area of 667 sq.km) in Thiruvarur and Thanjavur districts. The Government of Tamil Nadu vide G.O. (3D) No.1 Industries (MMA1) Department dated 01.01.2011 has issued Petroleum Exploration Licence (PEL) to GEECL for exploration and production of coalbed methane in Mannargudi Block No. MG-CBM-2008/(IV) over an area of 691 sq.km (effective area for operation is 667 sq.km) (392.944 sq.km in Thiruvarur district and 274.056 sq.km in Thanjavur district) for a period of 4 years subject to certain conditions.

The Government of Tamil Nadu and GEECL have executed a MoU on 04.01.2011 for implementation of the project. The Government of India Ministry of Environment and Forests has accorded Environmental Clearance for the above said proposed project vide F.No.J.1101/615/2010-IA II (I) dated 12th September 2012 to carryout, in Phase-I 46 core holes and 2 test wells (covering both the districts) and in Phase-II 30 test wells including 2 test wells drilled in Phase –I subject to certain conditions. GEECL applied for consent to establish to Tamil Nadu Pollution Control Board (TNPCB) in July 2012 and August 2012 for the proposed activity in Thiruvarur and Thanjavur districts respectively. TNPCB has called for certain additional details on the project and kept pending the issue of consent.

In the meantime, the representatives of farmers, functionaries of the Tamil Nadu Science Forum, political activists, Tamil Nadu Vivasayigal Sangam, environmentalists and stakeholders expressed their concern about the possible adverse impact of the project on the environment, ground water depletion, intrusion of sea water and affecting agriculture which will adversely impact on the livelihood of the farmers in the delta region. The public had gone on hunger strikes, staged various agitations and demonstrations against this project at various places in Thiruvarur and Thanjavur districts and they appealed not to issue any permission for extraction of methane gas against the wish of the people.

In this circumstances, considering the importance of sensitivity of the issue and growing public unrest in the local area towards the proposed project and in consideration of the welfare of the people of Tamil Nadu, first and foremost especially the farmers of the State, the Government of Tamil Nadu vide G.O. (Ms) No. 79 Industries (MMA1) Department dated 30.6.2014 had constituted an Expert Technical Committee consisting of eminent experts drawn from Anna University, IIT Madras, Tamil Nadu Agricultural University, M.S. Swaminathan Research Foundation (MSSRF), officers from the PWD, Agriculture Department, TNPCB and TIDCO to go into the matter *de novo* from all angles, including the environmental standpoint, the risk of sea water intrusion, livelihood and food security issues as well as the need to develop clean energy resources.

The Expert Technical Committee (ETC) had met on 15.7.2014, 2.8.2014 and 3.3.2015 discussed the pros and cons of the project. GEECL was called and they were asked to reply for the queries of the Committee. ETC had also consulted Experts in the field of CBM extraction. The findings of the ETC are given in the report.

Coalbed Methane is a form of natural gas extracted from coal beds. It is an energy resource. CBM gas comprises of Methane from 63 to 99 percent, carbon dioxide from 0.1 to 15 percent[11]. Coal is formed due to bio-conversion of fossil organic matter. In the process of coal formation, anaerobic conditions led to generation and trapping of methane in this coal seams. The pressure exerted by naturally formed water keeps the methane adsorbed on internal surfaces of coal. CBM exists in the coal seams in three basic states: as free gas, as gas dissolved in the water in coal, and as gas adsorbed on the solid surface of the coal. CBM extraction requires drilling wells into the coal seams and removes the formation of water contained in the coal seam to reduce hydrostatic pressure and allow the adsorbed CBM to be released from the coal. The process is termed as hydraulic fracturing. The water produced during CBM extraction is called 'produced water'. The proportion of water to methane pumped is initially high and declines with increasing coalbed methane production[4]. Produced water generally contains dissolved ions mainly sodium (Na), bicarbonate (HCO_3), and chloride (Cl) which depends on the geological formations[12].

Project Proposal of GEECL

GEECL's proposed CBM block (Block MG-CBM-2008-IV) geographically located in Kudavasal, Needamangalam, Mannargudi, Valangaiman taluks of Thiruvarur district and Tiruvidaimaruthur, Kumbakonam, Orathanad and Papanasam taluks of Thanjavur district of Tamil Nadu. The estimated Gas-in-Place in the effective area as per the DGH is 0.98 Trillion Cubic Feet (TCF). The unit proposed for the exploration, testing of wells with drilling of 46 core holes and 2 test wells in Phase I and 30 test wells in Phase-II. Once, the test is successful the unit will go for commercial exploration. There are many water bodies such as Cauvery River, Thirumalai Rajanar River, Mudikondan River, Nattar River, Puttar River, Vettar River,

Vennar River, Koriyur River, Thirumanai Vaykkal etc, which are closer to the proposed core hole and test well drilling sites. The wells are proposed to be located in Agricultural wet lands and nearby the villages. Some of the villages like Sitadi, Kudavasal, Keelapaliyur, Saranatham, Manickamanagalam, Keelvanthaseri, Kandiyur, etc are thickly populated areas.

The unit requires 1.5 to 2 acres of land for each core hole/test well. The core hole and test well will be done by rotary drilling using mobile land rig. The core hole of 96 mm dia will be drilled to depth of 400m to 650m[13]. The coal/lignite samples collected will be analysed for presence of methane gas. It was reported that the product may contain methane upto 96-97%, nitrogen 1-1.5% and CO_2 traces. The purpose of core hole is to collect samples of subsurface formation and to explore the feasibility of converting some holes as test wells for further investigation. After the coring operations, all the core holes except two (most promising) holes will be abandoned and site will be brought to its near original condition. These two promising holes will be further developed as test wells.

The unit reported that it is proposed to employ 15 to 20 persons in each drilling site at a time. The total water requirement for domestic purpose will be about 2.8 kilo litres per day (KLD). The unit has proposed to treat and dispose the domestic wastewater through septic tank and soak pit arrangement. The water requirement for drilling a core hole for the entire drilling period (10-15 days) is about 11KL. In case of test well, if air drill is used the water requirement is about 55KL as in the case of mud drill it needs about 65 KL. Equal amount of wastewater will be generated from the drilling operations. The unit has proposed to hold the wastewater in HDPE lined pits for solar evaporation[13].

The unit reported that average produced water (wastewater) of about 45 KL/day/well will be generated during test well drilling and not in core

hole[13]. The unit has estimated the quantity of produced water generation based on the similar geological parameters used in Powder River Basin, USA as the geological parameters are similar in both the locations. Total quantity of produced water generation will be 1350 KL per test well (ie., operation period 30 days; 45KL x 30 = 1350 KL). The unit has proposed to store the produced water in a lined pit of 1575 KL capacity and use a part of this water in drilling of subsequent test wells and solar evaporate the remaining.

The unit has proposed to use portable power generators (DG sets of 250 HP) for all the power requirements. According to GEECL, there will be no methane gas emission during coring operations. The unit has proposed to flare methane and other gases from the test well operation using appropriate flare stack. About 35 lts of used oil will be generated during drilling of one core hole and about 70 lts will be generated during one test well drilling. The unit has proposed to dispose the same through authorized recyclers. Drill cutting waste generation will be 6.5 T per core hole and 10.5 T per test well. The unit has proposed to dispose the drill cutting *in situ* if the oil content is less than 10 mg/Kg else disposed to TSDF site.

ETC Findings against the Proposal

The summary of the project explained above is only for the exploration phase. Environmental Impact Assessment (EIA) study done for the exploration phase lacks number of vital information which includes hydro geological history of the block, trace element data and isotopic composition of groundwater, trace element data of lignite beds, possible leakage of methane gas in the aquifers etc., Hence a detailed EIA study is required covering all the missing data. Further, GEECL has not done the EIA study for the production phase. MoEF & CC has granted environmental clearance only for exploration phase. The impact on ecology & environment will be much more during the production phase. This was not appraised by MoEF & CC.

ETC has observed that if the unit goes for full scale production, it will drill about 2133 wells in the entire Mannargudi block at the rate of one well in 80 acres spread area[7]. This will ultimately occupy about 4266 acres of fertile agricultural lands. GEECL stated that the Mannargudi block is closely similar to the geological setting of Powder River Basin in USA. According to this statement, the daily Production Water pumping out will be 45KL/day/well. 2133 wells will produce around 95,985 KLD of water. Such a large quantity of pumping of ground water throughout the life period 25 years will ultimately have impact on ground water table. People of Cauvery delta region are depending more and more on the ground water resource for agriculture and livelihood, due to long term failure of monsoon and insufficient water flow in the Cauvery River. Under the circumstances, large scale continuous pumping of water would quickly deplete the water resource and lower the water table to very deeper level. Mannargudi block is the only block in Thiruvarur district having good quality and quantity of ground water. It is about 40Km from sea. There is a possibility of Sea water intrusion in the area if groundwater extraction is in large scale.

Coal and Lignite consist of harmful trace elements like arsenic, mercury, lead, cadmium, molybdenum, selenium, chromium, zinc and occasional presence of radioactive elements too. These elements are likely to contaminate the produced water. Geological set up in Mannargudi block is such that the thick fresh water aquifers are directly occurring both at the top and bottom of lignite beds. Besides that smaller aquifers consisting of sandstone, siltstone and silty clay beds also occur in between the multiple lignite seams as parting lithology. Therefore, methane and associated gases like nitrous oxide, sulphur di oxide, carbon di oxide and some hydrocarbons are likely to seep into the adjoining aquifers and contaminate the water because of induced fractures for extraction of methane gas. Moreover,

produced water with these partially dissolved gases are likely to pollute the surface and drinking water too.

There are chances of emission of methane, hydrogen sulfide, nitrogen oxides and other aromatic hydrocarbons from CBM well sites. Further there are chances of emissions of methane and airborne pollutants from gas processing and pressurizing plant. Flare stacks will burn off unwanted gasses cause noise, light pollution and more toxic emissions. The atmospheric thermal inversion will take place at the time cause reduction in rainfall too.

Vadavur Bird Sanctuary is located within the southwest part of Mannargudi CBM block which may be affected by noise pollution due to continuous operation of drill machines, compressors, production of methane gas, movement of heavy vehicles and machineries etc. Flaring of gas at production well sites and gas processing area would raise the atmospheric temperature in the surrounding area and toxicity of air. Air current flow towards west to south westerly direction as recorded in the GEECL report would carry the atmospheric heat and toxicity towards Vadavur Bird Sanctuary which in due course may force the birds to abandon the sanctuary and migrate elsewhere.

Ultimately when the production of methane gas commences, all the gas wells would be interconnected by a tens or hundreds of kilometre long network of steel pipe lines went through/across agricultural lands and populated villages to transport methane gas to collection and gas processing centres and also to transport waste water for either disposal or treatment centres. There is always a lurking danger of possible gas fire and explosion of gas pipelines inflicting severe damage to loss of life, property and ecology. A few thousands of gas wells drilled can never be removed or recycled once its gas production capacity ceases. The steel, concrete structures and the

chemicals used for drilling plunged deep in to the subsurface will decay slowly over a period of time constantly causing subsurface pollution.

Over 25 years of production life, the quantity of gas proposed to be extracted from all the CBM blocks may be about 2 million cubic meters per day. This may fire a 450 MW power plant for 25 years. This is not a substantial quantity of energy compared to the adverse impact likely to be caused to the ecology and environment. The rice production in 4266 acres of land will feed 2.77 lakhs people for life long. There will be about 1781 daily wage unskilled labourers will get direct employment in agricultural activity for entire period of the year. In addition, there will be indirect employment like cattle growth, rice mills, transportation, whole sale & retail business etc. Whereas in CBM production phase 1000 skilled / semi skilled workers will be employed by the company. Out of 667 sq.km area awarded to GEECL, 293.72 sq.km area overlap with ONGC area. Exploration licence issued to GEECL by the Government of Tamil Nadu on 01.01.2011 for a period of 4 years expired on 31.12.2014.

Though CBM is a clean energy resource, the benefits proposed to be received from this CBM project is insignificant when compared with above losses both spatially and temporally. The People of the region seriously object to the proposed CBM project. The Expert Technical Committee does not see any significant cost benefit on account of the project considering the impact it has on a fertile and environmentally fragile region. The Cauvery delta is a historic reservoir of fresh water source serving millions of people in the State over the millennia. Hence the Government of Tamil Nadu may take an appropriate decision on the need for this project in view of the adverse impact on the fresh water resource and the ecology of the area.

REPORT OF EXPERT TECHNICAL COMMITTEE CONSTITUTED BY THE GOVERNMENT OF TAMIL NADU VIDE G.O. (MS). NO. 79 INDUSTRIES (MMA1) DEPARTMENT DATED 30.06.2014

1.0 BACKGROUND

M/s. Great Eastern Energy Corporation Limited (GEECL) Gurgaon, Haryana is a private sector company is in the field of Coalbed Methane (CBM) exploration near Asansol in the Burdwan district, West Bengal. They proposed for initiating CBM exploration activities in Mannargudi block of Thiruvarur and Thanjavur districts of Tamil Nadu.

The Government of India, Ministry of Petroleum and Natural Gas vide letter dated 13.8.2010 has informed that the Government of India has awarded methane block in Tamil Nadu (No. MG-CBM-2008/IV) to M/s. Great Eastern Energy Corporation Limited (GEECL) for exploration and production of coalbed methane in the IV round of coalbed methane policy (CBM-IV) over an area of 691 sq.km (effective area of 667 sq.km) in Thiruvarur and Thanjavur districts. The Government of India have also conveyed the approval under the Rule 5 (1) (11) of Petroleum and Natural Gas Rules, 1959 for issue of petroleum exploration licence to the GEECL and also requested the State Government for grant of petroleum exploration licence to the above company to enable to commence exploration and production activities in the said block.

Accordingly the State Government vide G.O. (3D) No.1 Industries (MMA1) Department dated 01.01.2011 has issued Petroleum Exploration Licence (PEL) to GEECL for exploration and production of coalbed methane in Mannargudi Block No. MG-CBM-2008/(IV) over an area of 691 sq.km (effective area for operation is 667 sq.km) (392.944 sq.km in Thiruvarur district and 274.056 sq.km in Thanjavur district for a period of 4 years subject to the following conditions :-

1. During the exploration activities, the licensee should not disturb the Vadavur Bird Sanctuary and also previous approval should be obtained from the Forest Department before the execution of Petroleum Exploration Licence.
2. Safety measures should be provided as per the guidelines stipulated under Petroleum and Natural Gas Rules, 1959.

The Government of Tamil Nadu and GEECL have executed a MoU on 04.01.2011 for implementation of the project. The Government of India Ministry of Environment and Forests has also accorded Environmental Clearance for the above said proposed project vide F.No.J.1101/615/2010-IA II (I) dated 12th September 2012 to carryout in Phase-I 46 core holes and 2 test wells (covering both the districts) and in Phase-II 30 test wells including 2 test wells drilled in phase –I subject to certain conditions (Annexure –I).

Subsequently, GEECL has applied to Tamil Nadu Pollution Control Board (TNPCB) through the District Environmental Engineers of Thiruvarur and Thanjavur Districts for grant of Consent to Establish (CTE) under the Water (Prevention and Control of Pollution) Act, 1974 and the Air (Prevention and Control of Pollution) Act, 1981 during July 2012 and August 2012 respectively. The TNPCB has not yet given its clearance for consent to establish to GEECL. For each core hole / test well, the company require about 1.5 to 2 acres of land. Therefore, GEECL may require about 160 acres of land for siting the coreholes and test wells and the land has to be privately purchased or leased from the land owners by the company itself.

In this regard the representatives of farmers, functionaries of the Tamil Nadu Science Forum, political activists, Tamil Nadu Vivasayigal Sangam, environmentalist and stakeholders have expressed their concern about the possible adverse impact of the project on the environment, ground water

depletion and intrusion of sea water, affects agriculture which will adversely impact the livelihood of the farmers in the delta region. Also they have represented that the drilling of number of bore-wells and production wells for extracting coalbed methane would result in the depletion of ground water and thereby adversely affect the irrigation sources and ultimately agricultural lands would be affected or ruined in Thanjavur and Thiruvarur districts.

The District Collector of Thiruvarur in his letter dated 24.06.2013 has reported to the Government that the public had gone on hunger strikes and staged various agitations and demonstrations against this project at various places in Thiruvarur district. Similarly the District Collector of Thanjavur in his letter dated 30.06.2013 has reported that agitations and demonstrations were staged against this project in various parts of Thanjavur district and requested not to issue any permission for extraction of methane gas against the wish of the people.

In the circumstances, considering the importance of sensitivity of the issue and growing public unrest in the local area towards the proposed project and in consideration of the welfare of the people of Tamil Nadu, first and foremost especially of the farmers of the State, the Government of Tamil Nadu vide G.O. (Ms) No. 79 Industries (MMA1) Department dated 30.6.2014 (Annexure – II) have constituted an Expert Technical Committee consisting of eminent experts drawn from Anna University, IIT Madras, Tamil Nadu Agricultural University, M.S. Swaminathan Research Foundation (MSSRF), and also officers from the PWD, Agriculture Department, TNPCB and TIDCO to go into the matter *de novo* from all angles, including the environmental standpoint and the risk of sea water intrusion, livelihood and food security issues as well as the need to develop clean energy resources. The committee is directed to submit a report to Government within three months. The

Government has also directed not to proceed further on the project until the Expert Technical Committee submits its report.

Expert Technical Committee

1	The Chairman, TNPCB	**Member Secretary / Convener**
		Members
2	Anna University	Dr P.Kannan, Professor , Department of Chemistry
3	Indian Institute of Technology Madras	Dr P.S.T.Sai, Professor, Department of Chemical Engineering
4	Tamil Nadu Agricultural University	Dr P.Doraisamy, Professor, Department of Environmental Sciences
5	M.S.Swaminathan Research Foundation	Dr V.Selvam, Senior Director (Coastal Systems Research)
6	Public Works Department	Thiru L.Muniappan, Superintending Engineer, PWD, Project Formulation Circle, Trichy
7	Agricultural Department	Thiru P.S. Karunakaran Deputy Director, Department of Agriculture
8	Tamil Nadu Industrial Development Corporation Limited (TIDCO)	Thiru R.Karthikeyan Development Manager, TIDCO

As per the Government Order the Expert Technical Committee had met on 15.7.2014, at TNPCB and discussed in detail on the project and raised many technical queries and the same was communicated to the project proponent. Further it was decided to collect details through TNPCB about the villages located within vicinity of the core holes, temples, historical monuments, drinking water wells, irrigation wells, canals, rivers, area of agricultural lands, crop cultivated, crop affected due to core hole activity, etc.

The Committee had again met on 2.8.2014 at TNPCB. The Project Proponent, GEECL had made a technical presentation and the committee raised various questions and sought clarifications. The committee also analyzed the data collected by the TNPCB as sought in the earlier meeting. The committee decided to collect additional information which includes social, economic and ecological profile in the project area, groundwater aquifer details, environmental protection measures during exploration, cost benefit analysis, commercial and ecological viability of the project by considering best and worst scenario of yield of CBM.

The Committee had met on 3.3.2015 and discussed on the reply furnished by the GEECL and the issue regarding overlapping of areas of GEECL and ONGC. It was decided to get the opinion from IIT Madras / PWD on seawater intrusion due to this project activity. Public concerns on this project, cost benefit analysis, environmental impact etc., were discussed. After getting complete information of the CMB projects and field conditions, this report is prepared and presented in the following chapters.

2.0 LITERATURE REVIEW

2.1 COALBED METHANE

Coalbed Methane (CBM) is a form of natural gas extracted from coal beds. It is well known that coal is formed due to bio-conversion of fossil organic matter. In the process of coal formation, anaerobic conditions led to generation and trapping of methane in this coal seams. The pressure exerted by naturally formed water keeps the methane adsorbed on internal surfaces of coal. Thus, coalbed gas is in mono-molecular state and not as free gas, as in natural oil/gas fields. Therefore, all coal fields of the world have coalbed methane, the only difference being the quantity of gas in individual coal seams. In recent decades CBM has become an important source of energy

in United States, Canada, Australia, and other countries. It is called 'sweet gas' because of its lack of hydrogen sulfide. CBM gas comprises of Methane from 63 to 99 percent; carbon dioxide from 0.1 to 15 percent[11]. CBM production began as a safety measure in underground coalmines to reduce the explosion hazard posed by methane gas.

2.2 HISTORY OF CBM PRODUCTION

Producing methane gas from coal seams began in the 1970s in the United States. Table 1 shows the major CBM production basins, their locations, typical well depths, and the thickness and depth of CBM seams[3].

Table 1 Characteristics of Major CBM Basins in USA

Basin	Location / Area	Coalbed Thickness	Well Depth or Depth to Target Coal Seam
Appalachian (Central)	23,000 square miles in Kentucky, Tennessee, Virginia, and West Virginia with greatest potential for development in a 3,000 square mile area in southwest Virginia and south central West Virginia	Variable	1,000 to 2,000 feet
Appalachian (Northern)	43,700 square miles in Kentucky, Maryland, Ohio, Pennsylvania, Virginia, and West Virginia	Average of 25 feet in Pennsylvania	Ranges from surface outcrops to depths of 2,000 feet with most occurring at depths of less than 1,000 feet
Arkoma	13,500 square miles in Arkansas and Oklahoma	600 to 2,300 feet	0 to 4,500 feet
Black Warrior	• Covers about 23,000 square miles in Alabama and Mississippi • Measures approximately 230 miles east-west and 188 miles north-south	1 to 8 feet	350 to 2,500 feet
Cherokee/Forest City	• Cherokee is 26,500 square miles in Oklahoma, Kansas, and Missouri • Forest City is 47,000 square miles in Iowa, Kansas, Missouri, and Nebraska	Few inches to 6 feet	Depth to coal in the shallow portion of Cherokee ranges from surface to 230 feet and up to 1,200 feet in the deeper portion
Greater Green River	Comprises five smaller basins in Wyoming, Colorado, and Utah	Multiple coal seams up to 50 feet thick	Not Readily Available
Illinois	Northwestern Kentucky, southeastern Indiana, and Illinois	Multiple thin coal seams	Most seams are at less than 650 feet;

Basin	Location / Area	Coalbed Thickness	Well Depth or Depth to Target Coal Seam
			across the basin, all seams are less than 3,000 feet deep
Piceance	7,225 square miles in Northwest Colorado	2,000 feet on west side to 6,500 feet on east site	Depth to methane-bearing formation is 6,000 feet, which has hindered development
Powder River Basin	25,800 square miles in northeastern Wyoming and southern Montana	Ranges by formation – Wasatch Formation has thin coals (6 feet or less) while Fort Union coals, which are below Wasatch, can be up to 6,200 feet thick	450 to 6,500 feet
Raton	• 2,200 square miles in southeastern Colorado and northeastern New Mexico • Measures 80 miles north-south and as much as 50 miles east-west	Vermejo coals are 5 to 35 feet thick and Raton coal layers are 10 to 140 feet thick	Not Readily Available
San Juan	• Covers an area of about 7,500 square miles across the Colorado/New Mexico line in the Four Corners region. • Measures approximately 100 miles north-south direction and 90 miles east-west.	Majority of production is in the Fruitland Formation. Coals of the Fruitland Formation range from 20 to over 40 feet thick	Wells drilled into the Fruitland coal seam typically range from 600 feet to 3,500 feet
Uinta	Eastern Utah (small portion in northwestern Colorado) covering 14,450 square miles	Exploration in Ferron Coals and Blackhawk formation	Depths to coal range from 1,000 to 7,000 feet
Wind River	Central Wyoming east of Powder River Basin	Potential for development in Upper Cretaceous Formation with thicknesses of up to 100 feet and Meeteetse Formation with thicknesses of less than 20 feet	Not Readily Available

Source: USEPA Coalbed Methane Extraction: Detailed Study Report - December 2010[3]

2.3 CBM PRODUCTION

CBM exists in the coal seams in three basic states: as free gas, as gas dissolved in the water in coal, and as gas adsorbed on the solid surface of the coal. CBM extraction requires drilling wells into the coal seams and removing the formation water contained in the coal seam to reduce hydrostatic pressure and allow the adsorbed CBM to be released from the coal. The process is

termed as hydraulic fracturing. The water produced during CBM extraction is called ‘produced water’. Produced water from CBM operations primarily consists of formation water, i.e., the water contained within the coal formation; in some cases, it may include wastewater from drilling activities. The infrastructure for CBM extraction sites typically comprises the well pad, gathering system pumps and pipelines, storage tanks, and treatment equipment.

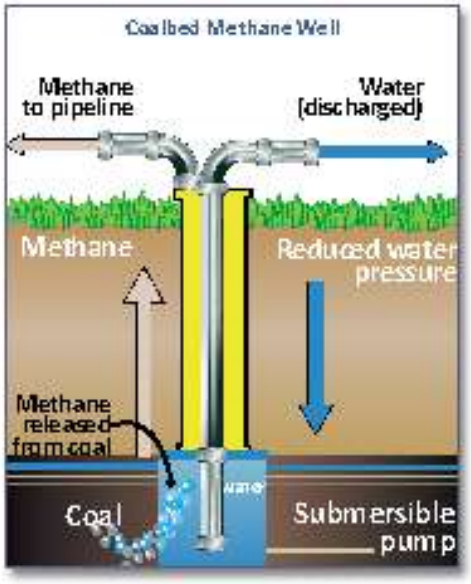

Figure 1 Coalbed Methane Exploration Well

2.4 HYDRAULIC FRACTURING

Hydraulic fracturing is a technique used by the oil and gas industry to improve the production efficiency of oil and coalbed methane wells[4]. The extraction of coalbed methane is enhanced by hydraulically enlarging and/or creating fractures in the coal zones. The resulting fracture system facilitates pumping of groundwater from the coal zone, thereby reducing pressure and enabling the methane to be released from the coal and more easily pumped through the fracture system back to the well (and then through the well to the surface). To initiate the process, a production well is drilled into the targeted

coalbeds. Fracturing fluids containing proppants (solid material, typically sand, treated sand or man-made ceramic materials, designed to keep an induced hydraulic fracture open), are then injected under high pressure into the well and specifically into the targeted coalbeds in the subsurface.

The fracturing fluids are injected into the subsurface at a rate and pressure that are too high for the targeted coal zone to accept. As the resistance to the injected fluids increases, the pressure in the injecting well increases to a level that exceeds the breakdown pressure of the rocks in the targeted coal zone, and the rocks 'breakdown'. In this way, the hydraulic fracturing process 'fractures' the coalbeds (and sometimes other geologic strata within or around the targeted coal zones). This process sometimes can create new fractures, but most often opportunistically enlarges existing fractures, increasing the connections of the natural fracture networks in and around the coalbeds. The pressure-induced fracturing serves to connect the network of fractures in the coalbeds to the hydraulic fracturing well (which subsequently will serve as the methane extraction or production well). The fracturing fluids pumped into the subsurface under high pressure also deliver and emplace the 'proppant.' The most common proppant is fine sand; under pressure, the sand is forced into the natural and/or enlarged fractures and acts to 'prop' open the fractures even after the fracturing pressure is reduced. The increased permeability due to fracturing and proppant emplacement facilitates the flow and extraction of methane from coalbeds.

Methane within coalbeds is not structurally 'trapped' by overlying geologic strata, as in the geologic environments typical of conventional gas deposits. Only about 5 to 9 percent of the coalbed methane is present as 'free' gas within the joints and cleats of coalbeds. Most of the coalbed methane is contained within the coal itself (adsorbed to the sides of the small pores in the coal).

Before coalbed methane production begins, groundwater and injected fracturing fluids are first pumped out from the network of fractures in and around the coal zone. The fluids are pumped until the pressure declines to the point that methane begins to desorb from the coal. Coalbed methane production initially requires pumping and removing significant amounts of water to sufficiently reduce the hydrostatic pressure in the subsurface so that methane can desorb from the coal before methane extraction can begin. Coalbed methane is produced at close to atmospheric pressure. The proportion of water to methane pumped is initially high and declines with increasing coalbed methane production (Figure 1). In contrast, in the production of conventional petroleum-based gas, the production of gas is initially high, and as gas production continues over time and the gas resources are progressively depleted, gas production decreases and the amount of water pumped increases.

The typical lifespan of a CBM well is between five and 15 years, with maximum methane production often achieved after one to six months of water removal. CBM wells go through the following production stages[3]:

- An early stage, in which large volumes of formation water are pumped from the seam to reduce the underground pressure and encourage the natural gas to release from the coal seam.
- A stable stage, in which the amount of natural gas produced from the well increases as the amount of formation water pumped from the coal seam decreases.
- A late stage, in which the amount of gas produced declines and the amount of formation water pumped from the coal seam remains low.

Almost every coalbed targeted for methane production must be hydraulically fractured to connect the production well bore to the coalbed fracture network. Although the general hydraulic fracturing process (described

above) is generally similar, the details of the process can differ significantly from location to location depending on the site-specific geologic conditions.

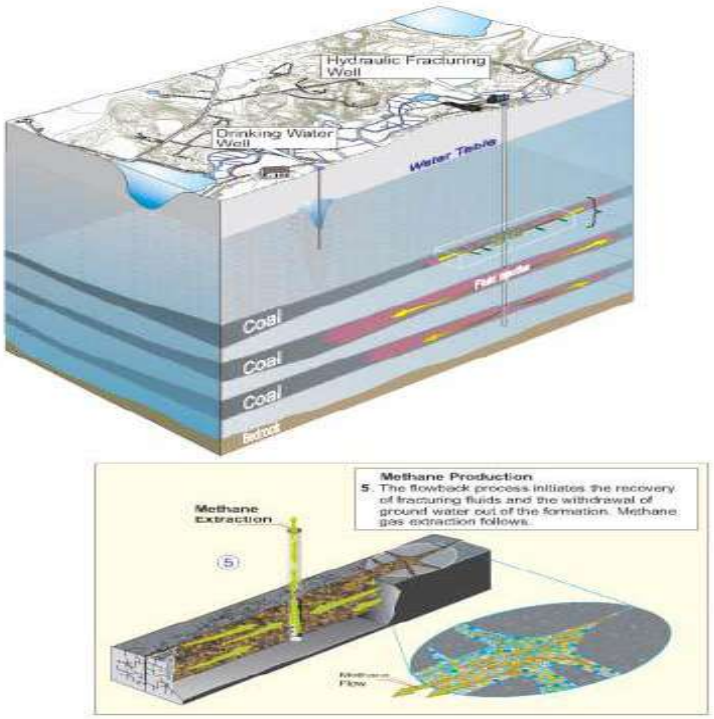

Figure 2 A Graphical Representation of the Hydraulic Fracturing Process in Coalbed Methane Wells (Source: USEPA EPA 816-R-04-003)

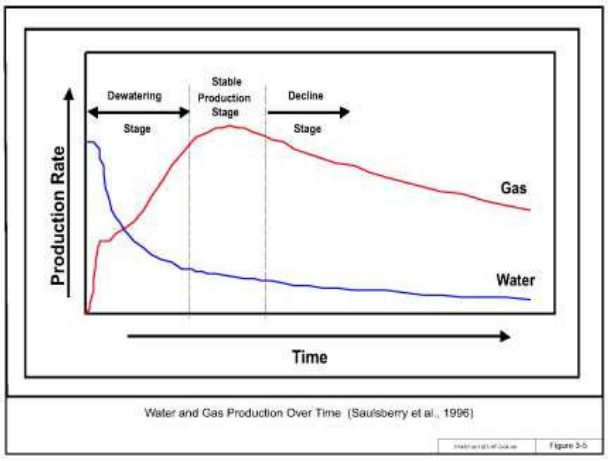

Figure 3 Generalizes the gas and water production curves for CBM wells (Source: USEPA EPA 816-R-04-003)

2.5 FRACTURING FLUIDS AND THE COMPOSITION

Water-based fracturing fluids have become the predominant type of coalbed methane fracturing fluid. However, fracturing fluids can also be based on oil, methanol, or a combination of water and methanol. Methanol is used in lieu of, or in conjunction with, water to minimize fracturing fluid leakoff and enhance fluid recovery. In some cases, nitrogen or carbon dioxide gas is combined with the fracturing fluids to form foam as the base fluid. A variety of other fluid additives are also used in addition to the proppants. These additives include biocides, fluid-loss agents, enzyme breakers, acid breakers, oxidizing breakers, friction reducers, and surfactants such as emulsifiers and non-emulsifiers. On any one fracturing job, different fluids may be used in combination or alone at different stages in the fracturing process.

Table 2 Fracturing Fluids and Conditions for their use

Base Fluid	Fluid Type	Main Composition	Used for
Water Based	Linear Fluids	Gelled Water, Guar, HPG, HEC, CMHPG	Short Fractures, Low Temperatures
	Crosslinked Fluids	Crosslinker + Guar, HPG, CMHPG, CMHEC	Long Fractures, High Temperatures
Foam Based	Water based Foam	Water and Foamer + N_2 or CO_2	Low Pressure Formations
	Acid Based Foam	Acid and Foamer + N_2	Low Pressure, Water Sensitive Formations
	Alcohol Based Foam	Methanol and Foamer + N_2	Low Pressure Formations with Water Blocking Problems
Oil Based	Linear Fluids	Oil, Gelled Oil	Water Sensitive Formations, Short Fractures
	Crosslinked Fluids	Phosphate Ester Gels	Water Sensitive Formations, Long Fractures
	Water External Emulsions	Water + Oil + Emulsifier	Good for Fluid Loss Control

Note: Guar is an organic powder thickener, typically used to make viscous fracturing fluids, completely, soluble in hot and cold water, insoluble in oils, grease and hydrocarbons. HPG– Hydroxypropylguar, CMHPG-carboxymethyl hydroxypropylguar, HEC- hydroxyethylcellulose CMHEC - carboxymethyl hydroxyethylcellulose . (Source : EPA 816-R-04-003)

Table 3 Summary of Chemical Additives used in Hydraulic Fracturing

Type of Additive	Function Performed	Typical Products
Biocide	Kills bacteria	Gluteridehyde carbonate
Breaker	Reduces fluid viscosity	Acid, oxidizer, enzyme breaker
Buffer	Controls the pH	Sodium bicarbonate, fumaric acid
Clay stabilizer	Prevents clay swelling	KCl, NH Cl, KCl substitutes
Diverting agent	Diverts flow of fluid	Ball sealers, rock salt, flake boric acid
Fluid loss additive	Improves fluid efficiently	Diesel, particulate, fine sand
Friction reducer	Reduces the friction	Anionic copolymer
Iron Controller	Keeps iron in solution	Acetic & Citric acid
Surfactant	Lowers surface tension	Fluorocarbon, Nonionic
Gel stabilizer	Reduces thermal degradation	MEOH, Sodium thiosulphate

(Source: EPA 816-R-04-003)

In the hydraulic cracking, the following are of potential concern:

- The hydraulically induced fracture may extend from the target formation into an Underground Sources of Drinking Water (USDW).
- The hydraulically induced fracture may connect with natural (existing) fracture systems and/or porous and permeable formations, which may facilitate the movement of fracturing fluids into a USDW.

2.6 QUALITY OF PRODUCED WATER

Produced water generally contains dissolved ions mainly sodium (Na), bicarbonate (HCO3), and chloride (Cl). The composition is controlled in great part by the association of the waters with a gas phase containing varying amounts of carbon dioxide (CO_2) and methane. The bicarbonate component potentially limits the amount of calcium (Ca) and magnesium (Mg) through the precipitation of carbonate minerals. CBM waters are relatively low in sulfate (SO_4) because the chemical conditions in coalbeds favor the conversion of SO_4 to sulfide. The sulfide is removed as a gas or as a precipitate. The total dissolved solids (TDS) of CBM water ranges from fresh (200 mg/L or parts

per million) to saline (170,000 mg/L) and varies among and within basins. The TDS of the water is dependent upon the depth of the coalbeds, the composition of the rocks surrounding the coalbeds, the amount of time the rock and water react, and the origin of the water entering the coalbeds[12].

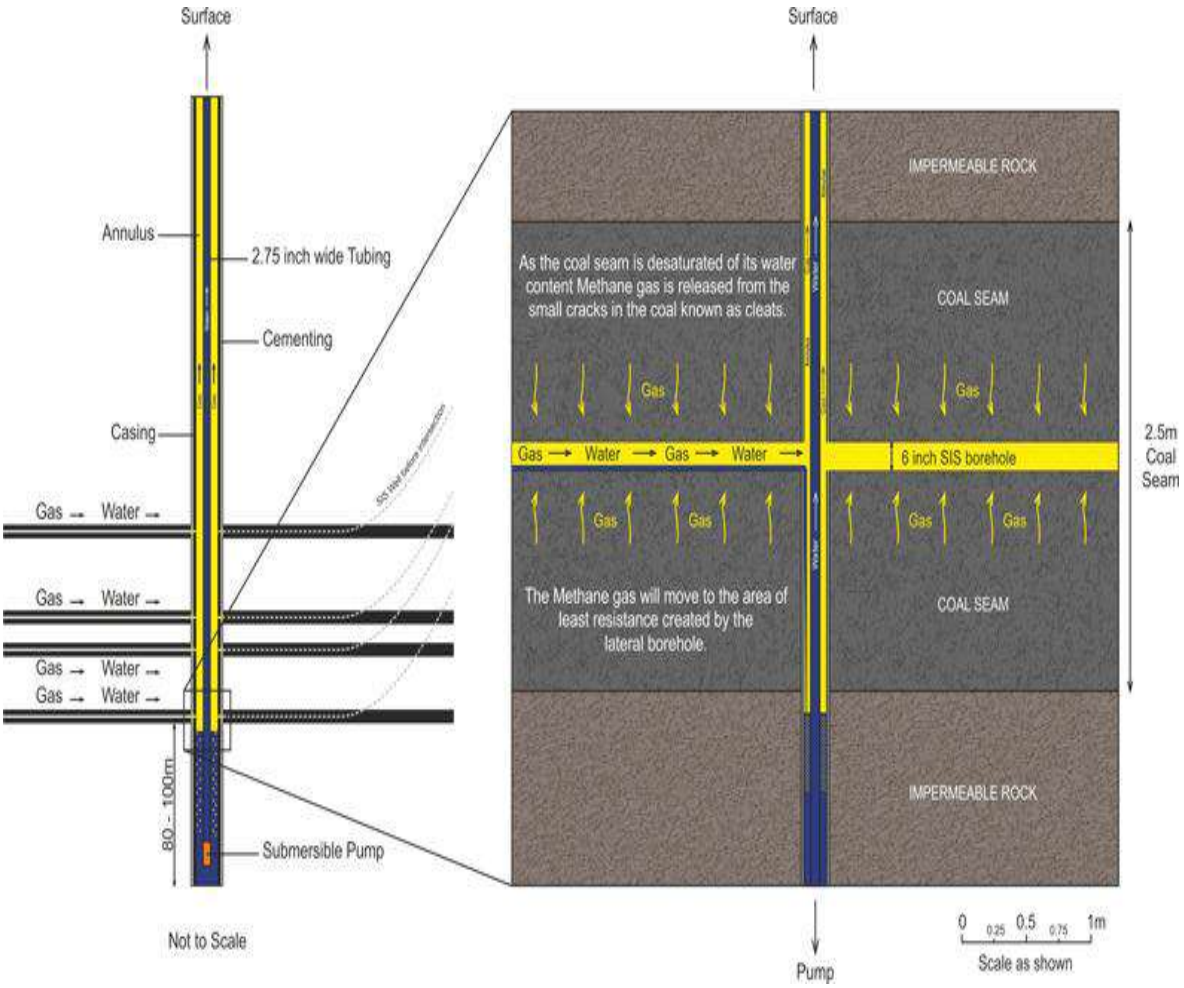

Figure 4 Coalbed Methane Seams

2.7 MANAGEMENT OF PRODUCED WATER

The gas and water content in the coal vary by hardness of coal or the 'rank' of the coal[3]. CBM operators often group wells together into projects to manage, store, treat, and dispose of produced water, a byproduct of CBM gas production. CBM operators often combine produced water from multiple wells and occasionally multiple projects into a produced water management system

(PWMS). To dispose produced water, CBM operators in USA currently choose from surface water discharge and zero discharge alternatives. Surface water discharge includes direct discharge to waters bodies and indirect discharge through Public Owned Treatment Works (POTWs) to surface water. Zero discharge includes underground injection, evaporation/infiltration ponds, land application (for crop or non-crop production), and livestock or wildlife watering.

2.8 POTENTIAL ENVIRONMENTAL IMPACTS FROM THE DIRECT DISCHARGE OF CBM PRODUCED WATER

United States Environmental Protection Agency (USEPA) defines a potential environmental impact to stream water quality, morphology, or aquatic community that could result from or be contributed to by the direct discharge of CBM produced water to a receiving stream. EPA's literature review identified 74 scientific studies, reports, and other sources describing potential environmental impacts from CBM produced discharges. The primary potential impacts include those to vegetation, water quality, and organisms due to changes in stream volume, turbidity, salinity, sodicity, Sodium Absorption Ratio (SAR), Total Dissolved Solids (TDS), specific conductance, toxicity, temperature, and pH.

Table 4 Summary of Documented Impacts From the Direct Discharge of CBM Produced Water Cited in Peer-Reviewed Literature

Citation	Impact Type	Summary
O'Neil et al., 1991a (cited in Davis et al. 2006)	Changes in communities of aquatic organisms	O'Neil et al. observed changes in fish species abundance and reproduction in response to water quality alterations resulting from CBM produced water discharges in the Black Warrior Basin. This suggests that CBM discharges are altering the aquatic environment and may cause permanent changes in species assemblages.
Davis, 2008	Changes in communities of aquatic organisms	In Davis's comparison of streams in the Power River Basin (PRB) with and without CBM development, some results indicated that CBM discharges were impacting fish assemblages, while others showed no impact. Impacts tied to CBM produced water discharges included a correlation of increased conductivity with decreased biotic integrity, a

Citation	Impact Type	Summary
		correlation between decreased abundance of certain fish with an increase in bicarbonate, and the presence of the salt-tolerant northern plains killifish only in streams receiving CBM produced water discharges.
Confluence Consulting, 2004b (cited in Confluence Consulting, 2004a)	Changes in aquatic organisms and riparian plant communities	In a study of the effects of CBM development on fish and water quality, Confluence Consulting observed elevated levels of dissolved solids, reduced numbers of sturgeon chub in the Powder River, and a prevalence of salt-tolerant shrubs.
Vickers, 1990	Changes in communities of aquatic organisms	In a study determining the effects of CBM produced water on surface waters of the Black Warrior Basin in Alabama, researchers from the University of Alabama observed a decrease of total macroinvertebrates as the in-stream chloride concentration at Shoal Creek increased. The decrease in taxa was not completely dependent upon chloride concentration, but may have been influenced by in-stream components and subsequent mixtures.
Mount et al., 1992	Changes in communities of aquatic organisms	In an in-stream study of surface waters in the Cedar Cove degasification field, the Geological Survey of Alabama (GSA) found no significant effects in streams on native invertebrates (acute toxicity of *Ceriodaphnia*) at chloride concentrations of 519 mg/L and below and consistent effects at chloride concentrations of 615 mg/L and above.
Mount et al., 1992	Changes in communities of aquatic organisms	In an in-stream study of surface waters in the Cedar Cove degasification field, the Geological Survey of Alabama (GSA) found no significant effects in streams on native invertebrates (acute toxicity of *Ceriodaphnia*) at chloride concentrations of 519 mg/L and below and consistent effects at chloride concentrations of 615 mg/L and above.
O'Neil et al., 1993	Changes in communities of aquatic organisms	A GSA study found that environmental effects caused by CBM water discharges were related to TDS rather than metals or other constituents. This study concluded that elevated chloride levels in CBM produced waters from coal seams in Alabama were the main driver behind deleterious effects on stream conditions. Specifically, an in-stream limiting chloride concentration of < 565 mg/L had no significant effect on the community structure of benthic macroinvertebrates. In contrast, chloride concentrations of > 565 mg/L in produced water always degraded or impaired the benthic macroinvertebrate community.

Source: USEPA Coalbed Methane Extraction: Detailed Study Report December 2010

Table 5 Scientific Studies Evaluating Potential Environmental Concerns from the Direct Discharge of CBM Produced Water

Citation	Impact Type	Summary
Clearwater et al., 2002 (cited in MacDonald., 2007)	Changes in water quality and aquatic communities	Changes in volume and salinity of water in receiving streams in the PRB can impact resident biota by disrupting environmental cues, which can alter reproduction and normal species behavior.
Patz et al., 2004	Changes in	The pH of CBM produced water may fluctuate due to

Citation	Impact Type	Summary
(cited in Davis et al., 2006)	water quality	atmospheric exposure following discharge to a receiving water in the PRB. These changes in pH can make downstream impacts difficult to pinpoint.
Horpestad, 2001 (cited in Todd, 2006)	Changes in water quality	In areas with minimal precipitation, such as eastern Montana, salts from CBM produced water can accumulate in surface waters.
Klarich et al., 1980 (cited in Regele and Stark, 2000)	Changes in water quality	Raising the salinity of southeastern Montana waters above 1,200 micromhos will potentially affect the biological health in streams receiving produced waters
Forbes et al., 2002, and Forbes et al., 2001 (cited in MacDonald et al., 2007)	Changes in water quality and aquatic communities	The water quality of CBM produced water and PRB receiving waters were linked to acute and chronic toxicity effects in *Ceriodaphnia dubia*, *Daphnia magna*, and fathead minnows.
Skaar et al., 2004 (cited in Davis et al., 2006)	Changes in water quality and aquatic communities	Exposure to sodium bicarbonate in reconstituted Tongue and Powder River water resulted in chronic and acute toxicity and mortality in fathead minnows.
Skaar et al., 2005	Changes in water quality and aquatic communities	Chronic exposure to sodium bicarbonate from simulated Tongue and Powder River water resulted in gill lesions, gill necrosis, and kidney damage in fathead minnows.
Ramirez, 2005	Changes in water quality, aquatic communities, and migratory bird communities	The U.S. FWS (citing Ohlendorf et al., 1988) reported that streams receiving produced water tend to have increased selenium concentrations, which can impact fish and migratory aquatic birds due to bioaccumulation. Birds with increased selenium concentrations can have low reproduction, increased mortality, and embryonic deformities. In addition, any prior impoundment of the produced water before discharge to receiving waters can increase selenium concentrations even further due to evaporation.
Ramirez, 2005	Changes in water quality and aquatic communities	U.S. FWS (citing Eisler, 2000) found that cadmium concentrations in aquatic invertebrates from some CBM produced water receiving sites exceeded the 0.1 µg/g "view with caution" level. Chromium in tiger salamanders at a number of sites ranged from 18.6 to 137 µg/g, and chromium in fathead minnows ranged from 24.4 to 307 µg/g. (Chromium concentrations of 4 µg/g or greater are considered evidence of chromium contamination.)
USGS, 2006b	Changes in water quality and aquatic communities	In a laboratory study, the USGS found that increased concentrations of, and exposure time to, sodium bicarbonate, a major constituent of CBM produced water in the Tongue and Powder River drainage basins, decreased fathead minnow survival, increased incidence of lesions and kidney damage, and interfered with ion uptake by fish.
USDOI, 2005	Changes in water quality and aquatic communities	The U.S. FWS measured cadmium concentrations ranging from 6.7 to 9.3 µg/L in wetlands in the PRB that receive CBM produced waters, exceeding the threshold of 3 µg/L considered hazardous to aquatic life. Chromium concentrations were

Citation	Impact Type	Summary
		typically low, except for one wetland site where concentrations in fathead minnows ranged from 24.4 µg/g to 307 µg/g, greatly exceeding the 4 µg/g threshold considered hazardous.
USDOI, 2005	Changes in water quality, aquatic communities, and bird communities	In a PRB study by U.S. FWS that took place from 2000 to 2002, concentrations of iron, manganese, lead, and copper in CBM produced water discharges were above concentrations that would impact fish and birds.
Jackson and Reddy, 2007	Changes in water quality and aquatic communities	Most CBM produced water being discharged at outfalls into the PRB was considered unsuitable for aquatic life due to aluminum and copper concentrations greater than the water quality standards for aquatic life.
Mount et al., 1992	Changes in water quality	The results of a study funded by the Gas Research Institute at the Cedar Cove degasification field indicated that laboratory toxicity tests could be used to predict in-stream effects of CBM produced water. The study reported that the TDS concentration, specifically the chloride concentration, accounted for most of the toxicity associated with CBM produced water at the site.
O'Neil et al., 199b	Changes in aquatic communities	CBM produced water discharges may account for some observed changes in fish abundance in the receiving waters of the Cedar Cove degasification field; however, the changes were within the range of variation observed under natural conditions
Gore, 2002	Changes in water quality, aquatic communities, and morphology	A study by Columbus State University used model simulations to evaluate the impact of increased flows from CBM produced water on aquatic communities. The modeling results determined that all study locations would lose habitat, impacting and possibly destroying macroinvertebrates and western silvery minnows and destabilizing the river ecosystem. Small increases in flow over a long period of time flushed organisms, decreased organic matter, changed channel morphology, and increased sedimentation, which could cause declines in the macroinvertebrate community, decreasing fish populations and decreasing diversity in the ecosystem.

Source: USEPA Coalbed Methane Extraction: Detailed Study Report December 2010

EPA identified several articles and documents that included general statements that CBM produced water discharges were not likely to cause an environmental impact; however, these statements were not substantiated by rigorous scientific research. EPA also identified several studies that concluded if the appropriate controls are in place (e.g., certain management practices or prior soil investigation), there will likely be minimal or no impacts from CBM produced water discharges.

2.9 OVER ALL IMPACTS OF CBM PROJECTS

2.9.1 Contaminated Aquifers and Produced Water

Citizen's Guide reported that CBM development often produces large amounts of water (i.e. draws it out of the underground coal seam and brings it to the surface) creating several environmental and health concerns. One CBM well can produce as much as 63,594 litres of water a day[9]. In the United States in some CBM basins it is predicted that the aquifer levels will drop by as much as 290 feet in the drilling fields, and CBM operations will suck water from more than 74 kilometres away. The depletion of aquifers caused by CBM operations affects aquifer recharge, river flows, wells and springs for 200 years. The decrease in aquifers can affect temperature of streams and the earth, which further harms soil productivity and wildlife. In addition to the problem of depleted aquifers, water produced in the initial stages of development is often contaminated by the chemicals used in CBM operations. In order to extract CBM, operators will pump fracturing ('fraccing') fluids into the coal seams to prop them open and release the methane gas. The chemicals used in fracturing fluids are often toxic and can contaminate groundwater and drinking water, detrimentally affecting human health. A study conducted in the United States found that when wells are hydraulically fractured, a portion of the fracturing fluids remains stranded in the target formation. In some areas, hundreds or thousands of wells are hydraulically fractured, often multiple times. This is especially problematic because several chemicals used during hydraulic fracturing operations (e.g., biocides, corrosion inhibitors, breakers and organic components such as benzene and naphthalene) "can be lethal at levels as low as 0.1 parts per million" and can easily contaminate drinking water.

In Colorado, New Mexico, Virginia, West Virginia, Alabama and Wyoming, citizens have reported changes in water quality and quantity following hydraulic fracturing operations. Common complaints include: murky or cloudy water, black or gray sediments, iron precipitates, soaps, black jelly-like grease, floating particles, diesel fuel or petroleum odours, increased methane in water, rashes from showering, gassy taste, and decrease or complete loss of water flow.

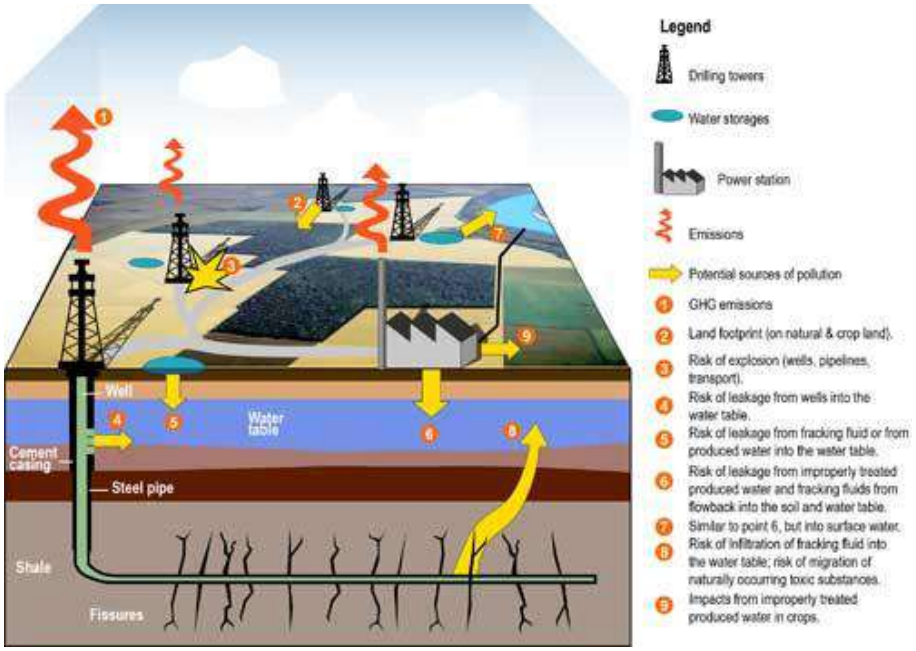

Figure 5 Picture Showing Environmental Impacts due to CBM Extraction

2.9.2 Flaring

During the initial stages of developing a CBM well, in particular during the dewatering phase, methane is usually flared, i.e., burnt off at the surface. A gas operator may flare or incinerate the gas for several weeks or months because the company does not know whether the well will be sufficiently economically viable to install pipelines. The chemicals produced by flaring are toxic. They can set off skin disorders, certain cancers, birth defects and reproductive problems. Residents downwind of flaring in both British

Columbia and Alberta report premature births, cancer, sick or dead livestock, allergies, multiple sclerosis, bloody noses, and nausea. This may be due to flare pollutants which can travel downwind, where they can affect the health of people and livestock far from a drilling site. In addition to health impacts, flaring contributes to British Columbia's greenhouse gas emissions. Methane's global warming potency is 20 times greater than carbon dioxide. The practice undermines the government's greenhouse gas reduction targets, as well as its commitments to eliminate flaring by 2016[9].

2.9.3 Cumulative Impacts

The CBM wells often produce gas for 40 years and need hundreds or thousands of wells, resulting in hundreds of flares and vast quantities of Produced Water. The number of wells in close proximity in combination with the length of time CBM is being extracted creates a large cumulative impact on the surrounding environment.

2.9.4 Well Spacing

Coalbed methane wells generally require much denser spacing than conventional gas wells[9]. The infrastructure necessary for CBM operations includes wells and well pads, roads, compressor stations, gas flares and pipeline rights of way, which have the potential to dramatically alter the land. Each of the hundreds or thousands of wells needed for CBM operations can disturb three to four acres of land, which cumulatively alters an enormous area, and displaces wildlife.

2.9.5 Seismic Testing

Prior to choosing locations for CBM development, operators frequently use seismic testing to identify the depth, shape and composition of underground formations. Seismic surveys typically require clearing several

precious of land in a straight line above the potential deposit. This leads to the loss of trees, carbon sinks, and soil erosion and compaction. In addition, seismic testing can result in stream and groundwater contamination through improperly capped seismic holes, alteration of drainage patterns and destruction of habitat.

Figure 6 Picture showing a CBM Extraction site

2.9.6 Noise Pollution

CBM operations can also produce a lot of noise, from truck traffic, drilling and completion activities, well pumps and compressors. For some landowners, noise from oil and gas operations is so loud that it makes them feel as if they are living in an industrial zone. In addition to noise, the visual impact of CBM operations results in the industrialization of the landscape.

3.0 COALBED METHANE EXPLORATION IN INDIA

India is having the 4th largest proven coal reserves and the third largest coal producer in the world. India holds significant prospects for commercial

recovery of CBM. Prior to 1997, due to absence of proper administrative, fiscal and legal regime, CBM Exploration and Production activities were limited to R&D only[14]. It was only after the formulation of the policy for exploration and production of CBM by the Government in July 1997, CBM exploration activity commenced in the country. Commercial CBM production has started since July 2007. Ministry of Petroleum & Natural Gas (MOP&NG) became the administrative Ministry and Directorate General of Hydrocarbons (DGH) became the implementing agency for CBM policy. DGH functioning under the aegis of MOP&NG plays a pivotal role in development of CBM resources in India.

According to DGH, Prognosticated CBM resources are 2600 Billion Cubic Meters of CBM in 11 states of India out of which initial-in-place reserves of 280 Billion Cubic Meters of CBM have been established in 3 states of India[2].

Table 4 CBM Resources in the States

Sl. No.	STATE	Prognosticated CBM Resources (BCM)	Prognosticated CBM Resources (TCF)
1	Jharkhand	722.08	25.5
2	Rajasthan	359.62	12.7
3	Gujarat	351.13	12.4
4	Orissa	243.52	8.6
5	Chattisgarh	240.69	8.5
6	Madhya Pradesh	218.04	7.7
7	West Bengal	218.04	7.7
8	Tamilnadu	104.77	3.7
9	Andhra Pradesh	99.11	3.5

Sl. No.	STATE	Prognosticated CBM Resources (BCM)	Prognosticated CBM Resources (TCF)
10	Maharashtra	33.98	1.2
11	North East	8.50	0.3
Total CBM Resources		2599.48	91.8

*Conversion factor: 1 cubic meter = 35.3147 cubic feet
BCM – Billion Cubic Meters
TCF – Trillion Cubic Feet
Source: DGH Report: INDIA – Hydrocarbon Exploration and Production Activities – 2013-14

In-place CBM resources of 9.90 TCF (Trillion Cubic Feet)/280.34 Billion Cubic Meters have been established by different operators as on 31.03.2014. Block wise reserves are given below:

Table 5 In-Place CBM Resources

S. No.	Block Name	Operator	In-place CBM Resources		State
			(BCM)	(TCF)	
1	SP (East)-CBM-2001/I	RIL	47.86	1.69	Madhya Pradesh
2	SP (WEST)-CBM-2001/I	RIL	55.50	1.96	Madhya Pradesh
3	Raniganj (South)	GEECL	54.37	1.92	West Bengal
4	RG (East)-CBM-2001/I	ESSAR	60.88	2.15	West Bengal
5	Raniganj (North)	ONGC	7.36	0.26	West Bengal
6	NK-CBM-2001/I	ONGC	9.63	0.34	Jharkhand
7	BK-CBM-2001/1	ONGC	30.02	1.06	Jharkhand
8	Jharia	ONGC	14.72	0.52	Jharkhand
Total			280.34	9.9	

Source: DGH Report: INDIA – Hydrocarbon Exploration and Production Activities – 2013-14

3.1 CBM PROJECT IN TAMIL NADU

The DGH at Ministry of Petroleum and Natural Gas identified CMB potential in the Mannargudi block of the Cauvery Basin. The Mannargudi CBM block forms a part of lignite basin in the coastal tracts of Tamil Nadu and Pondicherry in Cauvery Basin. The linear lignite belt extends from Bahur in Pondicherry through the Neyveli Lignite Mines, to Jayamkondacholapuram, Srimushnam to the Mannargudi area, further south. The lignite belt has been explored systematically through core drilling by various agencies, which proved the occurrence of very thick lignite seams of tertiary age at a relatively shallow depth. The lignite resources of Mannargudi were proven to occur over a large area of more than 760 km^2.

4.0 GREAT EASTERN ENERGY CORPORATION LIMITED

4.1 PROPOSED CBM PROJECT

M/s.Great Eastern Energy Corporation Limited (GEECL) proposed CBM exploration and production in Mannargudi block which falls in Thiruvarur and Thanjavur districts. In that Kudavasal, Needamangalam, Mannargudi, Valangaiman Taluks are in Thiruvarur District and Thiruvidaimarudur, Kumbakonam, Orathanad and Papanasam Taluks are in Thanjavur District. Mannargudi block is about 38km on western direction from sea and major water bodies in this block are Cauvery river, Vettar river, Vennar river and their tributaries. The pre-dominant land use is agriculture. Around 81.92% usage of the land in the study area falls under agricultural land category. The feature of soil is sandy clay loam. Map showing location of Mannargudi CBM block is given in Annexure – III. Map showing well location, land use pattern, soil cover, ground water table are given in Annexure-IV.

4.2 DRILLING PROCESS

The unit requires 1.5 to 2 acres of land for each core hole/test well to accommodate drilling rig, site office, mud pump, generator, laboratory, air pit, mud pit, fuel storage, DG set and flare. The core hole and test well will be done by rotary drilling using mobile land rig[13]. The core hole of 96 mm dia will be drilled to depth of 400m to 650m. In core drilling a hallow drill bit is attached to a core barrel so that cylindrical samples of the strata can be obtained. The coal/lignite samples collected will be analysed for presence of methane gas. It was reported that the product may contain methane 96-97%, nitrogen 1-1.5% and CO_2 traces. The purpose of core hole is to collect samples of subsurface formation and to explore the feasibility of converting some holes as test wells for further investigation. After the coring operations, all the core holes except 2 (most promising) holes will be abandoned and site will be brought to its near original condition. These 2 promising holes will be further developed as test wel

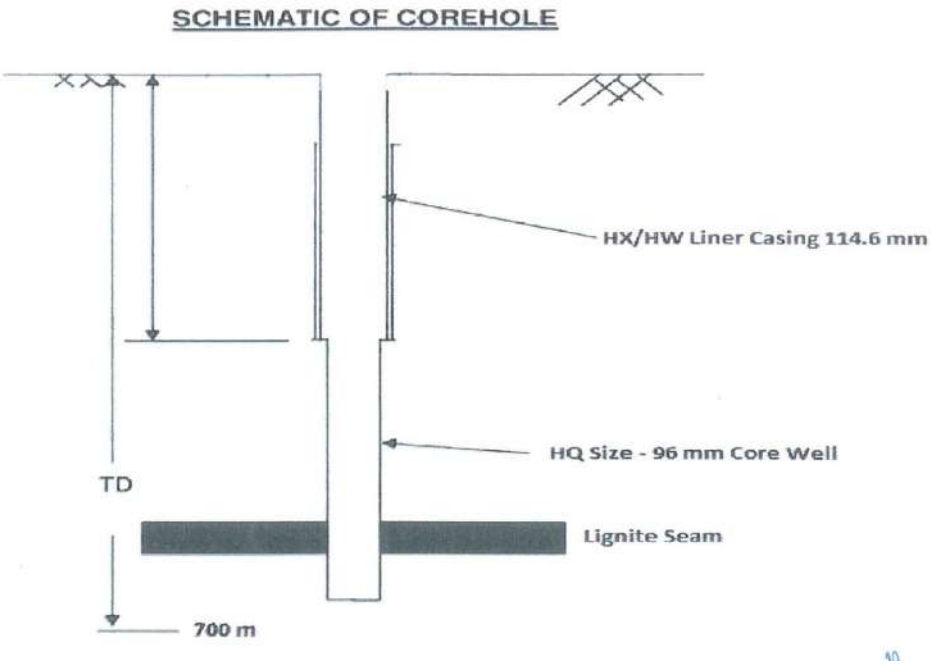

Figure 7 Schematic Diagram of Corehole

4.3 POLLUTION CONTROL MEASURES

The unit has proposed to employ 15 to 20 persons in each drilling site at a time. The total water requirement for domestic purpose will be about 2.8 kilo litres per day (KLD). The unit has proposed to treat and dispose the domestic wastewater through septic tank and soak pit arrangement. The water requirement for drilling a core hole for the entire drilling period (10-15 days) is about 11KL. The water requirement for drilling a test well is about 55KL if air drill is used and about 65 KL if mud drill is used. Equal amount of wastewater will be generated from the drilling operations. The unit has proposed to hold the wastewater in HDPE lined pits for solar evaporation.

Produced water (wastewater) say 45 KL/day/well will be generated during test well drilling and not in core hole[13]. The unit has estimated the quantity of produced water generation based on the similar plants at Powder River Basin in the USA as the geological parameters are similar in both the locations. Total quantity of produced water generation will be 1350 KL per test well (i.e., operation period 30 days; 45KL x 30 = 1350 KL). The unit has proposed to store the produced water in a lined pit of 1575 KL capacity and use a part of this water in drilling of subsequent test wells and solar evaporate the remaining.

The unit has proposed to use portable power generators (DG sets of 250 HP) for all the power requirements. According to GEECL, there will be no methane gas emission during coring operations. The unit has proposed to flare methane and other gases from the test well operation using appropriate flare stack. About 35 lts of used oil will be generated during drilling of one core hole and about 70 lts will be generated during one test well drilling. The unit has proposed to dispose the same through authorized recyclers. Drill cutting waste generation will be 6.5 T per core hole and 10.5 T per test well.

The unit has proposed to dispose the drill cutting in situ if the oil content is less than 10 mg/Kg else dispose it to authorized recyclers.

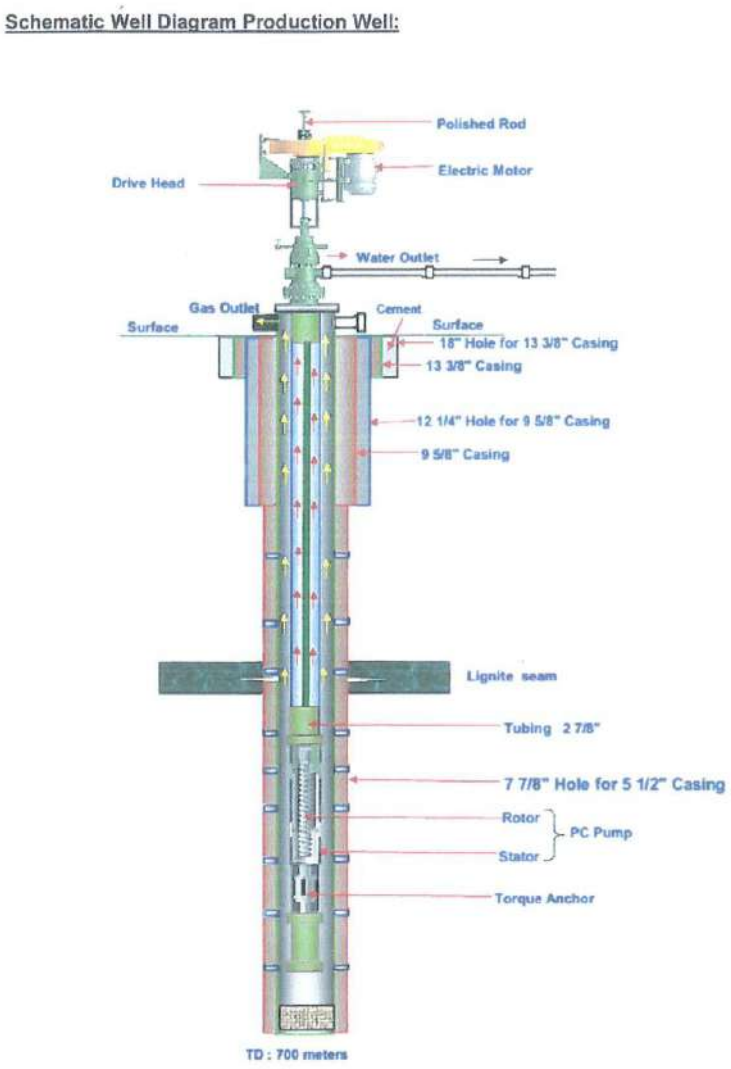

Figure 8 Schematic Diagram of Production Well

4.4 ENVIRONMENTAL CLEARANCE

As this project attracts EIA Notification, public hearing was conducted in Thanjavur district on 28.12.2011 for 12 core holes and in Thiruvarur District on 23.01.2012 for 38 core holes and 2 test wells. In the Public consultation held at Thanjavur, 65 participants attended the meeting. They

expressed their concern mainly about the safety, ground water depletion, impact on agricultural activities in the nearby lands, impact on the tiny industries in that area, laying of road in the agricultural lands for movement of heavy machineries, employment to the local people etc.,

In the public consultation held at Thiruvarur, 109 participants attended the meeting. They expressed their concern mainly about

i. The ground water quality will be affected. The ground water level will go down.
ii. Agricultural production and the livelihood of the agricultural labours will be affected.
iii. Food security will be affected.
iv. Sea water intrusion will take place due to continuous pumping of water.
v. Objections were raised by the farmers association regarding the possible pollution to their agricultural lands due to discharge of produced water.

Ministry of Environment and Forests, Government of India has accorded Environmental Clearance for the above said proposed project vide F.No.J.1101/615/2010-IA II (I) dated 12th September 2012. Total block area of Mannargudi block is 691sq.km whilst effective area of CBM activity is 667sq.km. Drilling will be carried out upto 600m depth. Environmental Clearance was issued with certain conditions interalia that the unit shall not drill any wells lying at a distance less than 10km of the Vadavur Bird Sanctuary.

4.5 TNPCB CONSENT

On getting environmental clearance, the unit has applied for consent to establish (CTE) to TNPCB under the Water (Prevention and Control of Pollution) Act, 1974 and the Air (Prevention and Control of Pollution) Act,

1981, for Thiruvarur and Thanjavur Districts separately for exploration of methane gas by drilling core hole / test well in agriculture lands and nearer to villages in the month of July 2012 and August 2012 respectively. As per TNPCB B.P.Ms.No.505, dated 2-9-1991 (Procedure for grant of consent to Oil & Natural Gas Exploration) consent has to be obtained for each core hole or well and get it renewed till it gets connected to pipe line or group gathering station.

This unit has proposed to drill shallow depth wells to extract lignite samples initially for geological studies and finally to extract coalbed methane gas if it is available in sufficient quantity. However all other operations are same except depth of well. Though common environmental clearance is accorded for this zone, site conditions for each well is different from one another and separate consent to establish has to be issued for each well.

The unit has stated that they will obtain the required land from the farmers by consent and they will enter into the required lease deed agreement. They proposed initially to drill 46 core holes + 2 test wells (Phase I – as per EC issued by MoEF). Therefore for Phase-I, they may require about 100 acres of land. In Phase-II, they proposed to drill 28 test wells, for which they may require about 60 acres of additional land. The matter of issue of CTE was placed before the Technical Sub-Committee of the Board on 11.3.2013. The Committee decided to obtain details of land requirements and the ways and means of acquiring the lands from the agriculturists. CTE is not yet issued to the unit.

In this regard, the TNPCB vide letter dated 22.03.2013 addressed the unit to assess the land requirement and submit documents after acquiring the land so as to proceed further on the issue of CTE to the project. Again TNPCB vide letter dated 08.07.2013 addressed the unit to furnish following details-

- The distance of each well from the sea shore.

- The quantity of produced water expected from each well during production of gas extractions per day for continuous period of 30 years.
- The method of produced water extraction, collection, treatment and disposal during the production phase.
- Characteristic of the produced water.
- During production whether there will be any depletion of ground water table, if so the methodology proposed to retain the ground water table without any change.
- Any geological study has been conducted about the sea water intrusion during extraction of water and gas. If no study has been done, carryout a study and submit a report.
- Land area required for each production well, if the well is abounded whether that area will be reclaimed for agricultural activities?
- What is the drainage pattern proposed at each well site?

In the meantime, the Government has constituted this Expert Technical Committee (ETC) to look into the project.

4.6 EXPERT TECHNICAL COMMITTEE'S DISCUSSIONS

The ETC met on 15.7.2014 and discussed in detail about the proposed CBM project and the mandate of the Committee. The ETC directed the unit to furnish details on technical queries raised by the committee and also it directed the TNPCB to collect field data such as population, distance from the core hole, no. of temples, historical monuments, drinking water wells, irrigation wells, canals, rivers, area of agricultural lands, crops cultivated etc.

The Committee has again met on 2.8.2014. During the meeting the unit representatives have answered various technical queries. The District Environmental Engineers (DEE), TNPCB Nagapattinam and Thanjavur have furnished data collected. After the discussion, the committee has directed the

unit to come out with complete details of the technical queries raised by the committee members. GEECL vide letter dated 11.8.2014 has furnished the reply for the questions raised by ETC in the meeting dated 15.7.2014. The query raised by the ETC and the reply furnished by GEECL is given as follows:

1 **ETC:** Schematic flow diagram on extraction of Coalbed Methane (CBM) from exploration wells/production wells, including the water intake/outfall process.

GEECL: Schematic of corehole is given in Figure

2 **ETC:** The quantity of methane gas expected to be produced from the blocks awarded by Government of India and the period (No. of years) that gas is expected to be available from these blocks.

GEECL: The estimated gas in-place for Mannargudi block is 0.98 TCF by DGH. In general technical recovery over original gas in-place is around 60% over 25 years of production life.

3 **ETC:** Proposed uses of the CBM extracted including the consuming industry such as power generation, transport, domestic sector, etc., and the duration of CBM availability for such use.

GEECL: CBM will be used by industrial units as a cleaner and more efficient fuel. It can be used as an Automobile fuel too but cannot be used for large scale units as ramp up of production in CBM is slow. Hence, CBM caters mainly to SME's.

4 **ETC:** The price of methane gas delivered at the consumptive point in terms of US $ / Million Btu. (Btu : British thermal unit)

GEECL: This will be as per the contract at arms length free market

pricing.

5 **ETC:** Analysis on the possibility of ground water depletion in the area of exploration & production.

GEECL: As per our experience in Raniganj (South) block CBM Operation, there is no ground water depletion. DGH has also conducted a study in Bheema Gas field (Block CB-ONN-2000/2), near Surat Gujarat, where the gas reservoir is at a shallow depth (about 200 meters below the ground surface level). The study concluded that there is no change in the water level data due to extraction of oil & natural gas. Hence possibility of ground water depletion in the area of exploration and production is remote.

The Lignite seams in Mannargudi block planned to be tapped for CBM is present at a depth (minimum 400 metres to maximum of 600 metre deep), much below the source of ground water used for irrigation and drinking purpose. Water extracted from lignite seam at that depth shouldn't be cause for depletion of ground water.

6 **ETC:** Method of disposal of recycled water and the method of disposal of sludge /impurities extracted during the treatment of the water pumped out of the wells.

GEECL: As our current practice at Raniganj (South) block CBM Operation, produced water shall be utilized for own operations. The water shall be stored in onsite in a pit lined with high density polyethylene (HDPE) sheets as stipulated by MoEF.

Produced water shall be analysed as per norms of CPCB & TNPCB for various parameters stipulated for Oil & Gas Industries. In case of the result is not within permissible limits, available treatment option under guidelines of MoEF shall be adopted. Sludge / Impurities shall also be

analysed and shall be disposed to TSDF of TNPCB if exceeding the permissible limit.

7 **ETC:** What are the sources of water proposed by the company for using it during exploration/ production stages and the required quantity of water available from the proposed sources?

GEECL: Initially water shall be sourced from private tankers for core hole drilling and for pilot production well drilling. The produced water from pilot production wells shall also be used for subsequent drilling. Care shall be taken to source water from safe taluks as categorized by Central Ground Water Board.

8 **ETC:** In case of farmers getting affected due to the plan and the process, the rehabilitation proposed for them.

GEECL: The land required for each well site is only 1.5 acre approx. which will be taken on lease / purchased from the farmers. Furthermore, GEECL are not asking the Government to acquire land on its behalf and GEECL are going to lease / purchase land directly from the farmers who are willing to do so. Thus there is no question of any farmers getting affected due to the plan.

The land adjacent to CBM Operations shall not be affected at any point of time as CBM operations are confined to a small area and conditions stipulated in environmental clearance by MoEF shall be strictly complied with. Again there is no question of any farmers getting affected due to the plan.

Furthermore, we would like to highlight that in our Ranigani (south) Block, CBM produced water is being used for gardening purpose at our CBM well sites and nearby farmers are also utilizing the water for cultivation. Anyone who visits Asansol region will realize that CBM

production and agriculture are going on hand in hand and the local people have only benefited from the site developmental work that has taken place in and around the production**.**

We are doing CSR activities in the Raniganj (South) block CBM Operation. This shall be also adopted for Mannargudi CBM operations.

9 **ETC:** The quantity of the water pumped out from the depths.

GEECL: After getting permeability data from corehole study, the expected quantity of water to be pumped shall be determined.

10 **ETC:** The cost effectiveness as estimated by the company.

GEECL: The economic viability of the project shall be dependent and shall be assessed by us based on the results of corehole and pilot well production study.

11 **ETC:** The impact of pumping of large volumes of water from deeper layers on the soil structure has to be assessed.

GEECL: As mentioned in above in point (5) the study conducted by DGH concluded that no resultant subsidence is observed even when the reservoir is at very low depth (about 200 meters below the ground surface level) and at a higher withdrawal rate of gas.

The GEECL again vide its letter dated 14.8.2014 furnished reply for the questions raised by the ETC in the meeting held on 1.8.2014

12 **ETC:** It is mentioned that Ministry of Petroleum and Natural Gas, Government of India has awarded GEECL for exploration and production of coalbed methane over an area of 691 Sq.Km in Mannargudi coal block. This clearly indicates that there are two phases in the project; exploration phase and production phase. However, information given is only related

to exploration phase. Hence provide more information about production phase.

GEECL: This will be determined based on the results obtained from the Exploration / Pilot Assessment Phase. The Field Development Plan will then be approved by DGH / MoPNG

13 **ETC:** It is mentioned that during the production phase one well should be established per 80 acre of land for commercial viability. If this is the case, nearly 2133 wells will be established in the entire 691 Sq.Km area (691 Sq.Km = 69100 hectare = 170677 acres (69100 x 2.47), (170677/80 = 2133 wells). Whether GEECL is going to establish such a number of wells in the Mannargudi coal block during the production phase?.

GEECL: Number of production wells to be drilled is dependent on the outcome of the results drilled from the core wells and pilot production wells. No production planning can be quantified at this stage.

14 **ETC:** Literature indicate that 14300 litre of water will be sucked out (water production) from each CBM producing well. It means that if all the 2133 wells are established 30501900 litre of water (30501 cubic metre) will be sucked out per day.

What will be the impact of extraction of such huge volume of water per day on irrigation wells, shallow bore wells or shallow aquifers from which water is drawn for irrigation and other domestic purposes?.

GEECL: As mentioned in point 5 and 11 above there will be no impact. Furthermore, quantity of water can only be determined once wells are dewatering and not based on literature as every block had different geological settings.

15 **ETC:** Will it cause sea water intrusion in the aquifers in the deltaic area ?

If no, what is the scientific basis to say that there will not be any sea water intrusion?.

GEECL: Mannargudi CBM Block boundary is around 40km away from the sea shore hence sea water intrusion will not be there.

16 **ETC:** Produced water contains high concentration of various components as shown below, which is higher than the drinking water and irrigation water standard in India. This will be case of produced water (wastewater) both during exploratory and production phase. The disposal of this produced water will certainly degrade lands, if it is discharged on the land or degrade quality of stream water, if it is discharged in stream.

CBM Field	TDS in mg/L	Chloride in mg/L	HCO_3 in mg/L
1	11000	2300	8500
2	8900	2500	5500
3	26000	14000	5200

How the quality of the produced water is going to be improved and how disposal of produced water is going to be managed both during exploratory and production phases?.

GEECL: Produced water quality is expected to be similar to that of Neyveli Lignite Operation. Produced water will be stored on site in lined pit. This water will be reused in drilling of subsequent test well and rest of the water will be allowed to evaporate naturally.

17 **ETC:** Considering the fact that huge volume of water to be extracted and its disposal poses the greatest problem and quality of produce water makes it not even suitable for irrigation then.

GEECL: As answered for question no. 15 &16.

18 **ETC:** What is the ecological economics of this project?.

GEECL: Methane is a very powerful source of energy and eco-friendly. It is better substitute of petrol and diesel as it produces 70% less carbon monoxide, 87% less nitrogen oxides than petrol and diesel. CBM gas exploration and exploitation has an important bearing on reducing the greenhouse effect and preventing the direct emission of methane gas from operating mines to the atmosphere further. Extraction of CBM through degassing of the coal seams prior to mining of coal is cost effective means of boosting coal production and maintaining safe methane level in working mines.

GEECL vide letter dated 14.8.2014 has furnished reply for the questions raised by the ETC in the meeting held on 2.8.2014, as follows:

1 **ETC:** The unit shall re-assess the requirement of core holes for exploration purpose and reduce to less than 20 core holes in phase I, taking into consideration the habitations, historical monuments and water bodies in and around those areas.

GEECL: As per production sharing contract with Government of India, we need to do specified no. of core holes as given in the minimum work program, which was part of the bidding process. The number of core holes has been decided to get the comprehensive reservoir data throughout the licensed area to assess the potential of the block on which future production planning will be made. Hence, we are unable to reduce the no. of core holes.

2 **ETC:** The unit shall also explore the possibility of using the ONGC abandoned wells in the Mannargudi block for the exploration purpose instead of going for new core holes. They can also explore the possibility

of using the data available with ONGC.

GEECL: Conventional oil & gas exploration process for reservoir study is different from that of CBM. Hence, ONGC data will not meet our exploratory study requirement. Coal reservoir needs desorption study to understand gases present within it which can only be done by removing solid core samples from the core wells and sealing those immediately (within a matter of seconds) into a reservoir simulated canister. There is no core samples left in the ONGC's abandoned wells to carry out tests essential for CBM exploration.

Hence the wells drilled by ONGC have no use for us. The data generated by ONGC was for oil exploration which cannot be used in Coalbed Methane exploration. We are open to reviewing the data of ONGC but that will not change in any manner our work program.

3 **ETC:** The unit shall furnish social, economic and ecological profile around each proposed core holes within 2 km radius. The profile shall include distance of the habitation, temples, historical monuments, population, no. of wells (open wells, bore wells used for drinking / irrigation), groundwater table, ground water quality, land use pattern, crop cultivated, land area occupied for core hole operations, land area occupied for approach road formation, area of cultivable land to be converted for the above purpose.

GEECL: The above details within 1 km of each core hole have been already submitted with our application for consent to establish to TNPCB on 23rd July 2012, as was requested by them, and the same has been confirmed by TNPCB team.

4 **ETC:** The unit shall mention the compensation to the farmers whose lands will be acquired for core hole and to the farmers whose lands will be

affected for passage to the core hole area. The amount of compensation to restore the land back to cultivation shall also be mentioned. The unit shall also mention the amount that will be given to the farmers for production loss during the five years lease period.

GEECL: Land purchase shall be at prevailing market rate from the farmer/land owner. Restoration of land will be undertaken by us as per the conditions mentioned in the contract with Government of India. Hence, compensation for restoration of land does not arise.

5 **ETC:** The unit shall obtain and furnish data from CGWA regarding the aquifer details at different depths and the ground water profile around each core hole, by entrusting such studies through agreement. This is required to understand the impact of drilling for production purposes on the reverie aquifers at various geological levels.

GEECL: The CGWA Aquifer details at different depth and ground water profile within Mannargudi CBM Block has been given in detail in our EIA Report at section 3.12.3 at page no.80. Table 3.17 and 3.18 at page no.81 and 82 mention the hydro geological details of exploratory boreholes drilled in Project area by CGWB. As and when CGWB, Tamilnadu do any exploratory bore wells around our Core Hole/ Test Wells locations, we shall obtain the same and submit to TNPCB.

6 **ETC:** The unit shall furnish the details of the proposed safeguard measures going to be undertaken by them for the densely populated area, historical monuments and water bodies near to the core hole drilling areas.

GEECL: Distance between drill site and nearest habitation will be kept at least 100 metres as per standard practice of oil & gas industry. Exploration and Production of CBM gas is very safe due to smaller equipment size, no blow out etc. in comparison to conventional oil & gas

drilling. Safeguard measures are all undertaken as per international safety standards and industry practices and all applicable Oil Industry Safety Directorate (OISD) safety standards are complied with as notified by the Government of India.

7 **ETC:** Quantity and Quality of wastewater, solid waste generation during core hole and test well drilling operations and the method of treatment and disposal of wastes.

GEECL: The above details have been already given in our EIA Report, Table 2.7, page No.32 and table 2.11 page No.35 and also submitted with our application for consent to establish to TNPCB dt.23rd July 2012.

8 **ETC:** If the test well is successful and if it is converted as production well, what are all the impacts associated with it in terms of gas production, lowering of water table due to produce water pumping, treatment and disposal of produce water, possible contamination of wells and subsequent irrigation, risk on sea water intrusion both lateral and as well as semi vertical etc.,

GEECL: The above details have been submitted vide our letter dt.11th August 2014 at point No.5,6 and C respectively. We are restating the same as under:

Lowering of water table due to produce water pumping, possible contamination of wells and subsequent irrigation:- As per our experience in Raniganj (South) block CBM Operation, there is no ground water depletion. DGH has also conducted a study in Bheema Gas field (Block CB-ONN-2000/2), near Surat Gujarat, where the gas reservoir is at a shallow dept (about 200 meters below the ground surface level). The study concluded that there is no change in the water level data due to extraction of oil & natural gas.

Treatment and disposal of produce water:- As our current practice at Raniganj (South) block CBM Operation, produced water shall be utilized for our own operations. The water shall be stored in onsite HDPE lined disposal pit.

Risk on sea water intrusion both lateral and as well as semi vertical:- Mannargudi CBM block boundary is around 40 KM away from the sea shore hence sea water intrusion will not be there.

9 **ETC:** The approximate cost at which the gas could be delivered to the end user and the proposed applications of the gas.

GEECL: The above details have been submitted vide our letter dt.11th August, 2014 at point no.4, and 3 respectively. We are restating the same as under

CBM Price:- This will be as per the contract at arm's length free market pricing.

Proposed Use of CBM:- CBM will be used by industrial units as a cleaner and more efficient fuel. It can be used as an automobile fuel too but cannot be used for large scale units as ramp up of production in CBM is slow. Hence, CBM caters mainly to SMEs.

10 **ETC:** The unit shall work out the commercial and ecological viability of project by considering the best scenario and worst scenario of yield of CBM. What are all the costs and benefits of the project in terms of social, economical, environmental factors?.

GEECL: The above details have been already submitted in our letter dt.11th August 2014 at point No.10 and point no .E respectively. These are restated as under:

Commercial Viability:- The economic viability of the project shall be dependent and shall be assessed by us based on the results of core hole

and pilot well production study.

Ecological Viability:- Methane is a very powerful source of energy and eco-friendly. It is better substitute of Petrol and diesel as it produces 70% less carbon monoxide, 87% less nitrogen oxide than petrol and diesel. CBM gas exploration and exploitation has an important bearing on reducing the green house effect and preventing the direct emission of methane gas from operating mines to the atmosphere further.

Extraction of CBM through degassing of the coal seams prior to mining of coal is cost effective means of boosting coal production and maintaining safe methane level in working mines which reduces/eliminates the risk of explosions in coal mines while mines. Hence, CBM is not only providing an environment friendly fuel but also increases the safety when mining will take place in the future.

Also we would like to state that the ecological viability considering the best and worst scenario has been studied as presented as Environmental Impact Study for the proposed work of core hole study and test wells. The EIA/EMP Report was appraised by Impact Assessment Department, Ministry of Environment & Forest (MoEF), New Delhi and after that by Expert Appraisal Committee (MoEF) and considering all impacts, the committee recommended to MoEF for grant of environmental clearance for corehole study and test wells.

The ETC has again vide letter dated 5.9.2014 directed the GEECL to furnish additional details on the project. GEECL vide letter dated 17.9.2014 has furnished the reply as follows:

1 **ETC:** Analysis on the possibility of ground water depletion in the area of exploration and production.

GEECL: Directorate General of Hydrocarbons (DGH) has conducted a study in Bheema Gas field (Block CB-ONN-2000/2,), near Surat Gujarat, where the gas reservoir is at a shallow depth (about 200 Metres below the ground surface level). The study concluded that there is no change in the water level data due to extraction of oil & natural gas. Hence possibility of ground water depletion in that area for exploration and production is remote. The study report is available in DGH Website and enclosed the same as annexure.

The lignite seams in Mannargudi block planned to be tapped for CBM is present at a depth of (minimum 400 metres to 600 metres deep), much below the source of ground water used for irrigation and drinking purpose. Water extracted from lignite seam at that depth shouldn't be a cause for depletion of ground Water.

2 **ETC:** Method of disposal of recycled water and the method of disposal sludge / impurities extracted during the treatment of the water pumped out of the wells.

GEECL: Produced water shall be utilized for our own operations as our current practice at Ranganj (south) block CBM Operation and shall be stored in a pit lined with High Density Poly Ethylene Sheets as stipulated by Ministry of Environment and Forests, (MOEF) New Delhi.

As submitted in our EIA report, produced water shall be analysed as per norms of CPCB & TNPCB for various parameters stipulated for Oil & Gas Industries. In case the result is not within permissible limits, available treatment option under guidelines of MoEF shall be adopted. Sludge/impurities shall also be analysed and shall be disposed to TSDF of TNPCB if exceeding the permissible limit.

3 **ETC:** What are the sources of water proposed by the company for using it

during exploration / production stages and the required quantities of water available from the proposed sources?.

GEECL: Initially water shall be sourced from private tankers for core hole drilling. During pilot production well drilling, the produced water from pilot production wells shall also be used for subsequent drilling. As mentioned in our EIA report, Page 148, care shall be taken to source water from safe taluks as categorized by Central Ground Water Board from ground water perspective.

4 **ETC:** In case of farmers getting affected due to the plan and the process, the rehabilitation proposed for them.

GEECL: The land acquired for each well site is only 1.5 acres approximately which will be taken on leased/purchased from the farmers. Further, more, we are not asking the Government to acquire land on our behalf and we are going to lease /purchase land directly from the farmers who are willing to do so. Thus there is no question of any farmers getting affected due to the plan.

The land adjacent to CBM shall not be affected at any point of time as CBM operations are confined to a small area and conditions stipulated in our environmental clearance by MoEF shall be strictly complied with. Again there is no question of any farmers getting affected due to this plan.

Furthermore, we would like to highlight that in our Raniganj (south block), CBM well sites and nearby farmers are also utilizing the water for cultivation. Anyone who visits Asansol region will realize that CBM production and agriculture are going on hand in hand and the local people have only benefitted from the developmental work that has taken place in and around the production site.

5 **ETC:** The impact of pumping of large volumes of water from deeper layers on the soil structure has to be assessed.

GEECL: As mentioned above in point 1, the same study of DGH concluded that no resultant subsidence is observed even when the reservoir is at very low depth (about 200 meters below the ground surface level) and at a higher withdrawal rate of gas.

6 **ETC:** Details regarding temples, historical Monuments, No. of wells (open wells, bore wells, used for drinking / irrigation), ground water table, ground water quality, crop cultivated, land area occupied for core hole operation, land area occupied for approach road formation, area cultivable land around each proposed core holes are not furnished.

GEECL: As stated in our letter dated14.08.2014, the above details of within 1 Km of each core hole have been already submitted with our application for "Consent to Establish" to TNPCB on 23 rd July 2012.

7 **ETC:** Details regarding impacts associated with it in terms of gas production, lowering water table due to produce water pumping, treatment and disposal of produce water, possible contamination of wells and subsequent irrigation pertaining to the proposed CBM project.

GEECL: As stated in point 1 & 2 above, we reiterate that there is no lowering of water table due to produced water pumping of CBM operation. Produce water shall be utilized for our own operation and shall be analyzed. Regarding apprehension of possible contamination of wells and subsequent irrigation pertaining to the proposed CBN project, we reiterate that we are using Casing Policy that has been recommended by American Petroleum Institute & Oil Industry Safety Directorate which prevents ground water contamination. Hence the chances of possible contamination of wells and subsequent irrigation pertaining to the

proposed CBN project are remote. We would like to reiterate that the project will only help to improve the livelihood of the local people and will have positive socio economic impact as follows:

- The project is expected to create over 1000 direct and indirect employment by helping the local economy and industries.
- The project will contribute towards improving the environment in its operational area through substitution of polluting fuels with the use of clean energy.
- To encourage better community physical health and welfare, the company sponsors a number medical camps, blood donation camps, sporting activities, a community health initiatives in the Asnol region and will do the same in and around our block in Mannargudi.
- CBM is a clean and environment friendly fuel. One trillion cubic feet of CBM is enough to generate about 100 billion Kilowatt hours of electricity or fuel 12 million natural gas fire vehicles for one year.

The reply was communicated to the committee members to offer their remarks. The Committee members have furnished their remarks. With this, the committee has met on 3.3.2015 at TNPCB, Chennai. In the meeting, the Committee has gone through the unit's reply and remarks of the each member. The issue referred by the Industries Department regarding the over lapping of the areas of GEECL and ONGC was also discussed. The DEE, Nagapattinam has mentioned that there is overlapping of areas of these two units. However their operations will be at different depth. The committee members have raised query on disposal of the large quantity of effluent arising out of core hole drilling and during regular operation of the well. The committee also wants to

look into the cost-benefit analysis of the project, socio and economic impact analysis, pipe line net works for conveying the methane gas, ground water intrusion, ground water depletion, cultivable land that would be affected in the core hole drilling as well as during full production, agricultural production in the project area, ownership of the land, land subsidence due exploration of methane gas etc.

5.0 ETC's COMMENTS ON GEECL's REPLY

5.1 CBM EXPLORATION AND PRODUCTION

The Ministry of Environment and Forests have granted environmental clearance to GEECL for exploration, testing of wells and commercial exploration of Mannargudi CBM block vide F.No. J-11011/615/2010-IA II (I) dated 12th September 2012. Production sharing contract was signed with Government of India on 26th July 2010. In Phase-I 46 core holes and 2 test wells (covering both the districts) and in Phase-II 30 test wells will be drilled. The MoEF imposed various conditions interalia that no development and additional wells shall be drilled without prior permission from the Ministry.

The GEECL has applied for consent to establish for the 46 core hole and 2 test well under phase-I. It has not applied for Phase II. The actual impact on the environment will be during the production phase. The project should be looked into by taking the impact in the production phase also.

5.2 DEPTH OF WELL

The schematics of bore well and production well furnished by the unit shows, both are to be made upto a depth of 700 metres. Whether the areas where these wells are to be established are suitable in terms of geology, soil structure and formation etc has to be established. The unit has not provided information on this aspect.

5.3 QUANTITY OF METHANE GAS

It has been indicated that the estimated gas in place for Mannargudi block is 0.98 TCF by DGH and in general technical recovery over original gas in place will be around 60 %. Over 25 years of production life, the quantity of gas proposed to be extracted from all the blocks may be about 2 million cubic meters per day. This may fire about a 450 MW Power plant for 25 years. This is not substantial quantity of energy and hence it will not be mitigating the impact created by the activities proposed to be carried out.

Moreover, it is expected that by 2018 about 5 million tonnes per year capacity Liquefied Natural Gas (LNG) Import Terminal will be in operation in Ennore by a Joint Venture of Indian Oil Corporation Limited (IOCL) and TIDCO. This will be equivalent to about 18 million metric standard cubic metres per day. This regassified LNG is mostly methane, which will be distributed by IOCL through pipeline network to various parts of the state. Also there is a proposal to set up another LNG Import Terminal in the form of Floating Storage Regasification Unit (FSRU) in Nagapattinam for use by gas based utilities and plants in the vicinity of such sources. Thus the 2 million cubic meters per day availability of methane from the CBM fields in Mannargudi block will not change the natural gas (Methane) availability scenario in the state.

The company has also mentioned that the gas cannot be used for large scale unit as ramp up of production in CBM is low. Hence CBM caters mainly to Small and Medium Enterprises. This also indicates that the quantity of gas proposed to be produced would be less.

5.4 LOSS OF AGRICULTURAL PRODUCTION AND EMPLOYMENT

During the production phase the company will occupy 4266 acres of agricultural land in Cauvery delta. Normally farmers in this delta region

cultivate paddy in all three seasons of year. Considering this, the following calculation is made.

Value of Agriculture Produce		
Crop cultivate	:	Paddy (3 crops in a year)
Paddy yield per acre per season[15]	:	2.14 tonnes
Paddy yield per acre per year (Considering three crops per year)	:	2.14 t x 3 = 6.42 tonnes
Market price of paddy	:	Rs 15000/tonne
Total price of paddy production per acre per year	:	6.42 t X Rs. 15000 = Rs. 96399
Total extant of cultivable land occupied by CBM wells	:	4266 acres
Total price of paddy production in 4266 acres of land per year	:	4266 x Rs. 96399 = Rs. 41,08,15,800 = Rs. 41 crores.
Food supply to the people		
Paddy production per acre per year	:	6.42 tonnes
Total paddy production in 4266 acres of land per year		4266 x 6.42 tonnes = 27387.72 tonnes
1 tonne of paddy milled will produce[16]	:	0.76 – 0.78 tonnes of rice
Total rice production form 4266 acres of land per year	:	27387.72 tonnes x 0.76 = 20814.67 tonnes
Per capita rice consumption in India[17]	:	75.1 kg/year
Total no. of people feed from the rice produced in 4266 acres of land per year	:	20814.67÷ 0.0751 = 277159 people
Employment to Agricultural labourers		
Average Man days required for cultivation of paddy crop per acre[18]	:	41.75 days

Man days required for cultivation of paddy @ 3 crops in a year per acre	:	41.75 x 3 = 125.25 days
Man days required for cultivation of paddy @ 3 crops in a year in 4266 acres	:	125.25 x 4266 = 534316.5 days
Considering 300 working days in a year, number of persons getting employment	:	534316.5 ÷ 300 = 1781 persons.

The rice production in 4266 acres of land will feed 2.77 lakhs people for life long, where as the CBM gas produce will be equal to fire 450 MW power plant for 25 years. There will be about 1781 daily wage unskilled labourers get direct employment in agricultural activity for entire period of the year. That means 1781 families will be benefitted and their livelily hood is assured. In addition, there will be indirect employment like cattle growth, rice mills, transportation, whole sale & retail business etc. In case of CBM well, during testing phase 15-20 skilled workers will be employed in a well for period of about 15 to 20 days. At a time, about 10 test wells will be under taken in different 10 locations. Therefore about 150-200 skilled workers will be employed by the company. During the regular production phase the company will employ about 1000 skilled / semi-skilled workers. Hence the agriculture loss cannot be compensated by the CBM project.

5.5 GROUNDWATER DEPLETION

It has been reported by the unit that based on their experience in Raniganj (South) block (West Bengal) CBM operations, there will not groundwater depletion. Further the unit is relying on the DGH report. DGH conducted a study in Bheema Gas field (Block CB – ONN-2002/2) near Surat, Gujarat where the gas reservoir is at a shallow depth (about 200 metre below ground surface). The study concluded that there is no change in the water level data due to extraction of oil & natural gas. DGH has conducted study through Central Mining Research Institute (CMRI). CMRI conducted land subsidence

investigation from August 2004 to 2005 and made following conclusion and recommendation.

i. There is no any land subsidence movement following 1.6 – 4.7 kg/cm^2 pressure depletion at shallow gas reservoirs.
ii. Irregular ground movements occurred due to seasonal effect on black cotton soil in which the subsidence monitoring stations are fixed.
iii. It is recommended to monitor ground movements thrice in a year to see further effect of pressure depletion of shallow gas reservoir on the ground surface from safety point of view as five villages and roads are lying above the reservoir.
iv. It is also recommended to monitor water level in the 30 selected tube / dug wells monthly as it will give a prior indication of ground movements due to shallow gas exploitation.

CMRI has further conducted land subsidence investigation between November 2006 to November 2007 and concluded that

i. Maximum subsidence, slope, compressive & tensile strains due to 7.2 – 12.5 kg/cm^2 pressure depletion in shallow gas reservoir were 162 mm, 1.73mm/M, 1.42mm/M & 0.75 mm/M respectively.
ii. Maximum subsidence, slope, compressive & tensile strains due to 7.2 – 12.5 kg/cm^2 pressure depletion in deep gas reservoir were 37 mm, 0.78mm/M, 0.36mm/M & 0.20 mm/M respectively.
iii. There is no change in the water level data except seasonal variation.
iv. All the villages lying above the gas reservoir are safe as the magnitude of ground movements are well within the safe limits.
v. It is recommended to monitor ground water movements thrice in a year to see the further effect of pressure depletion of gas reservoirs on the ground surface for the safety aspects of villages and agricultural fields.

vi. It is also recommended to monitor water level in the 30 selected tube / dug wells monthly as it will give a prior indication of damage of sub-strata over the reservoir due to gas exploitation.

Land subsidence investigation conducted by the team of IIT Mumbai between February 2004 and May 2006 led to the following conclusion and recommendations. The report concluded that no resultant subsidence is observed even when the reservoir is at very low depth (about 200 metres below the ground surface level) and at a higher withdrawal rate of gas.

In reference to the GEECL project, ETC observed that the prime input for agriculture is water. There is no specific detail on ground water depletion and sea water intrusion (both lateral and semi vertical). Since the proposed core hole's depth is >600 meter, there is a possibility of sea water intrusion and ground water depletion. Most of the lands in the proposed area depend on filter point bore wells for cultivation of Kuruvai paddy. Hence these lands cannot be lost on the statement made by the unit.

The GEECL in its EIA Report stated that the Mannargudi Block is closely similar to the geological setting of Powder River Basin (PRB) in USA mainly in respect of large thickness of lignite, significant resource base, shallow to moderate depth of occurrence and low but notable gas content of seams. GEECL further stated that under the circumstances it is best option to consider and adopt similar geological parameters used in the Powder River Basin. Accordingly the unit states that the expected water production is $45m^3$/day/well. Considering the maximum period of 30 days for drilling a test well, the produced water generation will be $1350m^3$/well for test operations.

It is to be noted that GEECL has not commented about the generation of produced water during the production phase. According to Jack A. Stanford and F.Richard Hauer each CBM well will produce 54,500 litres per day[7].

Based on this, the daily water pumped out from the 2133 wells in the entire Mannargudi block will be 1,16,248 KL. The life period is 25 years. This will certainly lead to ground water depletion. As per the GEECL each core hole requires 1.5 to 2 acres of land. Accordingly about 4266 acres of cultivable land will be encroached for the CBM exploration field.

As per the USEPA, the information available indicates that hydraulic fracturing currently is not widely used in Powder River Basin region due to concerns about the potential for increased groundwater flow into the coalbed methane production wells and collapse of open hole wells in coal upon dewatering[4]. According to the available literature, where hydraulic fracturing has been used in this basin, it has not been an effective method for extracting methane[4]. GEECL indicates that the Mannargudi Block geology is similar to Powder River Basin. Therefore during the production stage, there are chances for groundwater flow into the CBM production wells and collapse of open hole wells.

5.5.1. Basin Geology

The GEECL in its EIA Report stated that the Mannargudi Block is closely similar to the geological setting of Powder River Basin in USA[13]. According to USEPA Report, the Powder River Basin is a thick sequence of sedimentary rock formed in a large downwarp within the Precambrian basement[4]. The thermal content of the coals found in the Powder River Basin is typically 8,300 British thermal units per pound. Coal in the Powder River Basin was formed at relatively shallow depths (450 feet – 6500 feet) and relatively low temperatures. Most of the methane generated under these conditions is biogenic, which means that it was formed by bacterial decomposition of organic matter. Thermogenic formation (formed under high temperature) was not significant in most locations within the Powder River Basin. Consequently, coal in the Powder River Basin contains less methane

per unit volume than many other coal deposits in other parts of the country. Coal in the Powder River Basin has been found to contain 30 to 40 standard cubic feet of methane per ton of coal compared to 350 standard cubic feet of methane per ton in other areas. The gas is typically more than 95 percent methane, the remainder being mostly nitrogen and carbon dioxide.

5.6 COST BENEFIT ANALYSIS

5.6.1 Domestic Natural Gas Pricing

The Ministry of Petroleum and Natural Gas, Government of India notified the Domestic Natural Gas Pricing Guidelines, 2014 on 10th January, 2014 setting out the formula for the price of domestically produced natural gas considering the recommendations of the Rangarajan Committee Report on " the Production Sharing Contract Mechanism in Petroleum Industry" (December 2012). Para 1.1of the Guidelines states that these guidelines will be applicable to all natural gas produced domestically, irrespective of the source, whether conventional, shale, CBM etc., Under Para 1.2 it is also mentioned that these guidelines shall not be applicable where prices have been fixed contractually for a certain period of time, till the end of such period. As per the Para 7, the price determined under these guidelines would be applied prospectively with effect from 1st November, 2014. According to Para 8, Director General of Petroleum Planning and Analysis Cell (DG PPAC) under the Ministry of Petroleum and Natural Gas shall notify the periodic revision of prices under these guidelines. As per the Para 11 and 13 of these guidelines, the price determined under these guidelines would be in US$/MMBTU (million British thermal unit) and would be applicable to all sectors uniformly.

As per the above guidelines, the Petroleum Planning and Analysis Cell (PPAC) vide reference No. PPAC/Gas Pricing/November 2014 – March, 2015, Dated: 26.10.2014 has fixed the price of domestic natural gas for the period

from 1st November 2014 to 31st March, 2015 as US$ 5.05 / MMBTU on Gross Calorific value basis. Similarly, PPAC has fixed the price of domestic natural gas for the period from 1st April, 2015 to 30th September, 2015 as US$ 4.66 / MMBTU on Gross Calorific value basis.

5.6.2 Value of CBM of Mannargudi Block

GEECL has indicated that the estimated gas in place in Mannargudi Block is 0.98 TCF by DGH and in general technical recovery over original gas in place is around 60% over 25 years of production life. Hence 60% of 0.98 TCF is 0.588 TCF. According to the above mentioned guidelines by Ministry of Petroleum and Natural Gas, the natural gas produced domestically, irrespective of the source, whether conventional, shale, CBM etc and also these guidelines shall not be applicable where prices have been fixed contractually for a certain period of time, till the end of such period. Since it is not known whether the price of gas has been fixed contractually for GEECL or not, the price fixed by PPAC has been adopted for the domestic gas for calculating the value of methane gas proposed to be extracted from the CBM blocks.

The price fixed by PPAC as per the New Domestic Gas Pricing Guidelines, 2014 para 8, for the period from 1st April 2015 to 30th September 2015 is US$ 4.66/MMBTU on gross calorific value basis. Since the gross calorific value of the methane gas proposed to be extracted is not known, it is assumed to be same as natural gas for calculation purpose (25.2 Standard cubic metre of natural gas will have 1MMBTU of gross caloric value)[10].

The total gas quantity expected to be extracted from CBM Block is 0.588 TCF (60% of 0.98 TCF) and the gas quantity is equivalent to 16650305796 cubic metre (1cubic metre = 35.31 cubic feet) which will have gross calorific value of 660726420.48 MMBTU and the total value of the gas

is Rs. 19,089.71 crores. (1 MMBTU = US$ 4.66, 1 US$ = Rs.62). By considering life period of the project as 25 years, the net present value is calculated using the formula NPV = $P/(1+R)^n$, where P is the total value, n is the number of years, R discount rate. R is assumed as 10%. Accordingly NPV = $19089.71/(1+0.1)^{25}$ = Rs. 1761.90 crores. The net present value of the gas is Rs. 1,761.90 crores, assuming a discount rate of 10 %. This is based on the assumption that the gas price will remain constant at US $ 4.66 / MMBTU throughout the 25 years period of production life.

However it is unlikely that the gas price will remain constant in any region of the world throughout the 25 years period of production life. Similarly, the value of US $ will be varying (either depreciate or appreciate) over a 25 years of production life period. Therefore in order to arrive at an acceptable scenario on the total value of the gas proposed to be extracted by GEECL, the gas price viz., US$ 4.66 per MMBTU is escalated applying a factor of average percentage of change calculated during 2003-2015 i.e the past 12 years. For the purpose of calculating the average change of gas prices in percentage during the above said period. US Henry Hub Gas prices are considered. Similarly in case of US$, average value of US$ vis-à-vis India rupee every year, over a period of 12 years (2003-2015) is taken and the average variation percentage is applied to the gas price thus calculated.

In the Rangarajan Committee Report (Page 21) it has been indicated that the hub price includes well head price, transportation and treatment cost from well head to trunk pipeline, transportation cost from the trunk pipeline to the respective hub etc. Since the Hub price includes costs such as well head to trunk pipelines, transportation from trunk line to respective hub, etc., the US Henry Hub gas prices assumed to be realistic for calculation of gas price that could be extracted from the CBM blocks of Mannargudi for 25 years.

The average yearly US Henry Hub gas prices from 2003 to 2013 have been taken in to account for arriving the gas price, whereas for 2014 and 2015 the price fixed by PPAC have been taken in to account. The variation in gas prices in percentage increase / decrease every year with previous year have been calculated and the average percentage of this variation is (+) 3.42 %. The source of US Henry Hub Gas Prices from 2003 to 2013 is from BP Statistical Review of World Energy June 2014 (Gas Prices).

Similarly, the average US $ rates in INR per year have been taken in to account from 2003 to 2015 and variations in percentage increase / decrease every year with the previous year have been calculated and the average percentage of such variation arrived is (+) 2.44%. Hence the gas price fixed at US$ 4.66 during the year 2015 has been escalated at the rate of 3.42% every year, similarly US $ value is escalated at the rate of 2.44% every year from 2016 to 2040 for a period of 25 years. A copy of the working sheet showing calculations on arriving the escalation percentages in Gas prices and US$ rates is given in Annexure-V.

Based on the above assumption, the total quantity of gas expected to be extracted by GEECL from the CBM blocks of Mannargudi is 0.588 TCF, which is equivalent to 660726420.48 MMBTU and this total quantity of gas would be produced over a period of 25 years. Therefore every year the gas produce would be 26429056.82 MMBTU. If the value of this quantity of gas is calculated applying the escalations arrived as per the above said method every year, then the total value of the gas would be Rs. 44,459.04 crores and the net present total value of this gas quantity would be 12,265.52 crores. The gas prices calculated are indicative and approximate values, based on various assumptions indicated above. Hence, these estimates should be treated accordingly. The domestic gas prices in future will be fixed by PPAC every 6 months.

In order to arrive the cost benefit analysis of the project, gas value as mentioned above alone does not suffice, a complete data on existing consumers, proposed growth, vehicle population, cost of alternate fuel, damage cause to the environment, socio economic impacts etc. are needed. GEECL has not done this survey. Therefore a survey is to be carried out in this regard.

5.7 SEA WATER INTRUSION

During the production phase there will be a huge quantity of gas and water will be pumped out from the coal seams at a depth of around 600 metres, over a period of 25 years. Hence there will be rick in Sea Water intrusion into the underground aquifer. GEECL stated that CBM block boundary is around 40 km away from sea shore hence sea water intrusion will not be there. The unit has not produced any scientific data. Therefore ETC sought the opinion from the State Ground Water and Surface Water Resources Data Centre, Public Works Department, Chennai (Annexure-VI). The report is reproduced as follows:

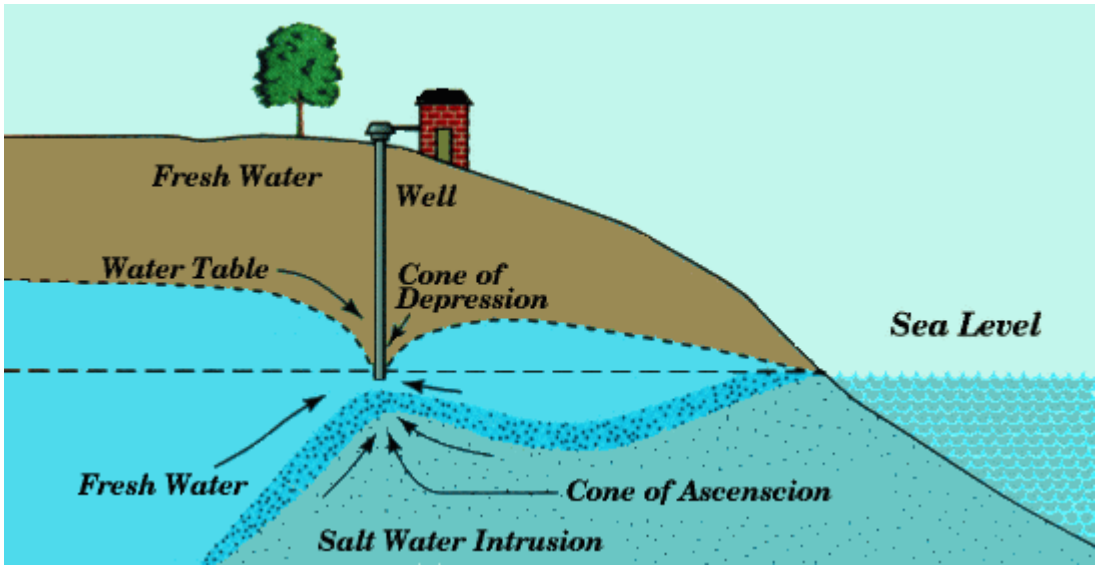

Figure 9 Picture showing sea water intrusions into pumping well

5.7.1. Location

Mannargudi block is one among 10 blocks of Thiruvarur District, which is almost centre of Cauvery deltaic region. The delta is granary of Tamilnadu. Mannargudi block is surrounded by Thiruthuraipoondi, Kottur in southern side, Thiruvarur in eastern side, Koradacherry, Needamangalam in northern side and Orathanadu, Madullur of Thanjavur district in western side. The area of Mannargudi block is 26,745 hectares. Total population in Mannargudi bock is 3,08,059.

5.7.2 Geology

The block covered by quaternary formation underlined by Pliocene and Miocene formation of tertiary age. Quaternary formation consists of sand, silt, clay, and tertiary formation consists of fine to coarse grained sand, sand stone, clay and calcarious materials. The sand has high porosity, hence the aquifers are good. The formation in the eastern side, as well as southern side of the block is deposited under marine condition hence the groundwater is generally saline below 6m in this region.

5.7.3 Hydrology

Mannargudi is the only block in Thiruvarur district has good quality and good quantity of groundwater. The average annual rainfall of the area is 1131 mm. The shallow water level in Mannargudi is 9.38 metre BGL observed on 19.01.2006 and the deepest water level is 24.87 metre BGL observed on 08.07.2014. The recharge of the groundwater is carried out by rainwater as well as surface water. The depletion of groundwater in Mannargudi block is in alarming stage due to paddy cultivation even in summer periods also. The majority of cultivation is paddy followed by Sugarcane, Cotton, Gingelly, Groundnut and Pulses.

5.7.4 General Scenario

There are 10 blocks in Thiruvarur district. As per the groundwater assessment 2009, Valangaiman, Kudavasal, Nannilam blocks are categorized as Over Exploited blocks and Koradachery, Kottur, Mannargudi and Needamangalam blocks are coming under safe category. Thiruvarur is the only bock which comes under semi critical. Both Thiruthuraipoondi and Muthupettai blocks are saline in nature. Though the Mannargudi block is in Safe category, the surrounding Thiruthuraipoondi and Muthupettai blocks are saline blocks and also adjacent Kottur block is in Safe category but the quality of groundwater is not good. Kilvelur, Keelaiyur and Thalaignayar blocks of Nagapattinam district are also present in the eastern side. These blocks are also saline blocks. In Mannargudi area, quality of groundwater is good and its Electrical conductivity value range between 560 to 610µs/cm. United Nations Development Programme had thoroughly investigated the area, which suggested that the large scale of groundwater extraction will lead to land subsidence. This in turn will make geotectonic movement. It will affect the entire delta region. There is a possibility of Sea water intrusion in the area if groundwater extraction is in large scale. The formation is deposited as layers. If any layer is disturbed by means of over exploitation, definitely it will have an impact in the area. The farmers in the area mainly depend on groundwater for the cultivation in lean months. There should be groundwater monitoring network to save the granary.

5.8 EXISTING PHYSICAL FEATURES

ETC has collected data on the existing physical features within 1 km radius of the proposed core hole sites. The data is given in Annexure VII. The data reveal that the core holes are proposed to be located nearby habitations and villages. The population of human settlement varies from 173 to 70000. There are number of historically important old temples located in the nearby

vicinity of the proposed core hole sites. The lands are cultivable lands mainly two crops and three crops per year. The extent of cultivable land in the core hole site varies from 20 hectares to 434 hectares.

Large number of irrigation wells and domestic wells are located. There are number of water bodies namely Mudikondan river, Adipuliyur river, Puttar river, Vettar river, Vennar river, Sullan river, Cholasudamani river, Pamini river, Koraiyar river, Koolaiyar river, Agamalan river, Pandavaiyar river, Kudamuruty river, Rajan vaikal, Vadku Rajan vaikal, Kottaiyur vaikal, Hanumanthapuram vaikal, Mangudi vaikal, Oorugudi vaikal, Perumalagaram vaikal, Elangargudy vaikal, Savalaikkaran vaikal, Vadaver vaikal, Puthur vaikal, Vadapathi vaikal, Thenpathi vaikal are located in the vicinity of the core hole sites.

GEECL has not carried out EIA study for the production phase. Though during the exploration & testing phase the impact is minimal, the impact will be large during the production phase. The pumping of underground water will be around 54.5 KLD from each well which will be ultimately discharged into the land or nearby water bodies. When high TDS water discharge on land and into water body it will affect the receiving system. GEECL has not properly addressed this issue. It simply says that production water will be stored on site in lined pit. This water will be used in drilling of subsequent test well and rest of the water will be allowed to evaporate naturally. The unit has not conducted the EIA study for the production phase which will have the real impact on the existing eco system.

5.8.1 Land Use Change associated with CBM Development

According to the GEECL's report, there will be 2133 No. of wells (one well for 80 acres area) in the entire Mannargudi block during the full operational phase. Therefore the associated roads, well pads, pipelines,

generating gas concentration stations and disposal ponds will leads to considerable landscape modification in the area. About 4266 acres (2acres per well) of cultivable land will be converted as activity area. Scientific literature on CBM development area shows mostly negative trends for native biota which is directly associated with increased access, noise and human contact in previously unroaded or minimally roaded areas. This will be the case for Mannargudi block also.

5.8.2 CBM Water Problem

The quality of ground water that will be pumped to the surface by CBM varies across the landscape. CBM water will have high sodium content[7]. Sodium reacts with natural clays to produce grease soil when wet and hard pan when dry, which impairs or prevent plant growth. According to literature SAR value in the Power River Basin (PRB) produced water is about 40. Since the Mannargudi block geology is similar to PRB, such water cannot be used to irrigate crops unless desalinized or substantially diluted or unless the soils are treated with a combination of gypsum and/or acid to counteract the clay-sodium interaction that causes the soil particles to disassociate and thereby changing soil structure adversely for plant growth. Direct discharge to the rivers of that much CBM water will change the chemistry of the rivers to the extent that use by native biota and farms could be impaired.

If the produced water is stored in pond for evaporation, it is expensive to build and cover a lot of space that ultimately will be useless salt pans when methane extraction is exhausted and the ponds evaporated. The pond beds will be high salt sources for decades if allowed to contact surface runoff.

6.0 ENVIRONMENTAL ISSUES PERTAINING TO CBM PROJECT IN MANNARGUDI BLOCK

Coalbed Methane (CBM) development affects land, water, wildlife and communities in many ways. It causes degradational and irreversible adverse environmental impact. Proposal for exploration and exploitation of CBM in Mannargudi Block of Cauvery Delta area comprising Thanjavur, Thiruvarur and Nagapattinam districts has created unrest and agitation among the people living in these districts and in particular Agricultural community. It may be stated that their fear and apprehension is very genuine and it is well founded by the adverse reports emerging from CBM production areas like USA, UK, Australia, Scotland, China etc. The development of CBM has met substantial resistance from Citizens and Environmental interest organizations and they brought a number of law suits against CBM operators in San Juan Basin, Raton Basin, Black Warrior Basin and Powder River basin of USA.

Fertile Cauvery Delta had been the 'Rice Bowl' of Tamil Nadu right through historical ages ensuring the 'Food Security' of the State and would continue to remain the same in future also. Priority to Food Security always outweighs Energy Security. Cauvery Delta is the life line for agriculture and it is the main livelihood for nearly about 70-80% of the population living the area. Agricultural land once polluted, degraded and its fertility is destroyed shall cause unspeakable misery to the ever growing lakhs of local population and deprive their right to live peacefully. Pollution free living is the birth right of every Citizen.

Cauvery Delta is a remarkable land where 2000 years of history and rich culture have flourished. It is a divine land of temples and birth place of carnatic music. It is the heavenly abode for tourists. Industrialization of the area would kill and bury the nicety and fineness of native people and their culture. Though methane gas by itself a clean gas for utility, the process of

exploration and extraction of CBM causes more harm to the land, water, atmosphere, bio sphere and community.

GEECL has conducted a lot of tests on prevailing air quality, water quality of surface water, and shallow bore wells water, noise pollution, wind flow direction etc. But there is no information or discussion about the EIA and EMP on pollution of air, surface and subsurface water, degradation of agricultural lands, hazards affecting bio sphere, adverse effect on historical temples, monuments etc after commencement of commercial exploitation of methane by drilling a few thousands of production bore wells. The report on environmental study of Mannargudi CBM Block submitted by GEECL is silent in this regard.

The EIA and EMP report of the GEECL lacks relevant information and data. Environmental issues relating to Mannargudi CBM block and clarifications sought are discussed below.

1. *Whether No Objection Certificate (NOC) for testing and extraction of CBM in Mannargudi Block, Tamil Nadu has been obtained from Central Ground Water Board (CGWB), Ministry of water Resources? Or from Ground Water Division of Public Works Department, If so, where is the certificate?*

   As CBM work involves drilling through a number of fresh water aquifer zones and continuous dewatering during CBM extraction it is mandatory to obtain the clearance from CGWB which is the premier Agency of the country, monitoring the groundwater potential, extraction, recharge, saline water intrusion etc at National level (or) NOC from Ground Water Division of Public Works Department. GEECL has not obtained the same.

2. *Scanty Ground water bore wells data discussed in the EIA report does not represent hydro geological history of the CBM Block. Locations of these bore wells are also not shown in the CBM block map.*

   Data input on ground water details like type, thickness of fresh water aquifers, discharge, drawdown and complete chemical analysis of water for aquifer zones of depths 100-300m, 300-500m (up to the top of lignite) and > 500m is very meager. Only four CGWB drilled deep boreholes data is given in the report for a total area of 667sq.km. Similarly the Ground water data of TWAD Board bore wells given in the report does not contain necessary and complete information.

3. *Water analyses data alone does not throw light on the hydrological parameters of the shallow aquifers in the CBM block.*

   A lot of water samples from shallow bore wells have been collected by GEECL in the CBM Block and analysed for chemical composition but no data on the depth of the bore wells, discharge rate, draw down has been collected. These data are very important and relevant for proper interpretation of hydrology of shallow aquifers of the area.

4. *Trace element data and isotopic composition of ground water finds no mention in the EIA report.*

   These data are very important for understanding the status of contamination of aquifer and associated water and their impact.

5. *Trace element data of lignite beds of Mannargudi CBM block is not included and discussed in the report.*

   Coal and Lignite consists of harmful trace elements like arsenic, mercury, lead, cadmium, molybdenum, selenium, chromium and zinc besides, occasional presence of radioactive elements too. These

elements are likely to contaminate the produced water. Lignite mining and exploring agencies normally carryout these study.

6. *Implications of drinking water contaminated with trace elements on human health animals and plant life are omitted in the GEECL report.*

Water produced from aquifers containing carbonaceous material and trace elements have been linked or suspected to be linked to diseases like Goitre, Patterns of multiple scelerosis occurrence, Balken endemic nephropathy, urotheial cancer and high cancer mortality rates.

7. *There is no mention or discussion about the possible leakage of methane into the adjoining fresh water aquifers because of fracturing of lignite for extraction of methane gas.*

Geological set up in Mannargudi block is such that the thick fresh water aquifers are directly occurring both at the top and bottom of lignite beds. Besides that smaller aquifers consisting of sandstone, siltstone and silty clay beds also occur in between the multiple lignite seams as parting lithology. Therefore, methane and associated gases like nitrous oxide, sulphur di oxide, carbon di oxide and some hydrocarbons are likely to seep into the adjoining aquifers and contaminate the water because of induced fractures for extraction of methane gas. Moreover, produced water with these partially dissolved gases is likely to pollute the surface and drinking water too. Reports from public domain indicate that 6% wells leak immediately and 50% of all gas wells leak within 15 years. Minor leakage of methane gas is also reported after abandonment of the gas well.

8. *Quantum of produced water (45cubic metre per day or 45,000 litres/day) projected based on the Powder River Basin Geological setup*

needs re-evaluation. No mention about treatment of water to improve the quality of polluted produced water before disposal by any method.

Lignite beds of Mannargudi block consists of high amount (48% to 58%) of moisture content compared to 18% to 28% of moisture in the sub bituminous coal of Powder River Basin. Moreover, the aquifers saturated with water are closely linked to the lignite beds both at the top and bottom in Mannargudi CBM block. The lignite beds are more likely to draw water from the adjoining aquifers during dewatering process and hence the possibility of enhanced produced water. Plan for disposal of produced water through evaporation is a criminal waste of precious National resource. Disposal by other methods should be preceded by treatment of water.

9. *A large quantity of produced water (more than 45,000 litres/day) is expected during methane production in Mannargudi CBM block as is recorded in Neyveli Lignite Block.*

   Upward water pressure of 6 to 8kg/sq.cm is recorded in the Neyveli Lignite Mine which is located north of Mannargudi CBM block. About 30,000 GPM or so is continuously pumped out through bore wells (<150m depth) round the clock to reduce water pressure and avoid bursting of lignite bed and flooding of mine due to high water pressure. Since the geological set up of Mannargudi and Neyveli Lignite blocks are same, upward water pressure and quantum of water discharge is also expected to be similar.

10. *There is an imminent danger of lowering of water table and as well as complete depletion of precious resource of ground water over a period due to continuous pumping of produced water while extraction of methane gas in the whole of Mannargudi CBM block.*

People of Cauvery delta are depending more and more on the ground water resource only for agriculture and living, in view of the long term failure of monsoon and insufficient water flow in the Cauvery river. Under the circumstances, large scale continuous pumping of water would quickly deplete the water resource and lower the water table to very deeper level.

A recent report by CGWB on the National Water Resource, reports that more than 60% of water bore wells have recorded considerable lowering of water table depth in many states including Tamil Nadu. The report also says that people of Tamil Nadu are depending more on ground water resource and hence the water table level has been lowered to greater depths.

11. *There is no mention/projection about the spacing parameter for production bore wells and total number of production bore wells planned for drilling after completion of core holes and test holes.*

Since the Geological setup of Mannargudi CBM block is compared to Powder River Basin by the GEECL it is presumed and extrapolated that at least 3000 to 4000 production wells are likely to be drilled in the CBM block. In such circumstances one cannot imagine the development of bore well jungle interconnected with a maze of criss-crossing network of gas and waste water pipelines and fire spewing gas pipe vents amidst the beautiful and evergreen agricultural land traversed by streams, rivers and water bodies.

12. *Problems and redress of air pollution and flaring of gas are to be dealt in detail.*

Methane, hydrogen sulfide, nitrogen oxides and other aromatic hydrocarbons are emitted from sites. Further emissions of methane and

airborne pollutants occur, as the gas is processed and pressurized in temporary structures. Flare stacks burn off unwanted gasses and cause noise and light pollution and more toxic emissions.

13. *Disturbance to Vadavur Bird Sanctuary due to air and noise pollution and flaring of gas.*

Vadavur Bird Sanctuary located within the southwest part of Mannargudi CBM block would be severely affected by noise pollution due to continuous operation of drill machines, compressors, production of methane gas, movement of heavy vehicles and machineries etc. Flaring of gas at production well sites and gas processing area would raise the atmospheric temperature in the surrounding area and toxicity of air.

Air current flow towards west to south westerly direction as recorded in the GEECL report would carry the atmospheric heat and toxicity towards Vadavur Bird Sanctuary which in due course may force the birds to abandon the sanctuary and migrate elsewhere.

14. *Drilling of 50 core wells and two test wells would cause immense damage to the drill site, adjoining cultivable lands and access road area to the drill site, fertile humus rich soils on the surface and water aquifer due to circulation of mud chemicals, left over steel pipes in the core wells etc despite a few remedial measures outlined by GEECL.*

All core wells and test wells are located in the interior parts of agricultural land. A large part of the cultivable land would be affected by drilling mud pit, evaporation pit, spillage of oil used for drilling and the rock cuttings coming out of the bore wells during drilling. Younger Tertiary age rock formation of Mannargudi block is very soft, unconsolidated and loosely packed and therefore a large quantity of

bentonite mud, mud chemicals like sodium silicate, soda ash, caustic soda, polymers etc would be essential for drilling and use of these chemicals would pollute the water aquifers and surface waters too if it flows to the adjacent fields.

15. *Subsurface pollution due to abandonment of steel drill pipes, concrete structures etc in the core wells and production wells.*

A few thousands of gas wells drilled can never be removed or recycled once its gas production capacity ceases. The steel, concrete structures and the chemicals used for drilling plunged deep in to the subsurface will decay slowly over a period of time constantly causing subsurface pollution.

16. *Danger due to gas pipelines to collection and processing centres.*

Ultimately when the production of methane gas commences, all the Gas wells would be interconnected by a tens or hundreds of kilometer long network of steel pipe lines through/across agricultural lands and populated villages to transport methane gas to collection and gas processing centres and also to transport waste water for either disposal or treatment centres. There is always a lurking danger of possible gas fire and explosion of gas pipes inflicting severe damage and loss to life and property.

17. *Corporate profit versus community cost*

Since Mannargudi CBM block falls within the fertile agricultural belt of Cauvery delta, the entry of CBM production industry would ring a death knell to the peaceful life of large native population and agricultural community as the impact and dangers are acute. However, the rewards of profit go to the elite shareholders, directors and investors.

7.0 OVER LAPPING OF GEECL AREA WITH ONGC AREA

The Government in Industries Department vide Letter No. 414/MMA.1/2013-7 dated 10.11.2014, has requested ETC to look into the issue on over lapping of the areas of GEECL and ONGC. In this connection the TNPCB sought a report from the Assistant Director, Geology and Mining, Nagapattinam & Thiruvarur. The Assistant Director vide letter No. RC. 17/(G&M)/2013 dated 26.12.2014 (Annexure – VIII) reported as follows:

The ED Basin Manager, Cauvery Basin, ONGC, Chennai had requested to grant Petroleum Mining Lease (PML) in respect of L-II PML for an area of 824.30 Sq.Kms. in Thiruvarur District for 7 years with effect from the date of grant of Petroleum Mining Lease. On knowing the fact the GEECL have given objections through their letter dated 07-03-2013 addressed to the Assistant Director of Geology and Mining, Nagapattinam / Thiruvarur stating that the mining lease applied by ONGC should not be entertained and should be summarily rejected, as it is contrary to the CBM contract signed with Ministry of Petroleum and Natural Gas and Environmental Clearance issued to them by the competent authorities. In view of the objects, remarks were called for from the ONGC.

The ED Basin Manager, Cauvery Basin, ONGC, Chennai vide letter No. SS/ED-BM, Cau./LI&II/2013, Dated: 08-07-2013 addressed to the District Collector Thiruvarur has stated that Cauvery basin is a very prospective basin and ONGC is having two nomination blocks viz., L-I and L-II since 01-04-1986 and the current Petroleum Exploration Licenses (PELs) valid upto March 2013 and now they have been converted to PMLs with validity upto 2019. ONGC’s intensive exploration efforts in these PEL blocks have resulted in many discoveries with resultant conversion of the part areas to PMLs and production activities. The overlapping area also encompasses four ONGC operated PMLs viz., Mattur, Kuthalam, Kuthalam-13 and Kuthanallur, which

have production and transportation facilities and are currently on production. It is to be noted that ONGC has duly paid the stipulated levies for licenses as well as for leases, in compliance of the P&NG rules.

In view of the prospectivity and highly encouraging results obtained in these two PEL blocks in the recent past, ONGC has proposed to convert the entire existing PEL areas to PMLs for a limited period of seven years, to execute its intended drilling programme, appraise discovery/leads and complete the assessment of these areas to establish envisaged accretion of around 100 MMt (O+OEG).

It is in the knowledge of MoPNG and DGH that part areas of L-I and L-II PMLs in Cauvery on land basin are overlapping with block MG-CBM-2008/4 which was awarded under CBM round IV in the year 2010 to GEECL with an area of 667 Sq.Km in the State of Tamil Nadu, of this, 27.70 Sq.Km and 266.02 Sq. Km overlap with L-I and L-II nomination PEL blocks (now PML blocks) respectively. The issue of overlapping was discussed in meetings organized by DGH and ONGC in which ONGC and GEECL had participated.

Subsequently after considering that ONGC was awarded the blocks in 1986 much earlier than that of the CBM block awarded to GEECL and the fact that ONGC is pursuing active exploration in the area along with hydrocarbon production, MoPNG has granted PML for an area measuring 1542.02 Sq. Km. in L-II block to ONGC in the national interest on 08-02-2013. In view of the above clarification provided, ONGC requested the District Collector, Thiruvarur to grant PML for an area of 1542.02 Sq.Km in L-II block to ONGC so that ONGC's activities are not jeopardized. In this connection a report has been sent to the Government in Industries Department, through the Commissioner of Geology and Mining, Guindy Chennai by the District Collector, Thiruvarur vide R.C. No. 17/G&M/2013 dated 22.02.2014.

In the above issue, ETC observed that out of 667 Sq.Km area awarded to GEECL 293.72 Sq.Km (27.70 + 266.02) area overlap with ONGC area. The depth of ONGC well is about 3000 metres where as GEECL well depth is about 600 metres. ONGC well operation differs from GEECL's CBM well operation.

8.0 RECOMMENDATIONS

The Expert Technical Committee has gone into the matter *de novo* from all angles, including the environmental stand point and the risk of sea water intrusion, livelihood and food security issues as well as the need to develop clean energy resources. The ETC made the following recommendations.

1. The unit has carried out EIA study for the CBM exploration (i.e) in phase I – 46 core holes and 2 test wells and in phase II – 30 test wells. MoEF have accorded environmental clearance for this activity only. The EIA study lacks of number of vital information on the hydro geological history of the block, trace element data and isotopic composition of groundwater, trace element data of lignite beds, possible leakage of methane gas in the aquifers etc. Hence a detailed EIA study is required covering all the missing data. Further the project need to be examined by taking into consideration of impacts up to the production phase. Therefore the Environmental Impact Assessment & Environmental Management Plan shall be done for both the Exploration and Production Phase, de novo.

2. As per the EIA report available, during the production phase there will be around 2133 numbers of production well, which will pump on an average 95985 KLD (45 KLD/Well) of water from the coal seams. This will take place for the entire life period of 25 years on a daily basis. This will ultimately have a negative impact on the ground water table.

The company has not produced the approval of Central Ground Water Authority / State Public Works Department which is the competent authority to report on such a large scale pumping of groundwater and its impact on the basin.

3. United Nations Development Programme had investigated the area, and suggested that the large scale of groundwater extraction will lead to land subsidence. This in turn will make geotectonic movement. It will affect the entire delta region. There is a possibility of Sea water intrusion in the area if groundwater extraction is in such a large scale. The geological formation is deposited as layers. If any layer is disturbed by means of over exploitation, it will definitely have an impact in the entire area. The farmers in the area mainly depend on groundwater for their cultivation in lean months.

4. The Geological set up in Mannargudi block is such that the thick fresh water aquifers are directly occurring both at the top and bottom of lignite beds. Besides that smaller aquifers consisting of sandstone, siltstone and silty clay beds also occur in between the multiple lignite seams as parting lithology. Therefore, methane and associated gases like nitrous oxide, sulphur di oxide, carbon di oxide and some hydrocarbons are likely to seep into the adjoining aquifers and contaminate the water because of induced fractures for extraction of methane gas. Moreover, produced water with these partially dissolved gases is likely to pollute the surface and drinking water too.

5. Upward water pressure of 6 to 8kg/sq.cm is recorded in the Neyveli Lignite Mine which is located north of Mannargudi CBM block. About 30,000 Gallon Per Minute of water or so is continuously pumped out through bore wells (<150m depth) round the clock to reduce water pressure and avoid bursting of lignite bed and flooding of mine due to

high water pressure . Since the geological set up of Mannargudi and Neyveli Lignite blocks are same, upward water pressure and quantum of water discharge is also expected to be similar.

6. People residing in the Cauvery delta are depending more and more on the ground water resource only agriculture and livelihood requirements, in view of the frequent failures of monsoon and insufficient receipt of water flow in the Cauvery River. Under the circumstances, large scale continuous pumping of water would quickly deplete the water resource and lower the water table to deeper levels.

7. Since the Geological setup of Mannargudi CBM block is compared to Powder River Basin by the GEECL it is presumed and extrapolated that at least 2100 production wells are likely to be drilled in the CBM block. In such circumstances there will be the development of bore well jungle interconnected with a maze of criss-crossing network of gas and waste water pipelines and fire spewing gas pipe vents amidst the beautiful and evergreen agricultural land traversed by streams, rivers and water bodies. The entire environment of this region will change the natural conditions now existing.

8. There are chances for emission of methane, hydrogen sulfide, nitrogen oxides and other aromatic hydrocarbons from CBM well sites. Further there are chances of emissions of methane and airborne pollutants from gas processing and pressurizing plant. Flare stacks will burn off unwanted gasses and cause noise and light pollution and more toxic emissions and also atmospheric thermal inversion will take place thereby causing reduction in rainfall.

9. Vadavur Bird Sanctuary located within the southwest part of Mannargudi CBM Block may be affected by noise pollution due to

continuous operation of drill machines, compressors, production of methane gas, movement of heavy vehicles and machineries etc. Flaring of gas at production well sites and gas processing area would raise the atmospheric temperature in the surrounding area and toxicity of air. Air current flow towards west to south westerly direction as recorded in the GEECL report would carry the atmospheric heat and toxicity towards Vadavur Bird Sanctuary which in due course may force the birds to abandon the Sanctuary and migrate elsewhere.

10. A few thousands of gas wells drilled can never be removed or recycled once its gas production capacity ceases. The steel, concrete structures and the chemicals used for drilling plunged deep into the subsurface will decay slowly over a period of time constantly causing subsurface pollution.

11. Ultimately when the production of methane gas commences, all the Gas wells would be interconnected by hundreds of kilometer long network of steel pipe lines crisscrossing agricultural lands and populated villages to transport methane gas to collection and gas processing centres and also to transport waste water for either disposal or treatment centres. There is always a lurking danger of possible gas fire and explosion of gas pipelines inflicting severe damage to loss of life, property and ecology.

12. Mannargudi CBM Block falls within the fertile agricultural belt of Cauvery Delta, the entry of CBM production industry would ring a death knell to the peaceful life of the large native population and agricultural community as the impact and dangers are acute.

13. Over 25 years of production life, the quantity of gas proposed to be extracted from all the CBM blocks may be about 2 million cubic meters

per day. This may fire about a 450 MW Power plant for 25 years. This is not substantial quantity of energy and hence it will not be mitigating the impact created by the activities proposed to be carried out.

14. The rice production in 4266 acres of land will feed 2.77 lakhs people for life long. About 1800 daily wage unskilled labourers will get direct employment in agricultural activity for entire period of the year. In addition, there will be indirect employment like cattle growth, rice mills, transportation, whole sale & retail business etc. Whereas in CBM production phase about 1000 skilled / semi skilled workers will be employed by the company.

15. In order to arrive the cost benefit analysis of the project, gas value as well as, a complete data on existing consumers, proposed growth, vehicle population, cost of alternate fuel, damage caused to the environment, socio economic impacts etc. are needed. GEECL has not done this survey. Therefore a survey needs to be carried out in this regard through appropriate consultant.

16. Out of 667 Sq.Km area awarded to GEECL 293.72 Sq.Km (27.70 + 266.02) area overlap with ONGC area.

17. The State Government vide G.O. (3D) No.1 Industries (MMA1) Department dated 1.1.2011 has issued petroleum exploration licence to GEECL for exploration and production of coalbed methane in Mannargudi Block. This licence is for a period of 4 years. This licence expired on 31.12.2014.

The EIA study report submitted by GEECL has covered only the exploration phase. The EIA study has not covered the entire project activities. The impact on environment during the production phase and the impact after the closure of wells are not covered. The project should be evaluated

holistically. In view of the above the Expert Technical Committee recommends that the Government may either reject or review the project by considering the implication as mentioned in this report.

9.0 CONCLUSION

Cauvery Delta Region is the Rice bowl of Tamil Nadu. The livelihood of the people in the region is agriculture. The proposed CBM projects will occupy about 4266 acres of cultivable land and pump out groundwater in the order of 1,00,000 Kilo litres on a daily basis for the entire life period of 25 years. This will lead to ground water depletion and possible seawater intrusion. The disposal of produced water will be a threat to the receiving environment. Criss-cross gas pipeline network covering an area of 667sq.km will also pose a hazard to the environment. Flaring of off gases will pollute the air. Though CBM is a clean energy resource, the benefits proposed to be received from this CBM project is insignificant when compared with the above losses both spatially and temporally. The People of the region seriously object to the proposed CBM project. The Expert Technical Committee does not see any significant cost benefit on account of the project considering the impact it has on an Environmentally fragile and fertile region. The Cauvery delta is a historic reservoir of fresh water source serving millions of people in the State over the millennia. Hence the Government of Tamil Nadu may take an appropriate decision on the need for this project in view of the adverse impact on the fresh water resource and the ecology of the area.

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ANNEXURE - I

F. No. J-11011/615/2010- IA II (I)
Government of India
Ministry of Environment and Forests
(I.A. Division)

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Dated 12th September, 2012

To,

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14th Floor, Signature Tower "A"
South City, N.H.-8, Gurgaon-122 001, Haryana

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Subject: **Exploration, Testing of wells and Commercial Exploration of Mannargudi CBM Block, MG-CBM-2008/IV, in District Thiruvarur & Thanjavur, Tamil Nadu by M/s Great Eastern Energy Corporation Ltd. (GEECL) – Environment clearance reg.**

Ref. : **Your letter no. GEECL/ EC/MG/03 dated 28th February, 2012.**

Sir,

This has reference to your letter dated 28th February, 2012 on the above mentioned subject alongwith project documents including Prefeasibility Report, Draft Terms of References, EIA/EMP, Public Hearing Reports and subsequent communication vide letter dated 27th July, 2012 on the above mentioned subject.

2.0 The Ministry of Environment & Forests has examined your application. It is noted that the proposal is for exploration, testing of wells and commercial exploration of Mannargudi coal bed methane (CBM) Block, MG-CBM-2008/IV, in District Thiruvarur & Thanjavur, Tamil Nadu by M/s Great Eastern Energy Corporation Ltd. (GEECL). Production sharing contract (PSC) was signed with Govt. of India on 26th July 2010. In phase-I, 46 core holes and 2 test wells (covering both the districts) and in phase II, 30 test wells will be drilled. Total block area of Mannargudi is 691 sq. km whilst effective area for CBM activity is 667 sq. km. Drilling will be carried out upto 600 m depth. Project cost is USD 20 million. Vadavur Bird Sanctuary exists within the CBM Blocks. Co-ordinates of CBM block MG-CBM-2008/IV are as given below:

S. N.	Latitude (E)			Longitude (N)		
	Deg.	Min.	Sec.	Deg.	Min.	Sec.
A	79	31	350	11	5	283
B	79	31	290	11	4	307
C	79	30	149	11	2	627
D	79	30	072	10	59	730

E	79	29	964	10	59	218
F	79	29	926	10	58	404
G	79	29	490	10	57	183
H	79	31	301	10	54	477
I	79	31	668	10	50	642
J	79	29	685	10	45	323
K	79	29	521	10	43	671
L	79	30	216	10	39	083
M	79	29	600	10	38	436
N	79	29	586	10	37	394
O	79	29	167	10	36	233
P	79	28	817	10	34	600
Q	79	27	000	10	33	983
R	79	26	366	10	33	302
S	79	25	759	10	40	492
T	79	19	202	10	39	950
U	79	19	321	10	38	559
V	79	17	517	10	37	017
W	79	17	433	10	35	500
X	79	16	167	10	35	483
Y	79	16	333	10	36	767
Z	79	15	767	10	37	567
AA	79	16	483	10	38	383
AB	79	16	467	10	40	450
AC	79	17	183	10	41	233
AD	79	16	767	10	44	267
AE	79	18	750	10	47	067

AF	79	20	300	10	47	750
AG	79	21	783	10	49	267
AH	79	23	167	10	48	633
AI	79	22	633	10	50	083
AJ	79	24	050	10	52	517
AK	79	24	467	10	54	700
AL	79	26	800	10	56	167
AM	79	27	183	10	58	233
AN	79	28	317	11	0	150
AO	79	28	967	11	2	617
AP	79	29	533	11	3	717
AQ	79	29	733	11	4	933
AR	79	31	350	11	5	283

List of core hole locations is given below:

Core Hole No.	Latitude (N)	Longitude (E)	Location Details
Thiruvarur District			
CH-5	10°53'31.68"N	79°30'23.10"E	Sithadi Village, Kudavasal Taluk
CH-6	10°51'56.64"N	79°28'26.58"E	Kudavasal, Kudavasal Taluk
CH-7	10°51'10.08"N	79°27'14.16"E	Melapalaiyur village, Kudavasal Taluk
CH-8	10°50'59.10"N	79°29'39.36"E	Maluvachery , Kudavasal Taluk
CH-9	10°50'21.06"N	79°28'41.94"E	Ohai Village, Kudavasal Taluk
CH-10	10°48'45.36"N	79°28'58.74"E	Keelapaliyur Village, Kudavasal Taluk
CH-11	10°48'53.70"N	79°27'16.02"E	Saranatham Village, Valangiman Taluk
CH-12	10°48'10.86"N	79°25'52.56"E	Manickamangalam Village, Valangiman Taluk
CH-13	10°47'15.18"N	79°26'57.84"E	Kamukakudi Village, Kudavasal Taluk
CH-14	10°47'11.88"N	79°29'9.42"E	Pathur Village, Kudavasal Taluk
CH-15	10°46'40.74"N	79°25'16.38"E	Kottaiyur Village, Valangiman Taluk
CH-16	10°45'56.58"N	79°26'24.24"E	Hanumanthapuram Village, Needamangalam Taluk
CH-17	10°46'3.42"N	79°28'48.72"E	Koradacheri Village, Kudavasal Taluk
CH-18	10°44'33.78"N	79°25'15.54"E	Poovanur Village, Needamangalam Taluk
CH-19	10°44'8.76"N	79°27'59.52"E	Keelalavandhacheri Village (Thondilam), Needamangalam Taluk
CH-20	10°41'58.50"N	79°27'39.84"E	Karnavur Village, Manargudi Taluk
CH-21	10°37'10.02"N	79°27'50.16"E	Vadapathi Village, Manargudi Taluk
CH-22	10°38'15.72"N	79°27'59.52"E	Serankulam Village Manargudi Taluk

CH-23	10°39'47.34"N	79°28'1.02"E	Manargudi, Manargudi Taluk
CH-24	10°40'58.74"N	79°28'10.02"E	Aravathur Village, Manargudi Taluk
CH-25	10°41'50.22"N	79°28'57.00"E	Savala Karan Village, Manargudi Taluk
CH-26	10°43'9.60"N	79°28'54.30"E	Arichapuram village, Needamangalam Taluk
CH-27	10°44'58.26"N	79°29'10.26"E	Hanumanthapuram Village, Needamangalam Taluk
CH-28	10°48'20.04"N	79°29'49.98"E	Arpar village, Kudavasal Taluk
CH-29	10°49'59.64"N	79°30'7.50"E	Manjakudi village, Kudavasal Taluk
CH-30	10°51'59.04"N	79°30'21.12"E	Vadaver village, Kudavasal Taluk
CH-38	10°52'4.98"N	79°26'22.02"E	Kil Vadayal village, Valangiman Taluk
CH-39	10°49'22.62"N	79°25'39.54"E	Rajendranallur village , Valangiman Taluk
CH-40	10°47'56.70"N	79°24'27.18"E	Narthangudi village, Valangiman Taluk
CH-41	10°47'10.20"N	79°22'13.14"E	Koilvenni village, Needamangalam taluk
CH-42	10°46'21.18"N	79°23'7.14"E	Adhanur village, Needamangalam Taluk
CH-43	10°43'50.82"N	79°19'49.56"E	Moovarkottai village, Manargudi Taluk
CH-44	10°50'1.08"N	79°27'0.00"E	Kandiyur village, Valangiman Taluk
CH-46	10°48'29.88"N	79°28'0.06"E	Sellur Village, Kudavasal Taluk
CH-47	10°42'0.18"N	79°23'59.88"E	Paruthi Kottai Village, Manargudi Taluk
CH-48	10°43'39.96"N	79°26'30.06"E	Annavasal Village, Needamangalam Taluk
CH-49	10°43'37.86"N	79°24'40.92"E	Kalanjimedu village, Manargudi Taluk
CH-50	10°45'2.22"N	79°23'30.06"E	Kalacheri village, Needamangalam Taluk
Thanjavur District			
CH-1	10°54'26.58"N	79°28'2.40"E	Kothangudi Village, Kumbakonam Taluk
CH-2	10°54'6.54"N	79°29'50.58"E	Perappadi Village, Kumbakonam Taluk
CH-3	10°54'5.82"N	79°28'49.92"E	Vanduvancheri Village, Kumbakonam Taluk
CH-4	10°53'0.48"N	79°27'30.12"E	Thirucherai Village, Kumbakonam Taluk
CH-31	10°56'5.10"N	79°29'20.22"E	Thukkatchi village, Kumbakonam Taluk
CH-32	10°57'48.06"N	79°28'59.70"E	Amangudi village, Kumbakonam Taluk
CH-33	10°58'50.16"N	79°28'51.36"E	Vittalur village, Kumbakonam Taluk
CH-34	10°59'58.62"N	79°29'40.20"E	Manjamali village, Tiruvidaimarudur Taluk
CH-35	11° 1'41.64"N	79°29'51.42"E	Narasingampettai, Tiruvidaimarudur Taluk
CH-36	10°55'49.92"N	79°28'10.50"E	Kumaramangalam village, Kumbakonam Taluk
CH-37	10°54'49.08"N	79°26'59.04"E	Natchiarkoil village, Kumbakonam Taluk

CH-45	10°40'8.76"N	79°18'36.90"E	Kulamnagalam village, Orathanad Taluk

3.0 Stack of adequate height will be provided to D.G. sets. Produced gas will be flared/utilized at the well site during testing. Water based mud system will be used to drill each exploratory well. Total water requirement for core hole and test wells from ground water source will be 11 and 56 m^3/day respectively. During well drilling, wastewater will be segregated into waste drilling fluid and drill cuttings. Drill cutting will be stored onsite impervious HDPE lined pit for solar evaporation and drying. Effluent will be properly treated and treated effluent will conform to CPCB standards. The produced water will be stored onsite HDPE lined pit and reused in drilling of new wells and fire hydrant system. Drill cuttings will be stored in HDPE lined pits, treated and disposed in accordance with CPCB guidelines. Waste oil/used oil will be sent to authorized re-processors.

4.0 Off-shore and on-shore oil and gas exploration, development & production are listed at S.N. 1 (b) under category 'A' and appraised at Central level.

5.0 The proposal was considered by the Expert Appraisal Committee (Industry-2) in its 20th and 36th Meetings held during 3rd–4th March, 2011 and 11th–12th June, 2012 respectively.

6.0 Public hearing/public consultation meetings were held on 29th December, 2012 and 23rd January, 2012 for Thanjavur and Thiruvarur Districts respectively.

7.0 The Ministry of Environment and Forests hereby accords environmental clearance to the above project under the provisions of EIA Notification dated 14th September, 2006 subject to strict compliance of the following specific and general conditions:

A. SPECIFIC CONDITIONS :

i. As proposed, In phase I only drilling of 46 core holes and 2 test wells (covering both the districts) shall be drilled. In phase II, drilling of 30 test wells including 2 test wells drilled in phase-I shall be drilled. No development and additional wells shall be drilled without prior permission from this Ministry.

ii. As proposed, no forest land shall be used for the proposed facilities/ activities.

iii. As proposed, Unit shall not drill any wells lying at a distance less than 10 Km of the Vadavur Bird Sanctuary. Therefore core well nos. CH-43, CH-45, CH-47 and CH-50 located within 10 Km from the Bird Sanctuary shall not be drilled.

iv. Compensation for the land acquisition to the land oustees, if any, and also for standing crop shall be paid as per the National Resettlement and Rehabilitation Policy (NRRP) 2007 or State Government norms. It may be ensured that compensation provided shall not be less than the norms of the NRRP, 2007.

v. The surface facilities shall be installed as per the applicable codes and standards, international practices and applicable local regulations.

vi. Ambient air quality shall be monitored near the closest human settlements as per the National Ambient Air Quality Emission Standards (NAAQES) issued by the Ministry vide G.S.R. No. 826(E) dated 16th November, 2009 for PM_{10}, $PM_{2.5}$, SO_2, NO_X, CO, CH_4, VOCs, HC, Non-methane HC etc. Efforts shall be made to improve the ambient air quality of the area.

vii. Mercury shall also be analyzed in air, water and drill cuttings twice during drilling period.

viii. The flare system shall be designed as per good oil field practices and Oil Industry Safety Directorate (OISD) guidelines. The company shall take necessary measures to prevent fire hazards and soil remediation as needed. At the place of ground flaring, the flare pit shall be lined with refractory bricks and efficient burning system. In case of overhead flare stacks, the stack height shall be provided as per the regulatory requirements and emissions from stacks shall meet the MOEF/CPCB guidelines.

ix. The company shall make the arrangement for control of noise from the drilling activity and DG sets by providing necessary mitigation measures such as proper acoustic enclosures to DG sets and meet the norms notified by the MoEF. Height of all the stacks/vents shall be as per the CPCB guidelines.

x. The company shall comply with the guidelines for disposal of solid waste, drill cutting and drilling fluids for onshore drilling operation notified vide GSR. 546(E) dated 30th August, 2005.

xi. Total fresh water requirement for core hole and test wells from ground water source shall not exceed 11 and 56 m^3/day respectively and prior permission shall be obtained from the concerned Authority and a copy submitted to the Ministry's Regional Office at Bangalore.

xii. During well drilling, wastewater shall be segregated into waste drilling fluid and drill cuttings. Drill cutting shall be stored onsite impervious HDPE lined pit for solar evaporation and drying. Effluent shall be properly treated and treated effluent shall conform to CPCB standards. The produced water shall be stored onsite HDPE lined pit for solar evaporation and reuse in drilling of new wells and fire hydrant system. Domestic effluent shall be disposed off through septic tank followed by soak pit.

xiii. Water produced during drilling shall be reused in drilling of other core/test wells.

xiv. Ground water quality monitoring shall be done to assess if produced water storage or disposal has any effect.

xv. Drilling wastewater including drill cuttings, wash water shall be collected in disposal pit lined with HDPE lining, evaporated or treated and shall comply with the notified standards for on-shore disposal on land. Proper toxicological analysis shall be done to ensure there is no hazardous material. Copy of toxicological analysis shall be submitted to Ministry's Regional Office at Bangalore.

xvi. Only water based drilling mud shall be used. The drilling mud shall be recycled. Hazardous waste shall be disposed of as per Hazardous Waste (Management, Handling and Transboudary Movement) Rules, 2008. The recyclable waste (oily sludge) and spent oil shall be disposed of to the authorized recyclers/re-processors.

xvii. The Company shall take necessary measures to prevent fire hazards, containing oil spill and soil remediation as needed. At place of ground flaring, the overhead flaring stack with knockout drums shall be installed to minimize gaseous emissions during operation.

xviii. To prevent underground coal fire, preventive measures shall be taken for ingress of ambient air during withdrawal inside the coal seams by adopting technologies including vacuum suction. Gas detectors for the detection of CH_4 and H_2S shall be provided.

xix. The design, material of construction, assembly, inspection, testing and safety aspects of operation and maintenance of pipeline and transporting the natural gas/oil shall be governed by

ASME/ANSI B 31.8/B31.4 and OISD standard 141. Pipeline wall thickness and minimum depth of burial at river crossing and casings at rails, major road crossings should be in conformity with ANSI/ASME requirements.

xx. The company shall develop a contingency plan for H_2S release including all necessary aspects from evacuation to resumption of normal operations. The workers shall be provided with personal H_2S detectors in locations of high risk of exposure along with self containing breathing apparatus.

xxi. Adequate well protection system shall be provided like Blow Out Preventor (BOP) or diverter systems as required based on the geological formation of the blocks.

xxii. The top soil removed shall be stacked separately for reuse during restoration process.

xxiii. Emergency Response Plan shall be based on the guidelines prepared by OISD, DGMS and Govt. of India. Recommendations mentioned in the Risk Assessment & Consequence Analysis and Disaster Management Plan shall be strictly followed.

xxiv. Project proponent shall comply with the environment protection measures and safeguards recommended in the EIA/EMP/risk analysis report/disaster management plan.

xxv. The company shall take measures after completion of drilling process by well plugging and secured enclosures, decommissioning of rig upon abandonment of the well and drilling site shall be restored in original condition. In the event that no economic quantity of hydrocarbon is found a full abandonment plan shall be implemented for the drilling site in accordance with the applicable Indian Petroleum Regulations.

xxvi. Occupational health surveillance of the workers shall be carried out as per the prevailing Acts and Rules.

xxvii. In case the commercial viability of the project is established, the Company shall prepare a detailed plan for development of gas fields and obtain fresh environmental clearance from the Ministry.

xxviii. All the commitments made to the public during the Public Hearing / Public Consultation meetings held on 29th December, 2012 and 23rd January, 2012 for Thanjavur and Thiruvarur Districts respectively shall be satisfactorily implemented.

xxix. Company shall adopt Corporate Environment Policy as per the Ministry's O.M. No. J-11013/41/2006-IA.II(I) dated 26th April, 2011and implemented.

xxx. Provision shall be made for the housing of construction labour within the site with all necessary infrastructure and facilities such as fuel for cooking, mobile toilets, mobile STP, Safe drinking water, medical health care, crèche etc. The housing may be in the form of temporary structures to be removed after the completion of the project.

B. **GENERAL CONDITIONS:**

i. The project authorities must strictly adhere to the stipulations made by the State Pollution Control Board (SPCB), State Government and any other statutory authority.

ii. No further expansion or modification in the project shall be carried out without prior approval of the Ministry of Environment & Forests. In case of deviations or alterations in the project proposal from those submitted to this Ministry for clearance, a fresh reference shall be made to the

Ministry to assess the adequacy of conditions imposed and to add additional environmental protection measures required, if any.

iii. The project authorities must strictly comply with the rules and regulations under Manufacture, Storage and Import of Hazardous Chemicals Rules, 2000 as amended subsequently. Prior approvals from Chief Inspectorate of Factories, Chief Controller of Explosives, Fire Safety Inspectorate etc. must be obtained, wherever applicable.

iv. The project authorities must strictly comply with the rules and regulation with regarding to handling and disposal of Hazardous Wastes (Management, Handling and Transboundary Movement) Rules, 2008 wherever applicable. Authorization from the State Pollution Control Board must be obtained for collections/ treatment/ storage/disposal of hazardous wastes.

v. The overall noise levels in and around the plant area shall be kept well within the standards by providing noise control measures including acoustic hoods, silencers, enclosures etc. on all sources of noise generation. The ambient noise levels shall conform to the standards prescribed under EPA Rules, 1989 viz. 75 dBA (daytime) and 70 dBA (nighttime).

vi. A separate Environmental Management Cell equipped with full fledged laboratory facilities must be set up to carry out the environmental management and monitoring functions.

vii. The company shall earmark sufficient funds for recurring cost per annum to implement the conditions stipulated by the Ministry of Environment and Forests as well as the State Government along with the implementation schedule for all the conditions stipulated herein. The funds so earmarked for environment management/ pollution control measures shall not be diverted for any other purpose.

viii. The Regional Office of this Ministry/Central Pollution Control Board/State Pollution Control Board will monitor the stipulated conditions. A six monthly compliance report and the monitored data along with statistical interpretation shall be submitted to them regularly.

ix. A copy of clearance letter shall be sent by the proponent to concerned Panchayat, Zila Parishad / Municipal Corporation, Urban Local Body and the local NGO, if any, from whom suggestions / representations, if any, were received while processing the proposal. The clearance letter shall also be put on the web site of the company by the proponent.

x. The project proponent shall upload the status of compliance of the stipulated environment clearance conditions, including results of monitored data on their website and shall update the same periodically. It shall simultaneously be sent to the Regional Office of the MOEF, the respective Zonal Office of CPCB and the TNPCB. The criteria pollutant levels namely; PM10, SO_2, NOx, HC (Methane & Non-methane), VOCs (ambient levels as well as stack emissions) or critical sectoral parameters, indicated for the projects shall be monitored and displayed at a convenient location near the main gate of the company in the public domain.

xi. The project proponent shall also submit six monthly reports on the status of the compliance of the stipulated environmental conditions including results of monitored data (both in hard copies as well as by e-mail) to the Regional Office of MOEF, the respective Zonal Office of CPCB and the TNPCB. The Regional Office of this Ministry / CPCB / TNPCB shall monitor the stipulated conditions.

xii. The environmental statement for each financial year ending 31st March in Form-V as is mandated to be submitted by the project proponent to the concerned State Pollution Control Board as prescribed under the Environment (Protection) Rules, 1986, as amended subsequently, shall

also be put on the website of the company alongwith the status of compliance of environmental conditions and shall also be sent to the respective Regional Offices of the MOEF by e-mail.

xiii. The Project Proponent shall inform the public that the project has been accorded environmental clearance by the Ministry and copies of the clearance letter are available with the TNPCB and may also be seen at Website of the Ministry of Environment and Forests at http:/envfor.nic.in. This shall be advertised within seven days from the date of issue of the clearance letter, at least in two local newspapers that are widely circulated in the region of which one shall be in the vernacular language of the locality concerned and a copy of the same shall be forwarded to the Regional office.

xiv. Project authorities shall inform the Regional Office as well as the Ministry, the date of financial closure and final approval of the project by the concerned authorities and the date of commencing the land development work.

8.0 The Ministry may revoke or suspend the clearance, if implementation of any of the above conditions is not satisfactory.

9.0 The Ministry reserves the right to stipulate additional conditions if found necessary. The Company in a time bound manner shall implement these conditions.

10.0 The above conditions shall be enforced, inter-alia under the provisions of the Water (Prevention & Control of Pollution) Act, 1974, the Air (Prevention & Control of Pollution) Act, 1981, the Environment (Protection) Act, 1986, Hazardous Waste (Management, Handling and Trans-boundary Movement) Rules, 2008 and the Public (Insurance) Liability Act, 1991 along with their amendments and rules.

P. Ahujarai

(Dr. P L Ahujarai)
Director

Copy to :-

1. The Principal Secretary, Department of Environment, Ground Floor, Panagal Buildings 1, Jeenis Road , Saidapet, Chennai - 600 015.
2. The Chief Conservator of Forests, Regional Office (Southern Zone, Bangalore) Kendriya Sadan, 4th Floor, E&F Wing, II Block Koramangala, Banglore-560034.
3. The Chairman, Central Pollution Control Board Parivesh Bhavan, CBD-cum-Office Complex, East Arjun Nagar, New Delhi - 110 032.
4. The Chairman, Tamil Nadu Pollution Control Board, Corporate Office, 76, Anna Salai, Guindy, Chennai - 600 032.
5. Joint Secretary, IA II(I), Ministry of Environment and Forests, Paryavaran Bhavan, CGO Complex, New Delhi.
6. Monitoring Cell, Ministry of Environment and Forests, Paryavaran Bhavan, CGO Complex, New Delhi.
7. Guard File/Monitoring File/Record File.

(Dr. P L Ahujarai)
Director

ANNEXURE - II

023633

ABSTRACT

Industries Department – Mines & Minerals – Coal Bed Methane - Exploration and production - Petroleum Exploration Licence granted to Tvl. Great Eastern Energy Corporation Limited – Public objections against the project – Detailed study and report - Expert Technical Committee - Constituted – Orders issued.

INDUSTRIES (MMA1) DEPARTMENT

G.O. (Ms) No. 79

Date: 30.06.2014
ஜய – ஆனி 16,
திருவள்ளுவர் ஆண்டு 2045

Read:

1. From the Secretary to Government of India, Ministry of Petroleum and Natural Gas, New Delhi D.O. letter No. O - 12012/29/2010-ONG-III, dated 13.08.2010.
2. G.O. (3D) No.01, Industries (MMA1) Department dated 01.01.2011.
3. Government of India, Ministry of Environment and Forest (I.A. Division), New Delhi letter F.No. J-11011/615/2010-IA.II (I), dated 12.09.2012.
4. From the District Collector, Tiruvarur letter Pdl 376/2013/ C2, dated 24.06.2013.
5. From the District Collector, Thanjavur letter Rc.767/(Mines)/ 2010 dated 30.06.2013.
6. From Tvl.Great Eastern Energy Corporation Limited letter No.GEECL/GTN/14 dated 14.05.2013.

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ORDER:

In the reference first read above, the Government of India, Ministry of Petroleum and Natural Gas has informed that the Government of India has awarded Methane Block in Tamil Nadu (No.MG-CBM -2008/IV) to Tvl. Great Eastern Energy Corporation Limited (GEECL) for exploration and production of Coal Bed Methane in the IV round of Coal Bed Methane policy (CBM-IV) over an area of 691 sq.km (effective area of 667 sq.km.) in Tiruvarur and Thanjavur Districts. The Government of India have also conveyed the approval under Rule 5 (1) (11) of Petroleum and Natural Gas Rules, 1959 for issue of Petroleum Exploration Licence to the Great Eastern Energy Corporation Limited and also requested the State Government for grant of Petroleum Exploration Licence to the above company to enable to commence exploration and production activities in the Block.

2. Accordingly, in Government order second read above, the State Government has issued Petroleum Exploration Licence (PEL) to Tvl. Great Eastern Energy Corporation Limited for exploration and production of Coal Bed Methane in Mannargudi Block No.MG-CBM -2008/(IV) over an area of 691 Sq.Kms (effective area for operation is 667 Sq.Kms.) (392.944 sq.kms. in Thiruvarur District and 274.056

sq.kms. in Thanjavur District) for a period of 4 years subject to the following conditions:-

1) During the exploration activities, the licensee should not disturb the Vadavur Bird Sanctuary and also previous approval should be obtained from the Forest Department before the execution of Petroleum Exploration Licence.

2) Safety measures should be provided as per the guide lines stipulated under Petroleum and Natural Gas Rules, 1959.

3. The Government of Tamil Nadu and Tvl. Great Eastern Energy Corporation Limited have executed a MoU on 04.01.2011 for implementation of the Project. The Government of India, Ministry of Environment and Forest has also accorded Environment Clearance to Tvl.Great Eastern Energy Corporation Limited in their letter third read above subject to certain conditions.

4. Subsequently, Tvl. Great Eastern Energy Corporation Limited has applied to Tamil Nadu Pollution Control Board through the District Environmental Engineers of Thiruvarur and Thanjavur Districts for grant of Consent to Establish (CTE) under Water (Prevention and Control of Pollution) Act, 1974 and Air (Prevention and Control of Pollution) Act, 1981. The Tamil Nadu Pollution Control Board has not yet given its clearance for Consent to Establish to Tvl. Great Eastern Energy Corporation Limited. Tvl. Great Eastern Energy Corporation Limited have proposed to drill 46 Coreholes and 30 test wells in phase - I and phase - II and for each Corehole / test well, the company require about 1.5 to 2 acres of land. Therefore, Tvl. GEECL may require about 160 acres of land for siting the Coreholes and test wells and the land has to be privately purchased or leased from the land owners by the company itself.

5. In this regard, the representatives of farmers, functionaries of the Tamil Nadu Science Forum, political activists, Tamil Nadu Vivasayigal Sangam, environmentalists and stakeholders have expressed their concern about the possible adverse impact of the project on the environment, ground water depletion and on the livelihood of the farmers. They have represented that the drilling of bore-wells and production wells for Coal Bed Methane would result in the depletion of ground water and thereby adversely affect the irrigation sources and ultimately agricultural lands would be affected or ruined in Thanjavur and Tiruvarur Districts.

6. The District Collector of Tiruvarur in his letter fourth read above has reported that the public had gone on hunger strikes and staged various agitations and demonstrations against this project at various places in Tiruvarur District. Similarly, the District Collector of Thanjavur in his letter fifth read above has reported that agitations and demonstrations were staged against this project in various parts of Thanjavur District.

7. In the circumstances, considering the importance and sensitivity of the issue and growing public unrest in the local area towards the proposed project and in consideration of the welfare of the people of Tamil Nadu, first and foremost especially of the farmers of the State, Hon'ble Chief Minister has announced that,

(a) An Expert Technical Committee (ETC) will be constituted consisting of eminent experts drawn from Anna University, IIT (Madras), Tamil Nadu

Agricultural University, M.S.Swaminathan Research Foundation (MSSRF) and also officers from the PWD, Agriculture Department, TNPCB and TIDCO to go into matter *de novo* from all angles, including the environmental stand point and the risk of sea water intrusion, livelihood and food security issues, as well as the need to develop clean energy resources. The Committee will be directed to submit a report within three months.

(b) not to proceed further on the project until the Expert Committee submits its report.

8. Accordingly, the Government accord sanction for constitution of an Expert Technical Committee comprising of the following persons:-

1.	The Chairman, Tamil Nadu Pollution Control Board	**Member Secretary / Convenor**

MEMBERS

2.	Anna University	Dr.P.Kannan, Professor and Head of the Department of Chemistry
3.	Indian Institute of Technology (Madras)	Thiru. P.S.T.Sai, Professor, Department of Chemical Engineering.
4.	Tamil Nadu Agricultural University	Thiru.P.Doraisamy, Professor, Department of Environmental Sciences.
5.	M.S. Swaminathan Research Foundation	Dr. V. Selvam, Senior Director, (Coastal Systems Research)
6.	Public Works Department	Thiru.L.Muniappan, B.E., Superintendent Engineer, PWD, Project Formulation Circle, Trichy.
7.	Agriculture Department	Thiru.P.S.Karunakaran,M.Sc.,(Agri), Deputy Director, Department of Agriculture
8.	Tamil Nadu Industrial Development Corporation Limited (TIDCO)	Thiru.R.Karthikeyan, Development Manager, TIDCO

9. The Expert Technical Committee is requested to go into the matter de novo for all angles, including environmental stand point and the risk of sea water intrusion, livelihood and food security issues as well as the need to develop clean energy resources. The Committee is directed to submit a report to Government through the Member Secretary / Convenor within three months.

10. The concerned authorities viz. the District Collectors Tiruvarur and Thanjavur, Tamil Nadu Pollution Control Board, Additional Chief Secretary / Commissioner of Revenue Administration, Additional Chief Secretary/ Commissioner of Land Administration, Commissioner of Town and Country Planning and other concerned authorities are instructed not to proceed further on the Coal Bed Methane exploration and production proposal of Tvl. Great Eastern Energy Corporation Limited in Coal Bed Methane areas of Tiruvarur and Thanjavur Districts until the Expert Technical Committee submit their report and a decision is taken by the Government based on the report of the Expert Technical Committee.

(BY ORDER OF THE GOVERNOR)

C.V.SANKAR
PRINCIPAL SECRETARY TO GOVERNMENT

To

The Chairman,
Tamil Nadu Pollution Control Board,
76, Anna Salai, Guindy, Chennai - 600 032.

Dr. P. Kannan,
Professor and Head of the Department of Chemistry,
Anna University,
Sardar Patel Road,
Chennai - 600 025.

Thiru P.S.T.Sai,
Professor, Department of Chemical Engineering,
Indian Institute of Technology, Madras,
Chennai 600 036.

Thiru P. Doraisamy,
Professor, Department of
Environmental Science,
Tamil Nadu Agricultural University,
Lawley Road,
Pappanaicken Pudur,
Coimbatore - 641 003.

Dr. V. Selvam, Senior Director,
(Coastal Research Systems),
M.S.Swaminathan Research Foundation,
3rd Cross Street, Institutional Area,
Taramani, Chennai 600 113.

Thiru L. Muniappan, B.E.,
Superintendent Engineer,
Project Formulation Circle,
Trichy-620 020.

Thiru P.S. Karunakaran, M.Sc., (Agri),
Deputy Director of Agriculture,
Agriculture Department,
Chepauk, Chennai -600 005.

Thiru R. Karthikeyan,
Development Manager,
Tamil Nadu Industrial Development Corporation Limited,
Rukmani Lakshmipathy Road,
Egmore, Chennai - 600 008.

The Commissioner of Geology and Mining,
Guindy, Chennai-32.

The District Collector,
Thanjavur - 613 001.

The District Collector,
Tiruvarur - 610 001

The Additional Chief Secretary/
Commissioner of Revenue Administration,
Chepauk, Chennai-600 005.

The Additional Chief Secretary/
Commissioner of Land Administration,
Chepauk, Chennai-600 005.

The Commissioner,
Town and Country Planning,
807, Anna Salai, Chennai-600 002.

Copy to:
Advisor to Government of Tamil Nadu,
Chennai - 600 009

Office of the Hon'ble Chief Minister,
Secretariat, Chennai 600 009.

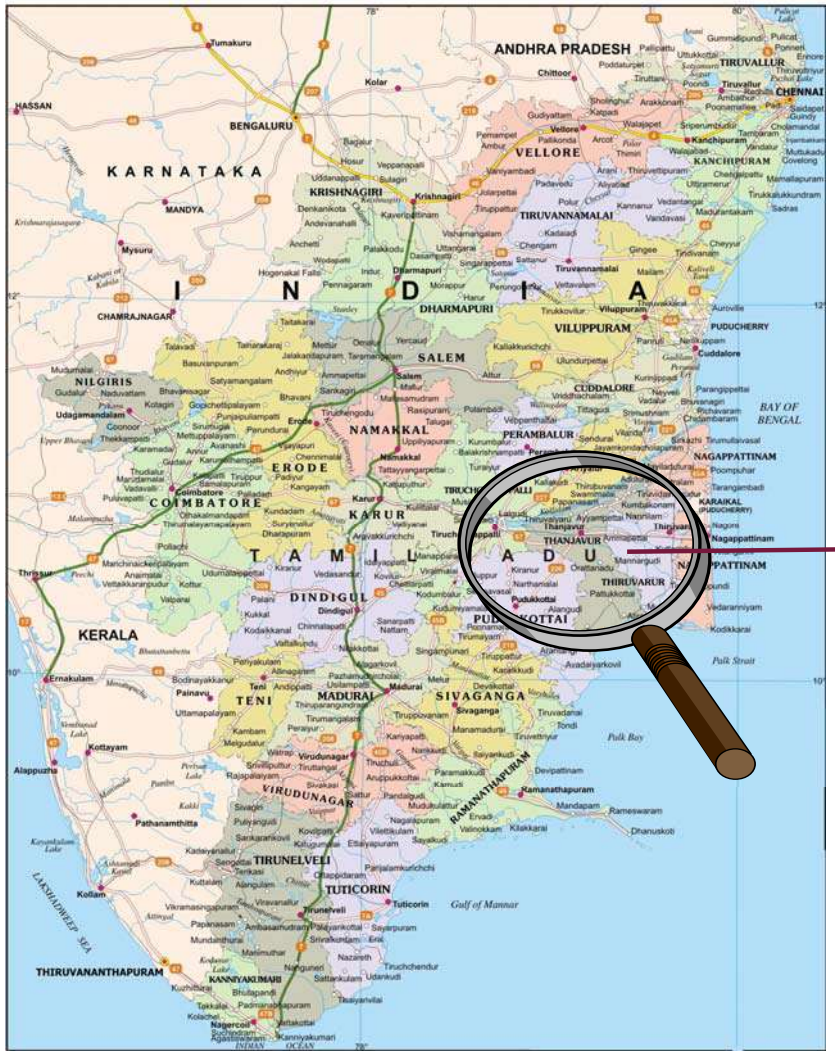
Office of the Hon'ble Minister (Industries),
Secretariat, Chennai-600 009.

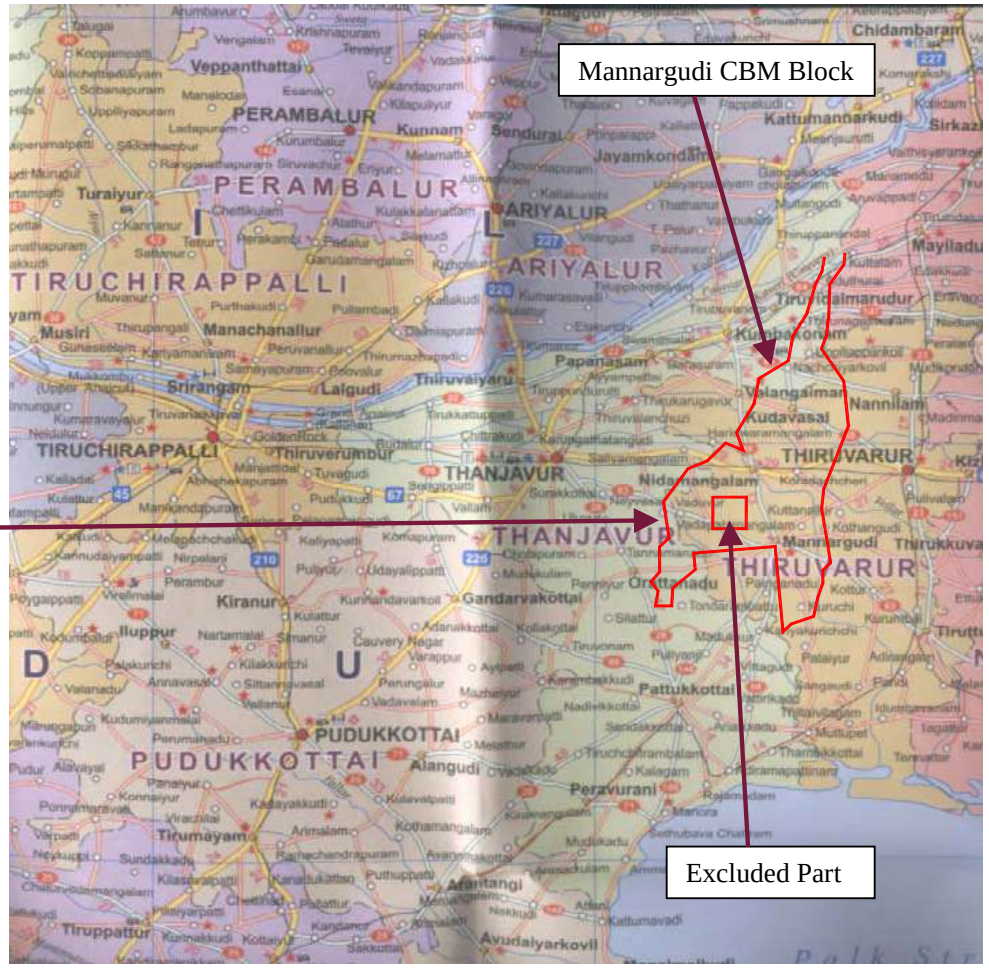
Industries(OP-II) Department,
Secretariat, Chennai - 600 009.
SF/SC's.

// Forwarded by Order //

Section Officer

30.6.2014.



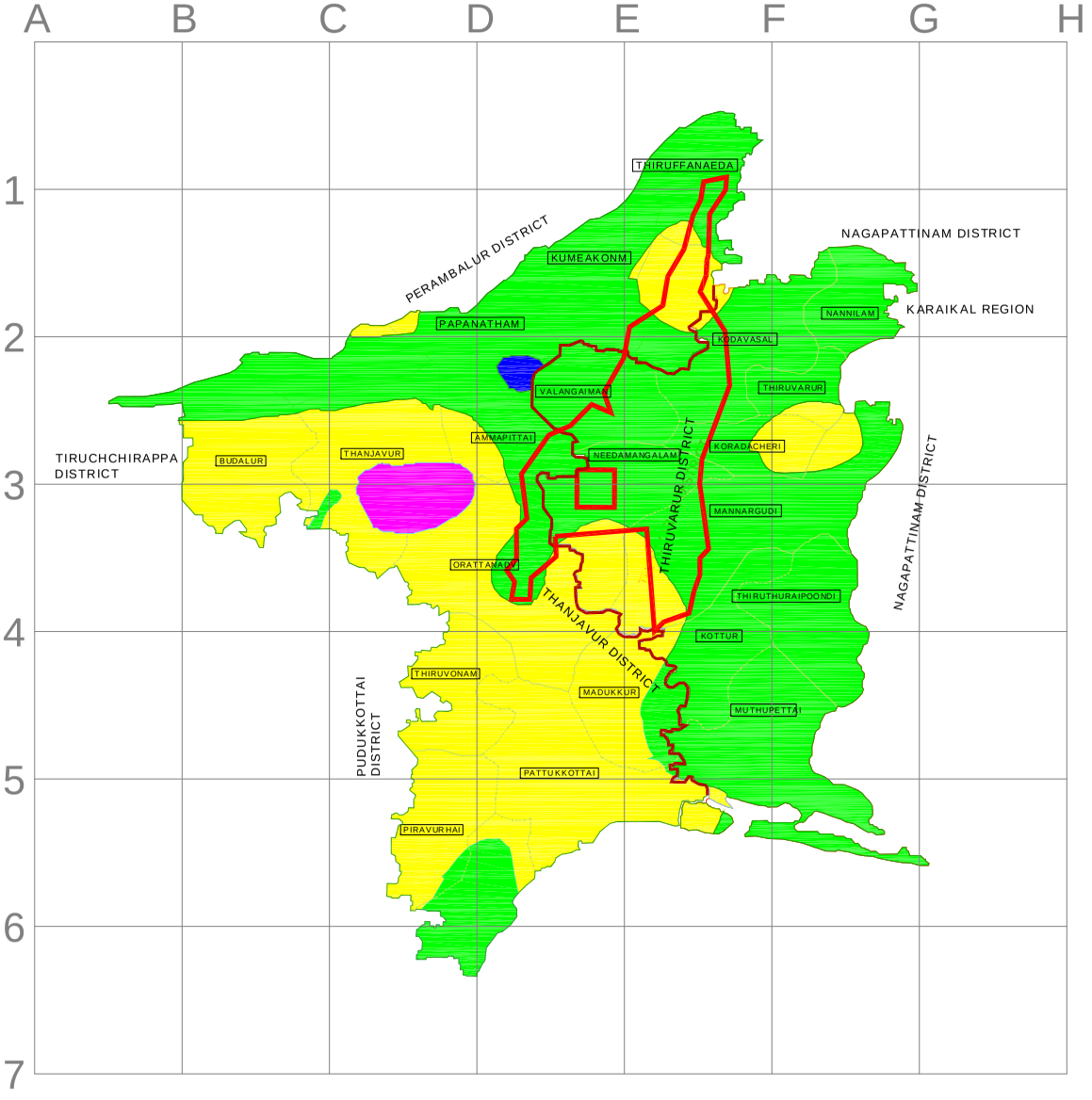


M-1.1: Map Showing Location of Mannargudi CBM Block

KADAM ENVIRONMENTAL CONSULTANTS
871/B/3, GIDC, MAKARPURA,
VADODARA-10

PROJECT: EIA/EMP & RA/DMP for Proposed CBM Drilling Operation in Manargudi Block MG-CBM-2008/IV
CLIENT: M/s Great Eastern Energy Corporation Limited
Map Not to Scale

DEPTH TO WATER LEVEL (m.bgl.)



0-2

>2-5

>5-10

>10-20

LEGEND

DISTRICT BOUNDARY

DRAINAGE

MANARGUDI
(MG-CBM-2008-IV BLOCK)

N

W E

S

SCALE

0 15 30 45KM

KADAM ENVIRONMENTAL CONSULTANTS

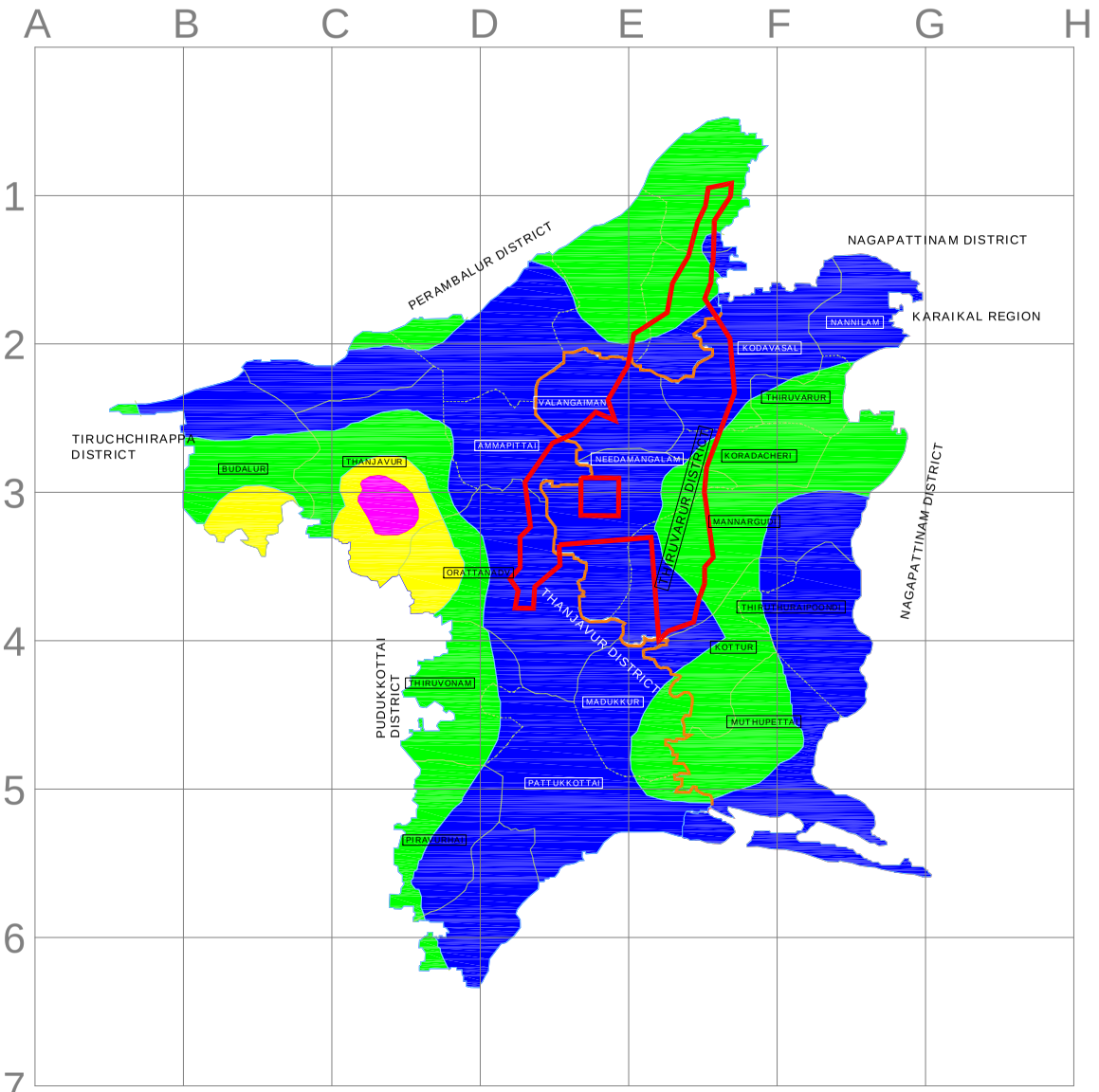
871/B/3, Near Himalaya Machinery
GIDC, Makarpura, Vadodara - 390 010.
Tel: +91 (0) 265 2644909 / 2647 213
Fax: +91 (0) 265 2638411
E-mail: kadamenviro@kadamenviro.com

PROJECT	EIA/EMP & RA / DMP FOR EXPLORATION AND TESTING OF WELLS AND COMMERCIAL EXPLORATION OF MANARGUDI BLOCK MG-CBM-2008-IV
OWNER	GREAT EASTERN ENERGY CORPORATION LTD
TITLE	Map showing Depth of Water Level in Pre monsoon

REVISION : 0	DRAWN BY : RP	DRAWING NO. M-3.4/B
SCALE : As Shown	CHD BY : JM	
DATE : 03/08/11	APPROVED BY : JM	

SOURCE : GOOGLE EARTH - ENHANCED VERSION - ACQUIRED ON 2009

DEPTH TO WATER LEVEL (m.bgl.)



LEGEND

- 0-2
- >2-5
- >5-10
- >10-20

- DISTRICT BOUNDARY
- DRAINAGE
- MANARGUDI (MG-CBM-2008-IV BLOCK)

N
W
E
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SCALE

0 15 30 45KM

KADAM ENVIRONMENTAL CONSULTANTS

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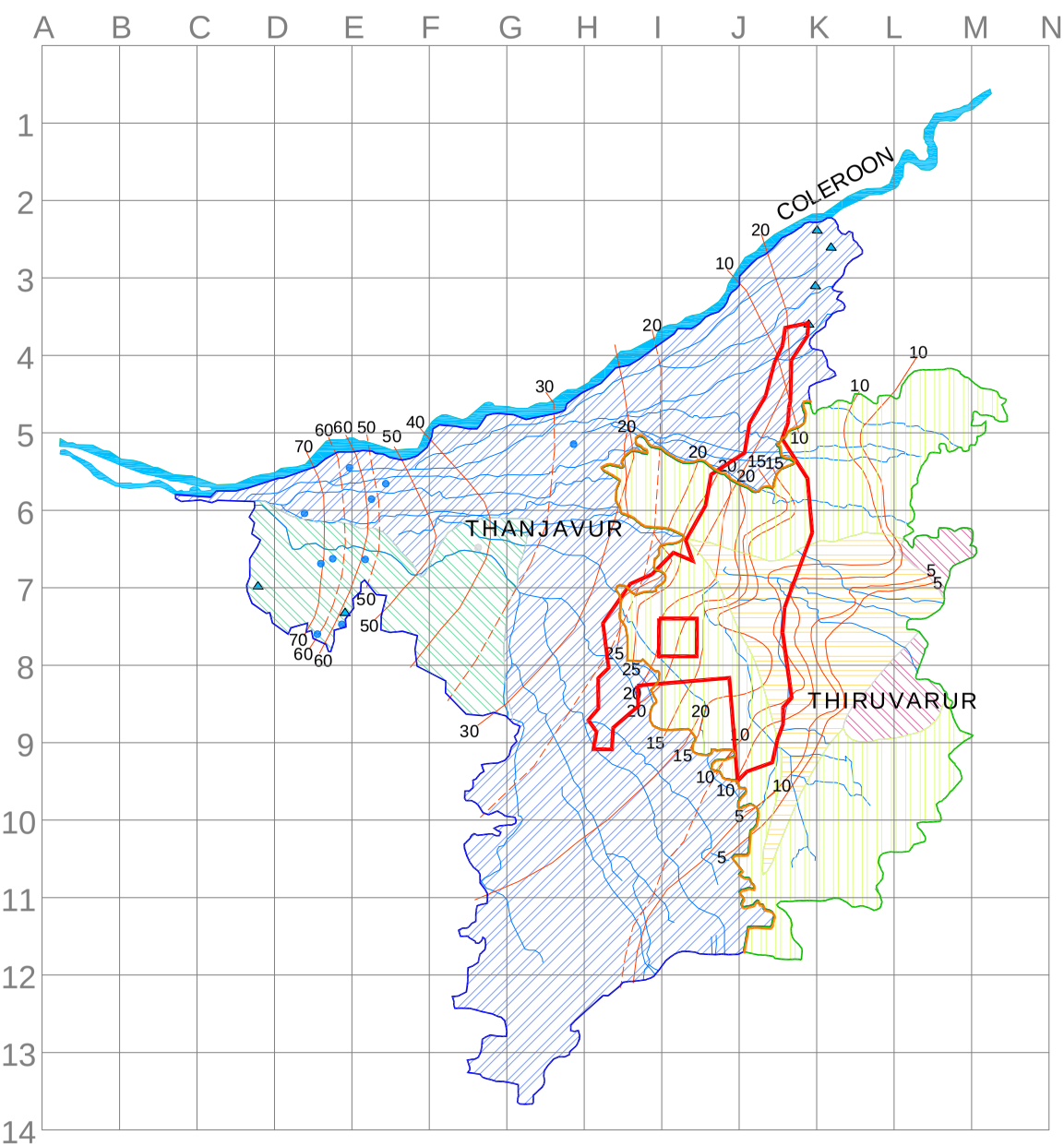
PROJECT	EIA/EMP & RA / DMP FOR EXPLORATION AND TESTING OF WELLS AND COMMERCIAL EXPLORATION OF MANARGUDI BLOCK MG-CBM-2008-IV
OWNER	GREAT EASTERN ENERGY CORPORATION LTD
TITLE	Map showing Depth of Water Level in Post monsoon

REVISION : 0	DRAWN BY : RP	DRAWING NO. M-3.4/A
SCALE : As Shown	CHD BY : JM	
DATE : 03/08/11	APPROVED BY : JM	

SOURCE : GOOGLE EARTH - ENHANCED VERSION - ACQUIRED ON 2009



REFERENCES

Water Table Contors (m.a. msl).
Premonsoon —— Post monsoon -----

GROUND WATER POTENTIAL
Yieid (Liters per second)

- 10 - 25
- 1 - 5

SOURCES OF IRRIGATION

- Canal
- Well
- Tubewell

- >21
- 14 - 21
- <14
- Thanjavur District
- Thiruvarur District
- Manargudi (MG-CBM-2008-IV BLOCK)
- Common Boundary of Two Districts

N W E S

SCALE

0 10 20 30 40 50KM

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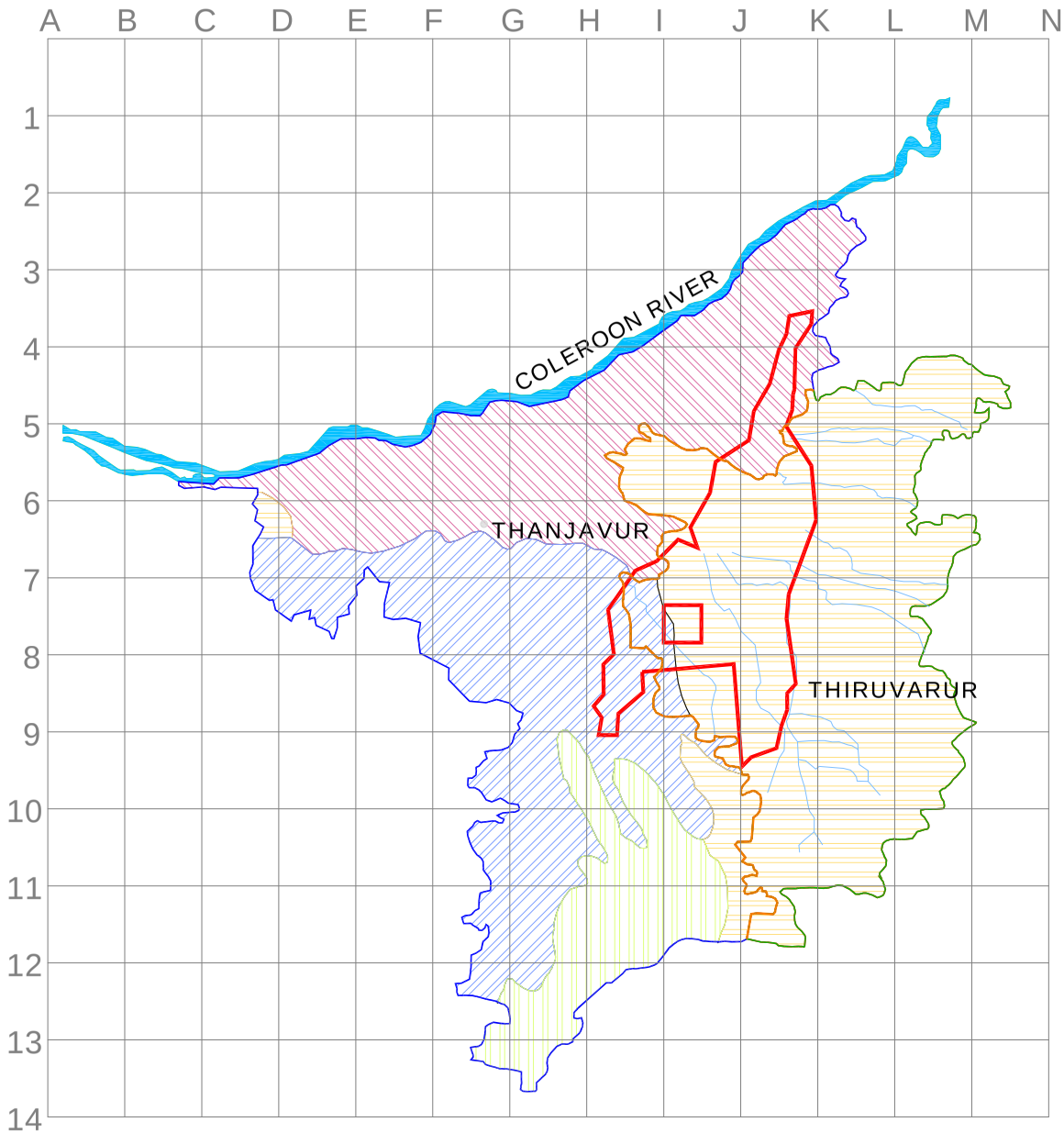
871/B/3, Near Himalaya Machinery
GIDC, Makarpura, Vadodara - 390 010.
Tel: +91 (0) 265 2644909 / 2647 213
Fax: +91 (0) 265 2638411
E-mail: kadamenviro@kadamenviro.com

PROJECT	EIA/EMP & RA / DMP FOR EXPLORATION AND TESTING OF WELLS AND COMMERCIAL EXPLORATION OF MANARGUDI BLOCK MG-CBM-2008-IV
OWNER	GREAT EASTERN ENERGY CORPORATION LTD
TITLE	Map showing Irrigation and Hydrogeology

REVISION : 0	DRAWN BY : RP	DRAWING NO.
SCALE : As Shown	CHD BY : JM	M-3.4/C
DATE : 03/08/11	APPROVED BY : JM	

SOURCE : GOOGLE EARTH - ENHANCED VERSION - ACQUIRED ON 2009



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REFERENCES

ENTISOLS
- Younger Alluvial
- Coastal Alluvial

ALFISOLS
- Deltaic Alluvial

ULTISOLS
- Laterite
- Thanjavur District
- Thiruvarur District
- Manargudi (MG-CBM-2008-IV BLOCK)
- Common Boundary of Two Districts

SCALE

0 10 20 30 40 50KM

KADAM ENVIRONMENTAL CONSULTANTS

871/B/3, Near Himalaya Machinery
GIDC, Makarpura, Vadodara - 390 010.
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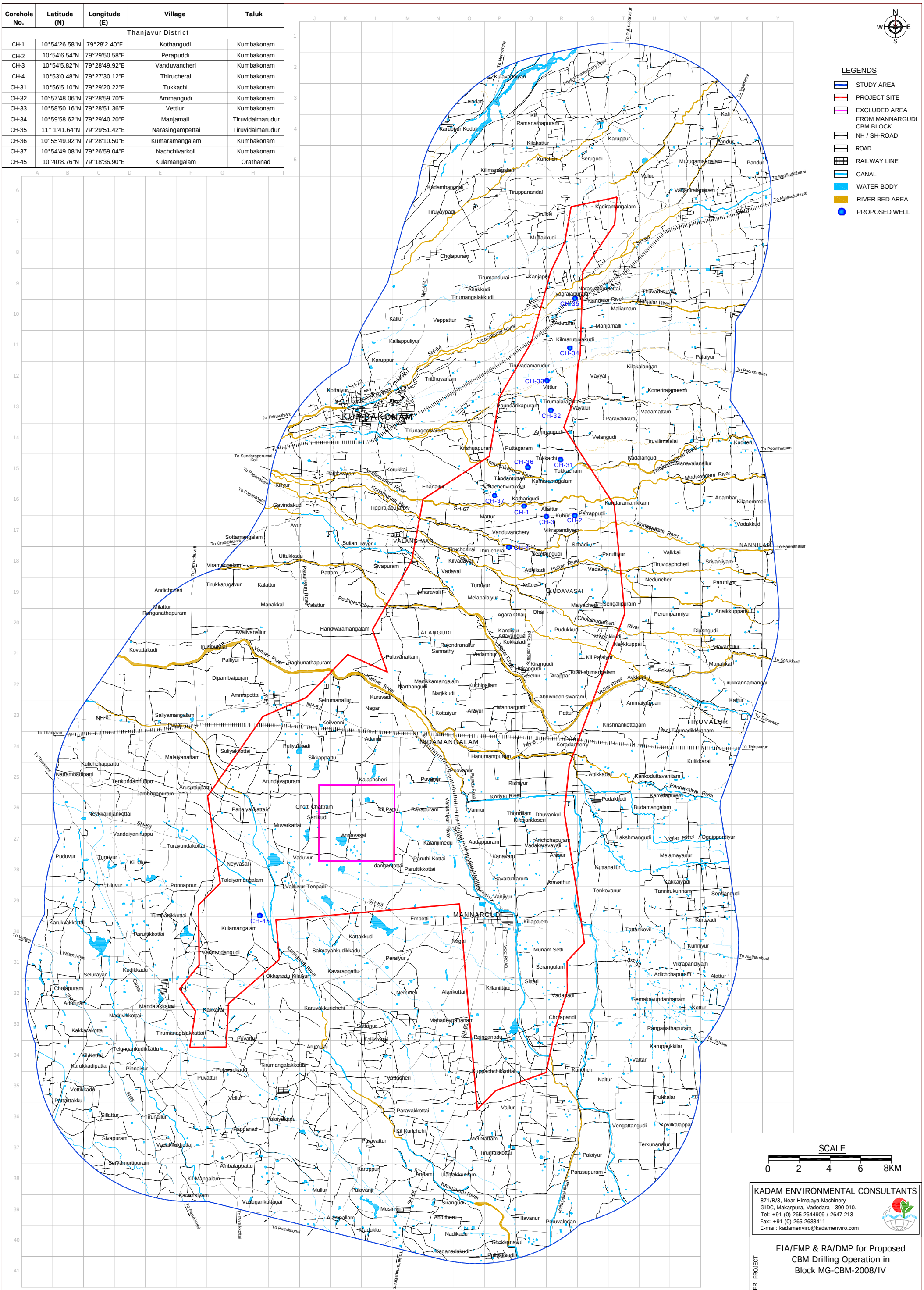
E-mail: kadamenviro@kadamenviro.com

PROJECT	EIA/EMP & RA / DMP FOR EXPLORATION AND TESTING OF WELLS AND COMMERCIAL EXPLORATION OF MANARGUDI BLOCK MG-CBM-2008-IV
OWNER	GREAT EASTERN ENERGY CORPORATION LTD
TITLE	Map showing Soil Cover

REVISION : 0	DRAWN BY : RP	DRAWING NO.
SCALE : As Shown	CHD BY : JM	M-3.4/D
DATE : 03/08/11	APPROVED BY : JM	

SOURCE : GOOGLE EARTH - ENHANCED VERSION - ACQUIRED ON 2009

Corehole No.	Latitude (N)	Longitude (E)	Village	Taluk
Thanjavur District				
CH-1	10°54'26.58"N	79°28'2.40"E	Kothangudi	Kumbakonam
CH-2	10°54'6.54"N	79°29'50.58"E	Perapuddi	Kumbakonam
CH-3	10°54'5.82"N	79°28'49.92"E	Vanduvancheri	Kumbakonam
CH-4	10°53'0.48"N	79°27'30.12"E	Thirucherai	Kumbakonam
CH-31	10°56'5.10"N	79°29'20.22"E	Tukkachi	Kumbakonam
CH-32	10°57'48.06"N	79°28'59.70"E	Ammangudi	Kumbakonam
CH-33	10°58'50.16"N	79°28'51.36"E	Vettlur	Kumbakonam
CH-34	10°59'58.62"N	79°29'40.20"E	Manjamali	Tiruvidaimarudur
CH-35	11° 1'41.64"N	79°29'51.42"E	Narasingampettai	Tiruvidaimarudur
CH-36	10°55'49.92"N	79°28'10.50"E	Kumaramangalam	Kumbakonam
CH-37	10°54'49.08"N	79°26'59.04"E	Nachchivarkoil	Kumbakonam
CH-45	10°40'8.76"N	79°18'36.90"E	Kulamangalam	Orathanad



KADAM ENVIRONMENTAL CONSULTANTS
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Tel: +91 (0) 265 2644909 / 2647 213
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E-mail: kadamenviro@kadamenviro.com

PROJECT: EIA/EMP & RA/DMP for Proposed CBM Drilling Operation in Block MG-CBM-2008/IV

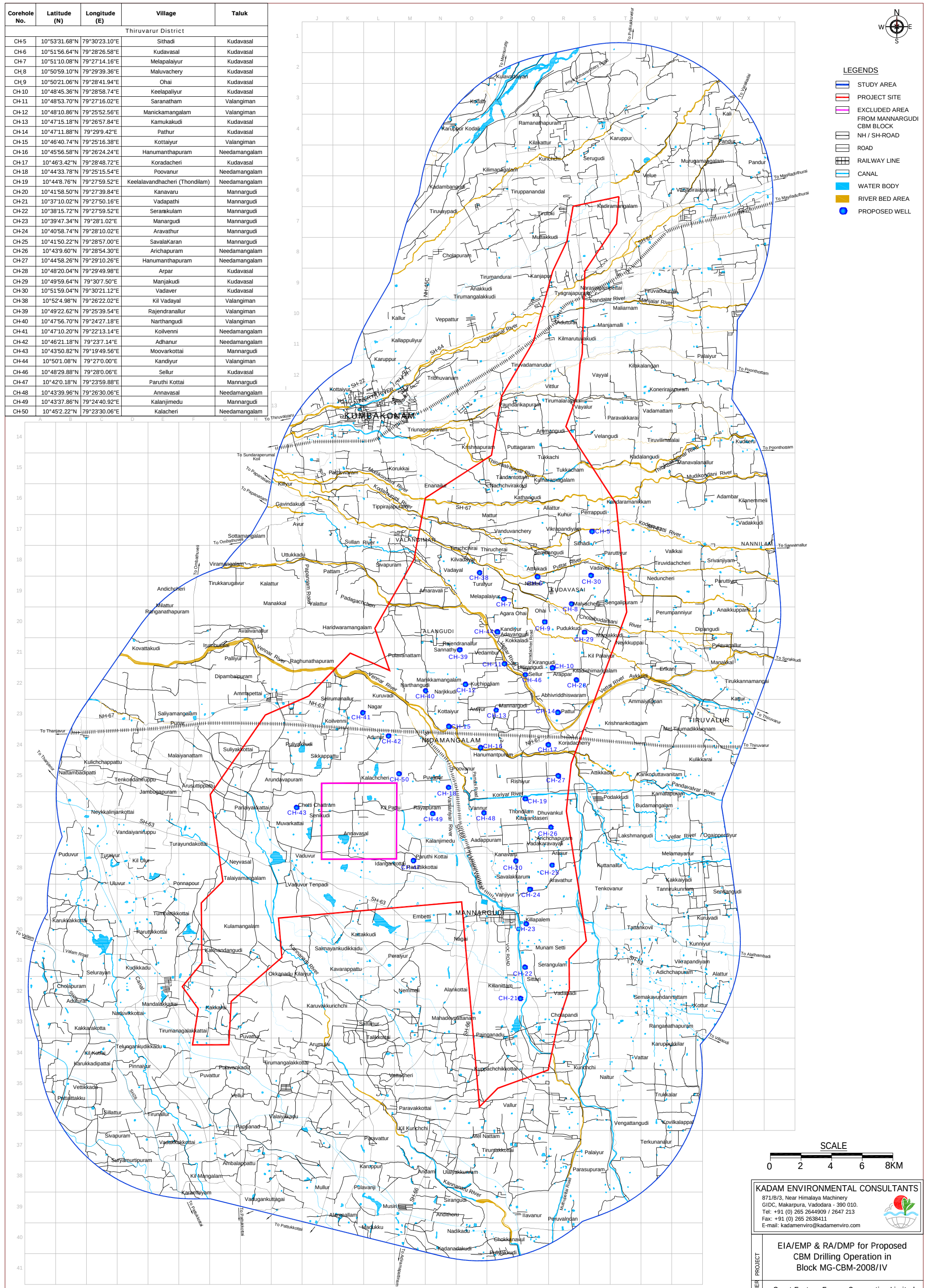
OWNER: Great Eastern Energy Corporation Limited

TITLE: Map Showing WELL LOCATION in Thanjavur District

REVISION : 0	DRAWN BY : KK	DRAWING NO. M-2.1/B
SCALE : As Shown	CHD BY : JM	
DATE : 24/08/2011	APPROVED BY : SK	

SOURCE : Satellite image taken from Enhance Version of Google earth

Corehole No.	Latitude (N)	Longitude (E)	Village	Taluk
Thiruvarur District				
CH-5	10°53'31.68"N	79°30'23.10"E	Sithadi	Kudavasal
CH-6	10°51'56.64"N	79°28'26.58"E	Kudavasal	Kudavasal
CH-7	10°51'10.08"N	79°27'14.16"E	Melapalaiyur	Kudavasal
CH_8	10°50'59.10"N	79°29'39.36"E	Maluvachery	Kudavasal
CH_9	10°50'21.06"N	79°28'41.94"E	Ohai	Kudavasal
CH-10	10°48'45.36"N	79°28'58.74"E	Keelapaliyur	Kudavasal
CH-11	10°48'53.70"N	79°27'16.02"E	Saranatham	Valangiman
CH-12	10°48'10.86"N	79°25'52.56"E	Manickamangalam	Valangiman
CH-13	10°47'15.18"N	79°26'57.84"E	Kamukakudi	Kudavasal
CH-14	10°47'11.88"N	79°29'9.42"E	Pathur	Kudavasal
CH-15	10°46'40.74"N	79°25'16.38"E	Kottaiyur	Valangiman
CH-16	10°45'56.58"N	79°26'24.24"E	Hanumanthapuram	Needamangalam
CH-17	10°46'3.42"N	79°28'48.72"E	Koradacheri	Kudavasal
CH-18	10°44'33.78"N	79°25'15.54"E	Poovanur	Needamangalam
CH-19	10°44'8.76"N	79°27'59.52"E	Keelalavandhacheri (Thondilam)	Needamangalam
CH-20	10°41'58.50"N	79°27'39.84"E	Kanavaru	Mannargudi
CH-21	10°37'10.02"N	79°27'50.16"E	Vadapathi	Mannargudi
CH-22	10°38'15.72"N	79°27'59.52"E	Seramakulam	Mannargudi
CH-23	10°39'47.34"N	79°28'1.02"E	Manargudi	Mannargudi
CH-24	10°40'58.74"N	79°28'10.02"E	Aravathur	Mannargudi
CH-25	10°41'50.22"N	79°28'57.00"E	SavalaKaran	Mannargudi
CH-26	10°43'9.60"N	79°28'54.30"E	Arichapuram	Needamangalam
CH-27	10°44'58.26"N	79°29'10.26"E	Hanumanthapuram	Needamangalam
CH-28	10°48'20.04"N	79°29'49.98"E	Arpar	Kudavasal
CH-29	10°49'59.64"N	79°30'7.50"E	Manjakudi	Kudavasal
CH-30	10°51'59.04"N	79°30'21.12"E	Vadaver	Kudavasal
CH-38	10°52'4.98"N	79°26'22.02"E	Kil Vadayal	Valangiman
CH-39	10°49'22.62"N	79°25'39.54"E	Rajendranallur	Valangiman
CH-40	10°47'56.70"N	79°24'27.18"E	Narthangudi	Valangiman
CH-41	10°47'10.20"N	79°22'13.14"E	Koilvenni	Needamangalam
CH-42	10°46'21.18"N	79°23'7.14"E	Adhanur	Needamangalam
CH-43	10°43'50.82"N	79°19'49.56"E	Moovarkottai	Mannargudi
CH-44	10°50'1.08"N	79°27'0.00"E	Kandiyur	Valangiman
CH-46	10°48'29.88"N	79°28'0.06"E	Sellur	Kudavasal
CH-47	10°42'0.18"N	79°23'59.88"E	Paruthi Kottai	Mannargudi
CH-48	10°43'39.96"N	79°26'30.06"E	Annavasal	Needamangalam
CH-49	10°43'37.86"N	79°24'40.92"E	Kalanjimedu	Mannargudi
CH-50	10°45'2.22"N	79°23'30.06"E	Kalacheri	Needamangalam



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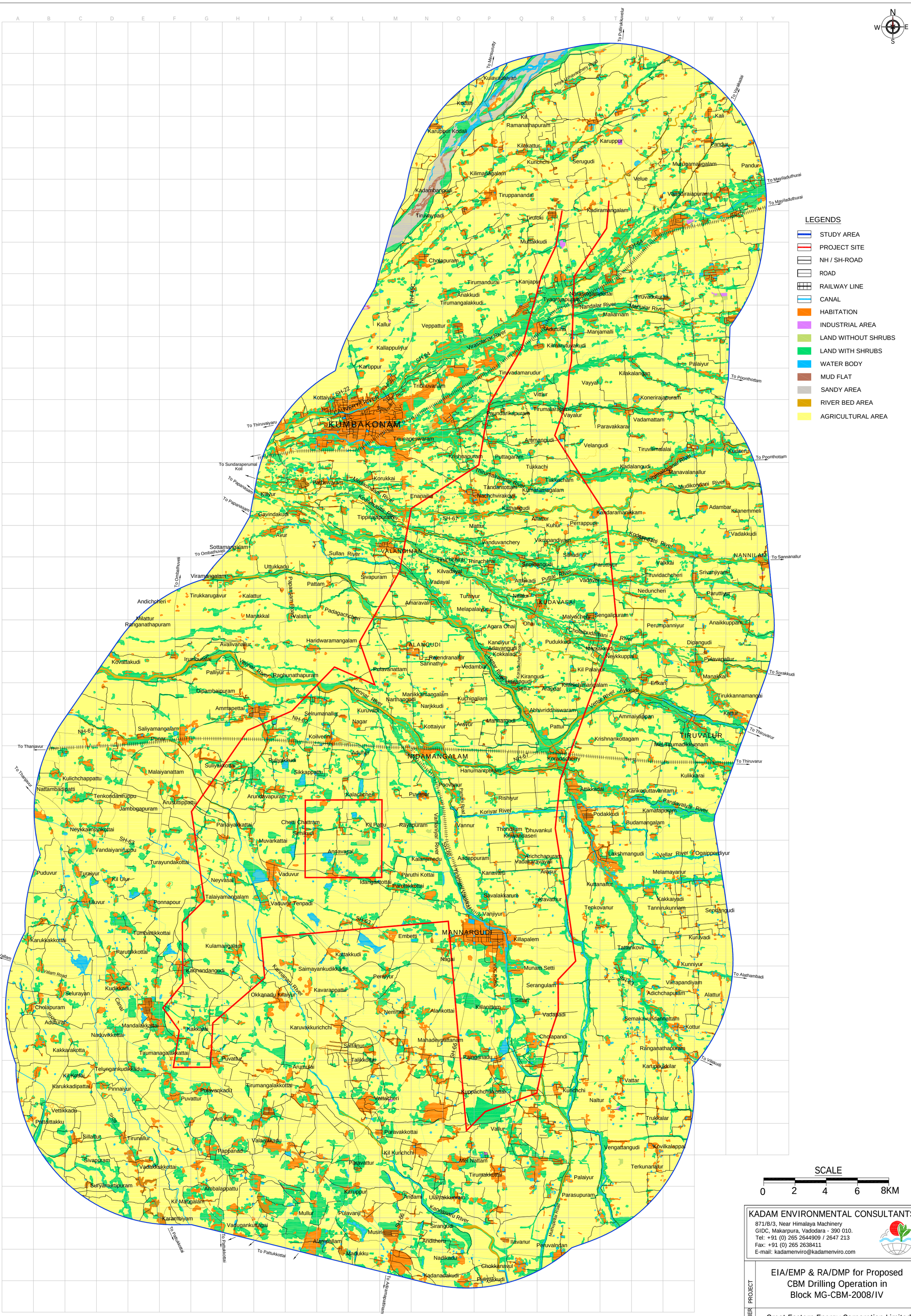
PROJECT: EIA/EMP & RA/DMP for Proposed CBM Drilling Operation in Block MG-CBM-2008/IV

OWNER: Great Eastern Energy Corporation Limited

TITLE: Map Showing WELL LOCATION in Thiruvarur District

REVISION : 0	DRAWN BY : KK	DRAWING NO. M-2.1/A
SCALE : As Shown	CHD BY : JM	
DATE : 24/08/2011	APPROVED BY : SK	

SOURCE : Satellite image taken from Enhance Version of Google earth



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E-mail: kadamenviro@kadamenviro.com

PROJECT: EIA/EMP & RA/DMP for Proposed CBM Drilling Operation in Block MG-CBM-2008/IV

OWNER: Great Eastern Energy Corporation Limited

TITLE: Map Showing AAG LANDUSE/LAND COVER in the study area

REVISION : 0	DRAWN BY : KK	DRAWING NO: M-3.1
SCALE : As Shown	CHD BY : JM	
DATE : 24/08/2011	APPROVED BY : SK	

SOURCE : Satellite image taken from Enhance Version of Google earth

ANNEXURE - V

Calculation of Total Value of the Gas to be extracted from Coal Bed Methane Blocks at Mannargudi assuming the Gas Price would remain constant for the next 25 years

1. 1 TCF = 28316846592 CM
2. 0.588 TCF = 16650305796 CM (60% recoverable from 0.98 TCF of Methane gas)
3. 1 MMBTU = 25.2 SCM (as per the General Conversions in the gas industry given in GAIL India Limited Official website - http://www.gailonline.com/final_site/energyconversionmatrix.html)
4. 0.588 TCF = 16650305796 / 25.2 SCM = 660726420.48 MMBTU
5. 1 MMBTU = US $ 4.66 / MMBTU on Gross Calorific Value basis, as per the price fixed by PPAC for the period April to September, 2015.
6. 66072645.48 MMBTU = 660726420.48 * 4.66 = US $ 3078985119.44
7. 66072645.48 MMBTU = 3078985119.44 * 62 = Rs. 19,089,70,77,405
8. The total value of 0.588 TCF of CBM gas is **Rs. 19,089,70,77,405**
9. Net Present Value = $P/(1+R)^n$ - P = 190897077405, R = 0.1 (assuming a 10% discount rate), n = 25 Years (taking in to account the 25 years production life period)
10. Net Present Value of the total gas quantity - $190897077405/(1+0.1)^{25}$ = **Rs. 1,761,90,36,308**

Calculation of Variations in Annual Average Gas Prices and Annual Average Variations in US$ in INR Rates

Year	*Annual Average US Henry Hub Gas Price in USD	Variation	Variation (%)	#Annual Average USD Ratse in INR	Variation	Variance (%)
2003	5.63					
2004	5.85	0.22	3.91		-2.444	-5.05
2005	8.79	2.94	50.26		-1.020	-2.22
2006	6.76	-2.03	-23.09		-0.658	-1.46
2007	6.95	0.19	2.81		1.011	2.28
2008	8.85	1.9	27.34		-5.044	-11.14
2009	3.89	-4.96	-56.05		5.676	14.11
2010	4.39	0.5	12.85		1.500	3.27
2011	4.01	-0.38	-8.66		-1.840	-3.88
2012	2.76	-1.25	-31.17		2.346	5.15
2013	3.71	0.95	34.42		6.486	13.53
2014	5.05	1.34	36.12		6.604	12.14
2015	4.66	-0.39	-7.72		1.588	2.60
			41.01			29.33
			3.42			2.44

* US Henry Hub Gas Prices Source - BP Statistical Review of World Energy June 2014 (Gas Prices)

Average USD in INR per year Source - PricewaterhouseCoopers.

Calculation of GEECL Coal Bed Methane Gas Prices by Applying the escalation in Gas Prices and US$ Rates

Year	Gas Price in USD	Variation	Variation (%)	USD in INR Rates	Variation	Variation (%)	Price in INR $ Per MMBTU	Gas Qty in US $ MMBTU Per Year	Gas Price in INR	Net Present Value of Gas in INR
2015	4.66			62.60			291.722	26429056.82	7709943798	
2016	4.82	0.15937	3.42	64.13	1.5275	2.44	309.061	26429056.82	8168180298	7425618452.70
2017	4.98	0.16482	3.42	65.69	1.5647	2.44	327.429	26429056.82	8653651847	7151778385.56
2018	5.15	0.17046	3.42	67.30	1.6029	2.44	346.890	26429056.82	9167977144	6888036922.71
2019	5.33	0.17629	3.42	68.94	1.6420	2.44	367.507	26429056.82	9712871098	6634021650.39
2020	5.51	0.18232	3.42	70.62	1.6821	2.44	389.350	26429056.82	10290150541	6389373888.63
2021	5.70	0.18855	3.42	72.34	1.7231	2.44	412.491	26429056.82	10901740288	6153748184.75
2022	5.90	0.19500	3.42	74.11	1.7652	2.44	437.007	26429056.82	11549679553	5926811825.60
2023	6.10	0.20167	3.42	75.92	1.8083	2.44	462.980	26429056.82	12236128751	5708244367.74
2024	6.31	0.20857	3.42	77.77	1.8524	2.44	490.497	26429056.82	12963376701	5497737184.96
2025	6.52	0.21570	3.42	79.67	1.8976	2.44	519.650	26429056.82	13733848254	5294993032.47
2026	6.75	0.22308	3.42	81.61	1.9439	2.44	550.535	26429056.82	14550112384	5099725627.24
2027	6.98	0.23071	3.42	83.60	1.9913	2.44	583.255	26429056.82	15414890747	4911659243.67
2028	7.22	0.23860	3.42	85.64	2.0399	2.44	617.921	26429056.82	16331066763	4730528324.32
2029	7.46	0.24676	3.42	87.73	2.0897	2.44	654.647	26429056.82	17301695224	4556077104.91
2030	7.72	0.25520	3.42	89.87	2.1407	2.44	693.555	26429056.82	18330012483	4388059253.17
2031	7.98	0.26392	3.42	92.07	2.1929	2.44	734.776	26429056.82	19419447243	4226237520.99
2032	8.25	0.27295	3.42	94.31	2.2464	2.44	778.447	26429056.82	20573631992	4070383409.46
2033	8.54	0.28229	3.42	96.61	2.3012	2.44	824.714	26429056.82	21796415111	3920276846.18
2034	8.83	0.29194	3.42	98.97	2.3574	2.44	873.731	26429056.82	23091873709	3775705874.54
2035	9.13	0.30192	3.42	101.39	2.4149	2.44	925.660	26429056.82	24464327215	3636466354.38
2036	9.44	0.31225	3.42	103.86	2.4738	2.44	980.676	26429056.82	25918351781	3502361673.81
2037	9.77	0.32293	3.42	106.39	2.5342	2.44	1038.962	26429056.82	27458795542	3373202471.52
2038	10.10	0.33397	3.42	108.99	2.5960	2.44	1100.713	26429056.82	29090794776	3248806369.41
2039	10.44	0.34540	3.42	111.65	2.6593	2.44	1166.133	26429056.82	30819791037	3128997715.08
2040	10.80	0.35721	3.42	114.37	2.7242	2.44	1235.441	26429056.82	32651549291	3013607333.82
								Total	**444590359772.37**	**122652459018.02**

ANNEXURE - VI

1 012257

PUBLIC WORKS DEPARTMENT

FROM
Er .V.SHANMUGAM.
BE., M.B.A, M.Sc(IT), M.I.E,
Chief Engineer, WRO/PWD
State Ground and Surface Water
Resources Data Centre,
Tharamani, Chennai-600 113.

TO
The Chairman,
Tamil Nadu Pollution Control Board,
76, Mount Salai, Guindy,
Chennai – 600 032

21 APR 2015

Lr. No. / AD(GP)/CBM / 2015 / dt:16/ 04 / 2015

Sir,

Sub: Coal Bed Methane Exploration Project of Mannargudi block of Thiruvarur district- report submitted - Regarding

Ref: 1. The Chairman TNPCB,Chennai.
Lr.No T6/TNPCB/F.23633/2014/Dt 10.03.2015

****

As requested by the Chairman, Tamilnadu Pollution Control Board Chennai in the reference cited, a report on the impact due to Coal Bed Methane (CBM) exploration in and around Mannargudi block of Thiruvarur district regarding the sea water intrusion, water level and water quality is prepared and sent herewith for favour of necessary action.

Encl: Report – 1 No

16/4/15

For CHIEF ENGINEER,
State Ground and Surface Water
Resources Data Centre, Chennai-113

REPORT ON IMPACT OF COAL BED METHANE EXPLORATION IN MANNARGUDI BLOCK OF THIRUVARUR DISTRICT.

LOCATION

Mannargudi Block is one among 10 blocks of Thiruvarur District. Which is almost centre of Cauvery deltaic region. The delta is granary of Tamilnadu. Mannargudi block is surrounded by Thiruthuraipoondi, Kottur in southern side Thiruvarur in Eastern side. Koradacherry, Needemangalam in Northern side and Orathanadu, Madukkur of Thanjavur district in Western side. The area of Mannargudi block is 26745 hectares. Total population in Mannargudi block is 308059.

GEOLOGY

The block is covered by quaternary formation underlined by Pliocene and Miocene formation of tertiary age. Quaternary formation consists of sand, silt, clay and Tertiary formation consists of fine to coarse grained sand, sand stone, clay and calcarious materials. The sand has high porosity, hence the aquifers are good. The formation in the eastern side, as well as southern side of the block is deposited under marine condition hence the groundwater is generally saline below 6m in this region.

HYDROGEOLOGY

Mannargudi is an only block in Thiruvarur district has good quality and good quantity of ground water. The average annual rainfall of the area is 1131 mm. The shallow water level in Mannargudi is 9.38 m. BGL observed on 19/01/2006 and the deepest water level is 24.87m. BGL observed on 08/07/2014. The recharge of the ground water is carried out by rainwater as well as surface water. The depletion of ground water in Mannargudi block is in alarming stage due to paddy cultivation even in summer periods

also. The majority of cultivation is paddy followed by Sugarcane, Cotton, Gingelly, Groundnut and Pulses.

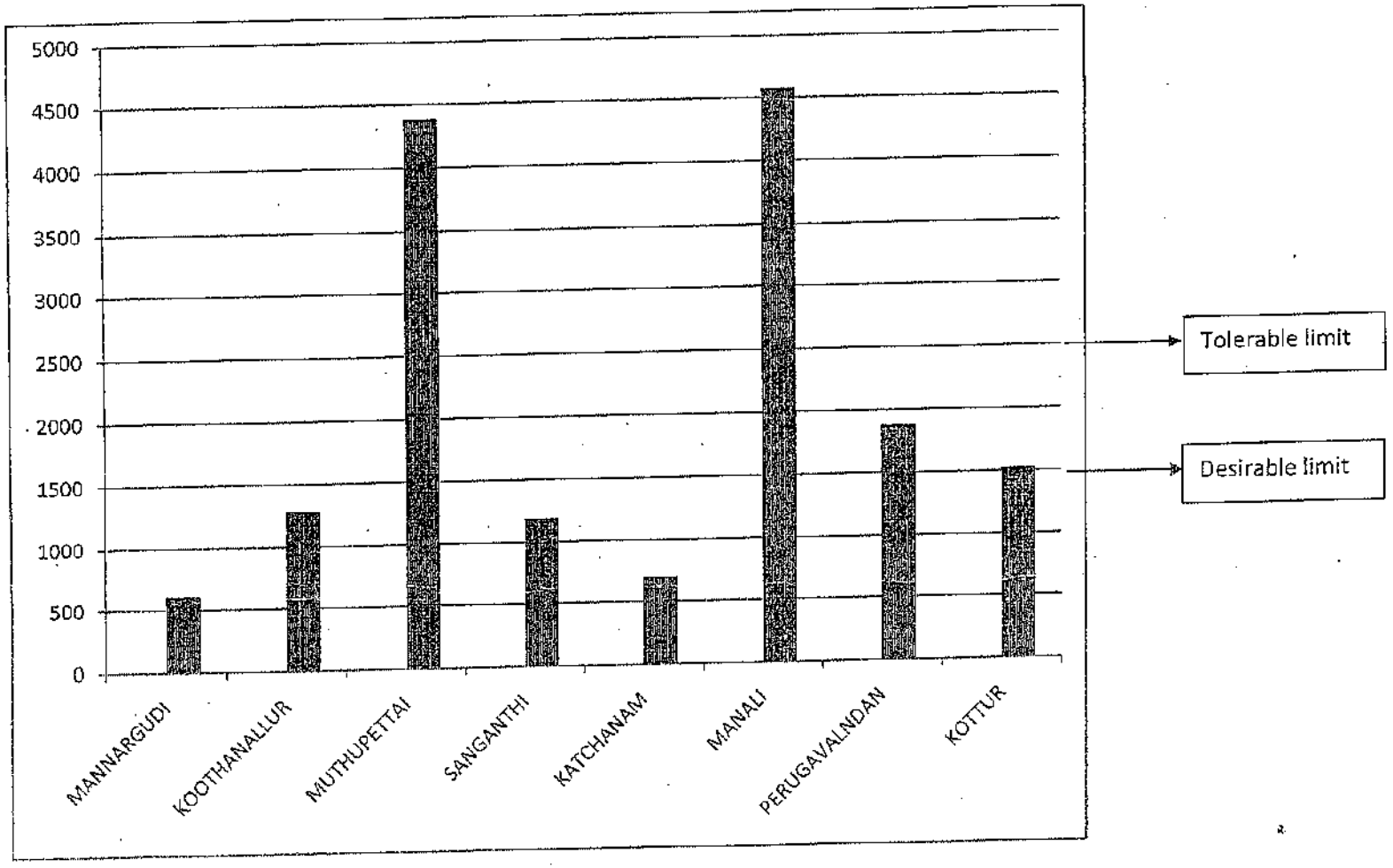
GENERAL SCENERIO

There are 10 blocks in Thiruvarur district. As per the groundwater assessment 2009, Valangaiman, Kudavasal, Nannilam blocks are categorized as Over Exploited blocks and Koradachery,Kottur,Mannargudi and Needamangalam blocks are coming under safe category. Thiruvarur is the only block which comes under semi critical. Both Thiruthuraipoondi and Muthupettai blocks are saline in nature. Though the Mannargudi block is in Safe category, the surrounding Thiruthuraipoondi and Muthupettai blocks are saline blocks and also adjacent Kottur block is in Safe category but the quality of Ground water is not good. Kilvelur, Keelaiyur and Thalaignayar Blocks of Nagapattinam District also present in the eastern side. These Blocks are also saline Blocks. In Mannargudi area, quality of Ground Water is good and its Electrical conductivity value range between 560 to 610 µs/cm. United Nation Development Programme had thoroughly investigated the area, which suggested that the large scale of ground water extraction will lead to land subsidence. This in turn will make geotectonic movement. It will affect the entire delta region. There is a possibility of Sea water intrusion in the area if ground water extraction is in large scale. The formation is deposited as layers. If any layer is disturbed by means of over extraction, definitely it will have an impact in the area. The farmers in the area mainly depend on ground water for the cultivation in lean months. There should be ground water monitoring network to save the granary.

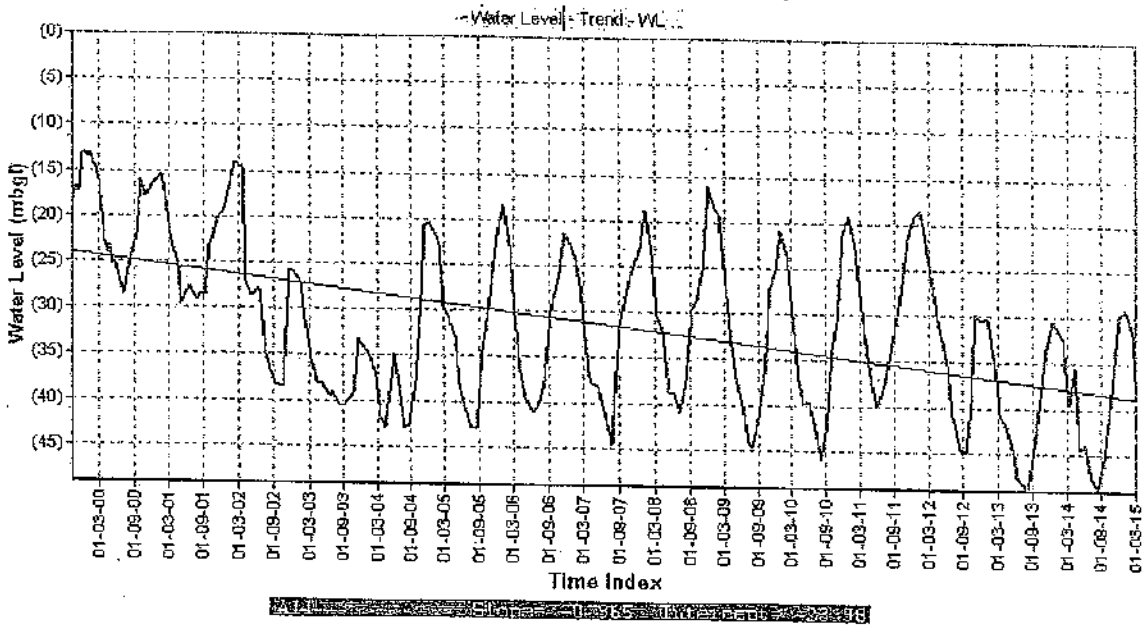
For CHIEF ENGINEER,
SG&SWRDC, CHENNAI-113

Electrical Conductivity Values

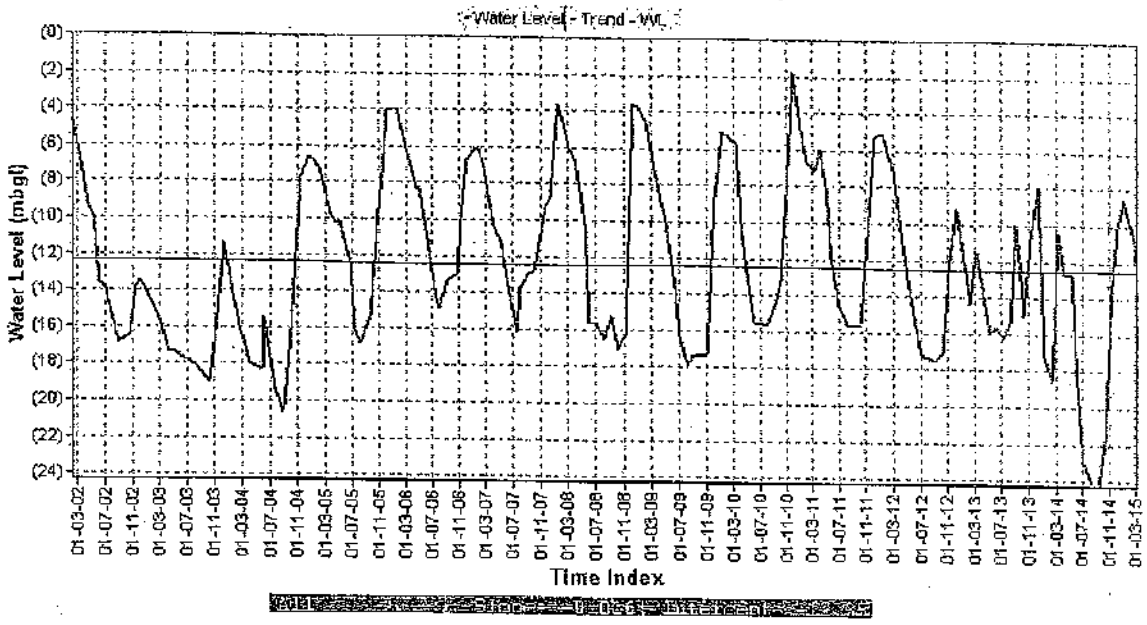
Thiruvarur District

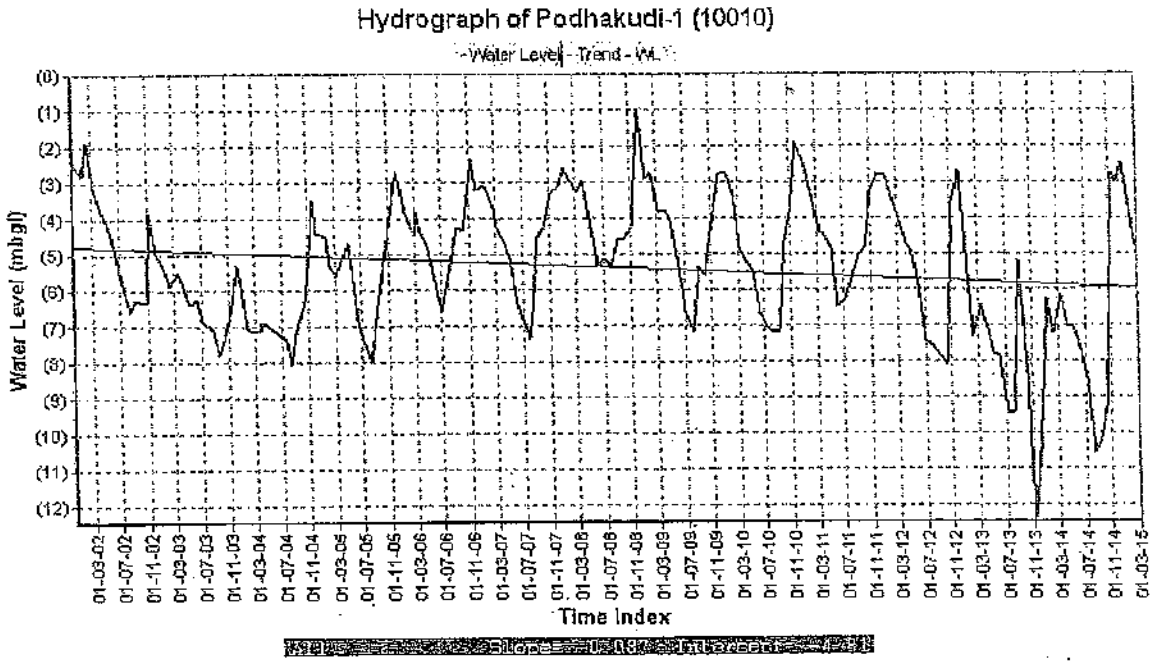


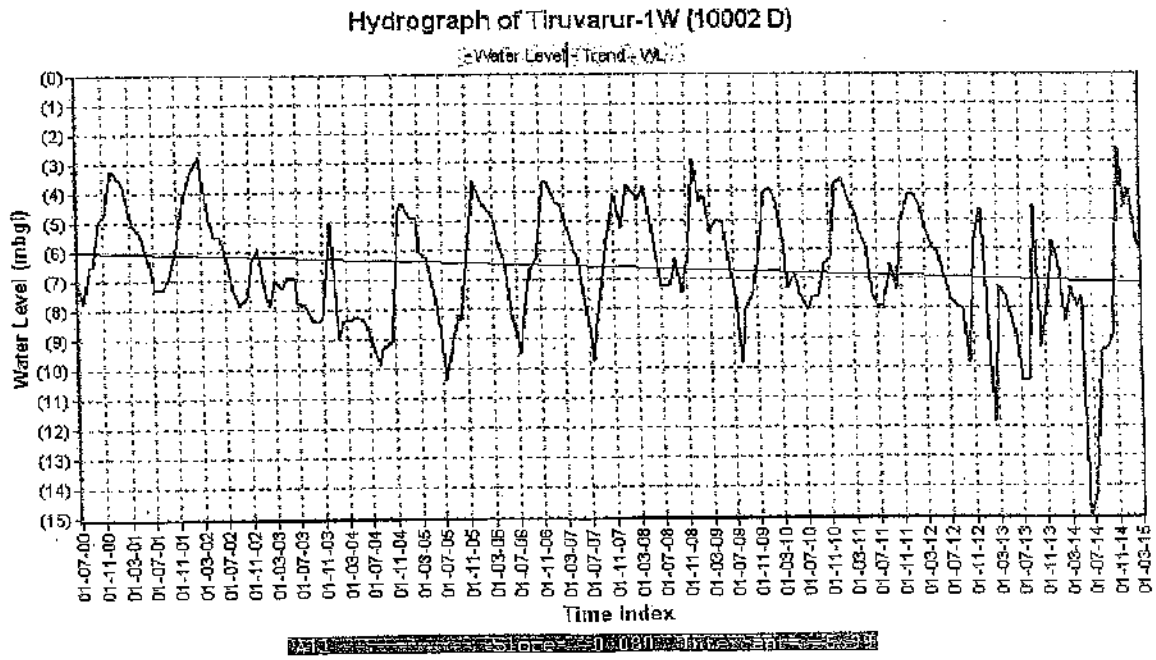
Hydrograph of Eachankottai (08014 D)



Hydrograph of Mannargudi-1 (10008)




Hydrograph of Podhakudi-1 (10010)
Water Level - Trend - WL
Water Level (mbgl)
Time Index


Hydrograph of Tiruvarur-1W (10002 D)
Water Level - Trend - WL
Water Level (mbgl)
Time Index

Details pertaining to M/S Great Eastern Energy Corporation Ltd. activities at Thanjavur district.

particulars	Core Hole Number										
	CH.-1	CH -2	CH-3	CH - 4	CH -31	CH -32	CH-33	CH-34	CH-35	CH-36	CH -37
S.F. No	272-5A & 255-2	77/2,78/2,78/3	142-3,142-4,142-5B	Not finalized							
Latitude and Longtitude	N 10°54'26.58" and E 79° 28' 2.40"	N 10°54'6.54" and E 79°29'50.58"	N 10°54' 5.82" and E 79°28' 49.92"	N 10°53'0.48" and E 79°27' 30.12"	N 10°56.5' 5.10" and E 79°29' 20.22"	N 10°57' 48.05" and E 79° 28.59' 70"	N 10°58' 50.16" and E 79° 28.51' 36"	N 10°59' 58.62" and E 79° 29.40' 20"	N 11°1.41' 64" and E 79° 29.51' 42"	N 10°55'49.92" and E 79°28'10.50"	N 10°54'49.08" and E 79° 26' 59.04"
Village	Kothangudi	Perappadi	Vanduvancheri	Tiruchirai	Tukkachi	Ammangudi	Vitalur	Kilmaruthuvakudi	Narsingampettai	Kumaramangalam	Natchiyarkoil
Taluk	Kumbakonam	Kumbakonam	Kumbakonam	Kumbakonam	Kumbakonam	Kumbakonam	Kumbakonam	Thiruvidaimaruthur	Thiruvidaimaruthur	Kumbakonam	Kumbakonam
Revenue District	Thanjavur	Thanjavur	Thanjavur	Thanjavur	Thanjavur	Thanjavur	Thanjavur	Thanjavur	Thanjavur	Thanjavur	Thanjavur
Local Body	Village Panchayat	Village Panchayat	Village Panchayat	Village Panchayat	Village Panchayat	Village Panchayat	Village Panchayat	Village Panchayat	Village Panchayat	Village Panchayat	Village Panchayat
East	wet agriculture	wet agriculture land	Agricultural Land	Residence	Paddy field	paddy field	dry land	wet agriculture	coconut trees	Paddy field	wet agriculture
West	Residence	wet agriculture land	Agricultural Land	Agricultural Land	Paddy field	paddy field	Mud road, houses	wet agriculture	hamlet	Paddy field	Road, Wet Agriculture
North	wet agriculture	Road, Paddy Field	Agricultural Land	Residence, Temple	Paddy field	paddy field	wet agriculture land	sugar cane	sugar cane field	Paddy field	hamlet
South	wet agriculture	wet agriculture land	Agricultural Land	Agricultural Land	Paddy field	paddy field	dry land lakshmi narayana temple	wet agriculture Railway line	sugar cane field	Paddy field	wet agriculture
Details of near by water bodies	Thirumalai rajanar river	Mudikondan River	Thirumalai rajanar river ; Mudikondan River	Mudikondan River, Kudamuriti River	Arasalar River	Krittamanar River	Nattar River , Krittamanar River	Veerachozhan River	Pallar River, Nandalar River , Marijalara River, Cauvery River	Arasalar River	Thirumalai Rajan River
Aerial distance of water bodies from site(Km)	0.2 NE	0.5	0.74 NNW	0.16 NE	0.94 SSE	0.82 N	0.08NW, 0.93 S	1.25	3.63 NNW, 0.70 SE, 3.57 E, 0.71 NNW	0.51 SSW	0.76 South
No. of Ponds	3	7	3	6	2	4	4	6	9	3	3
Aerial distance from site(Km)	0.73 SE,1.5	0.89 NE, 0.17 NE	0.72 NW, 0.61 SW	0.7 NE, 0.62 SW	0.72 NE, 1.5	1.5	0.18 NW, 0.61 NW, 0.62 NE, 0.27 SE	1.5	2	2	0.53 NW, 0.6 NE, 0.43 NE

ANNEXURE - VII

particulars	Core Hole Number										
	CH -1	CH - 2	CH-3	CH -4	CH -31	CH -32	CH-33	CH-34	CH-35	CH-36	CH -37
Habitation	Kothangudi	Perappadi, Koohur, Kandramanickam	Allanur, Koohur	Thiruchirai , Panthi	Tukkachi	Vilangkudy, Thirumalarajan	Vitalur	Kilamaruthuvakudi , Thiruneelakudy, Maruthuvakugy	Thiyagarajapuram	Tandatottam	Nachiyar koil
Aerial distance Distance (m)	488 NE	120 E,471NW, 796 NE	574 N , 354 SW	383 SW, 1.5	755 SW	1.5	157S	2	331 W	635 S	106 N
population (in thousands)	1.959	1.403	1.471	3.38	2.19	2.1	1.68	3.8	1.7	1.35	7.128
No. of temples	7	Temple:08 Church:02	3	7	5	Temple:7, church:2	Temple:5 Church:4	6	15	8	2
No. of Historical monuments	0	0	0	0	0	0	0	0	0	0	0
No. of Drinking water Bore Wells	4	12	6	10	3	1	8	4	5	4	12
No. of Irrigation Bore Wells	73	64	11	70	30	96	150	45	106	30	13
No. of canals	4	5	2	4	3	57	15	30	2	2	0
No. of River	1	1	2	2	1	1	2	1	1	1	1
Area of Agricultural Land in Hectare	244.91	164.11	119.42	123.61	232.81	252.96	274.23	266.52	118.57	209.16	121.9
Area of Crop Cultivated in Hectare	215.98	164.11	96.98	65	232.81	242.28	256.47	246.8	72.57	209.16	83.88

District Environmental Engineer,
Tamil Nadu Pollution Control Board,
Thanjavur.

Details pertaining to M/s. Great Eastern Energy Corporation ltd activities at Thiruvarur District :

Sl. No.	Core Hole No	Taluk	Name of Village	Population	Distance of Habitation in KM	Rivers/canals	Borewells		Agriculture area Hect	Crop cultivated (single/ double/three)	No. of temples/ historical monument
							Irrigation	Domestic			
1.	CH-5	Kudavasal	Sithadi	1875	0.41	Mudikondan river Adipuliyur river	60	6	150	3	2
2.	CH-6	Kudavasal	Kudavasal	17997	0.18	Puttar river	120	3	380	1	1
3.	CH-7	Kudavasal	Melapalaiyur	1300	0.11	Vettar river Sullan river	26	3	134	1	-
4.	CH-8	Kudavasal	Maluvachery	173	0.22	Cholasudamani river	10	1	20	2	-
5.	CH-9	Kudavasal	Ohai	950	0.63	Cholasudamani river	24	1	250	1	1
6	CH-10	Kudavasal	Keelapaliyur	1530	0.23	Vettar river	30	2	222.63	1	4
7.	CH-11	Valangaiman	Saranatham	2157	0.36	Vettar river	27	7	334	1	-
8.	CH-12	Valangaiman	Manickamangalam	1600	0.47	Vettar river	34	4	281.77	2	-
9.	CH-13	Kudavasal	Kamukakudi	1357	0.27	Vennar river Vettar river Rajan vaikal	24	7	434.09	3	-
10.	CH-14	Kudavasal	Pathur	5000	0.18	Vettar river Vadaku rajan vaikal	28	6	195	2	1

11.	CH-15	Valangaiman	Kottaiyur	2095	0.42	Vennar river Kottaiyur vaikal	45	9	266.54	2	1
12.	CH-16	Needamangalam	Hanumanthapuram	1175	0.23	Vennar river Hanumanthapuram vaikal	43	7	308.41	2	1
13.	CH-17	Kudavasal	Koradacheri	6575	0.73	Vennar river Vettar river Mangudi vaikal Oorugudi vaikal Perumalagaram vaikal Elangargudy vaikal	42	18	223.96	2	1
14.	CH-18	Needamangalam	Poovanur	2734	0.33	Pamini river Koraiyar river	112	8	476.25.50	2	1
15.	CH-19	Needamangalam	Keelalavandhacheri (Thondilam)	1150	0.62	Koraiyar river	45	7	249.60	2	-
16.	CH-20	Mannargudi	Karnavur	1840	0.26	Agamalan river	55	10	397.28.0	1	-
17.	CH-21	Mannargudi	Vadapathi	2100	0.62	Pamini river Koraiyar river	28	14	320.00	2	1
18.	CH-22	Mannargudi	Serankulam	3900	0.79	Pamini river	25	11	160.00	2	-
19.	CH-23	Mannargudi	Manargudi	66997	0.1	Pamini river	15	23	64.00	2	1 (Rajagopala swamy temple at 1.5 km)

20.	CH-24	Mannargudi	Aravathur	952	0.28	Pamini river	42	4	254.00	1	-
21.	CH-25	Mannargudi	Savala Karan	3428	0.73	Agamalan river Savalaikkaran vaikal	34	8	341.00	1	-
22.	CH-26	Needamangalam	Arichapuram	1450	0.63	Koolaiyar river	19	15	174.105	2	-
23.	CH-27	Needamangalam	Hanumanthapuram	1175	-	Koraiyar river Pandavaiyar river Hanumanthapuram vaikal	43	7	308.41	2	1
24.	CH-28	Kudavasal	Arpar	930	0.65	Vettar river Rajan vaikal	26	3	356.00	3	-
25.	CH-29	Kudavasal	Manjakudi	2245	0.12	Cholasudamani river	180	7	220.00	1	-
26.	CH-30	Kudavasal	Vadaver	1595	0.87	Puttar river Kudamuruty river Vadaver vaikal	28	3	127.01	2	1
27.	CH-38	Valangaiman	Kil Vadayal	1700	0.73	Kudamuruty river Sullan river	52	7	369.33.50	2	2
28.	CH-39	Valangaiman	Rajendranallur	425	0.1.	Vettar river Vennar river	10	2	181.69	2	-
29.	CH-40	Valangaiman	Narthangudi	1560	0.26	Vennar river	46	5	200.64	2	-
30.	CH-41	Needamangalam	Koilvenni	4226	0.46	Vennar river	155	21	524.00	3	2
31.	CH-42	Needamangalam	Adhanur	3663	0.24	Puthur vaikkal vadapathi vaikal Thenpathi vaikal	180	20	398.02.75	3	1

32.	CH-44	Valangaiman	Kandiyur	1325	0.16	Vettar river Sullan river	13	4	388.68	2	-
33.	CH-46	Kudavasal	Sellur	2578	0.16	Vettar river Rajan vaikal	18	5	249.63	2	2
34.	CH-48	Needamangalam	Annavasal	1200	0.8	Koraiyar river Koolaiyar river	49	5	311.00	2	-
35.	CH-49	Mannargudi	Kalanjimedu	2850	0.28	Pamini river	260	9	415.00	2	-

All the data are collected from the respective VAO

District Environmental Engineer
TamilNadu Pollution Control Board
Nagapattinam

ANNEXURE - VIII

From	To
Thiru S.B.R. Jeyaseelan, M.Sc., Assistant Director (I/C), Geology and Mining, Nagapattinam / Thiruvarur.	The Chairman, Tamil Nadu Pollution Control Board, 76, Mount Salai, Guindy, Chennai – 600 032.
R.C.No.17 / (G&M) / 2013 dated 26-12-2014	

Sir,

Sub : TNPCB – Industries – Coal Bed Methane Exploration project of M/s. Great Eastern Energy Corporation Ltd., at Mannargudi Block of Thanjavur and Thiruvarur District – Overlapping areas between Oil and Natural Gas Corporation Limited and M/s. Great Eastern Energy Corporation Ltd., - Report – Called for – Sent.

Ref : Chairman, Tamil Nadu Pollution Control Board, Chennai Letter No.T3/TNPCB/F23633/ETC/2014 dated 08-12-2014

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I invite kind attention to the reference cited, wherein, it has been requested to send report regarding the overlapping of areas of Tvl. Oil and Natural Gas Corporation Ltd., and Tvl. Great Eastern Energy Corporation Ltd., in their lease area to an extent of 667 Sq. Kms. In this connection, I send my report as follows :

The ED Basin Manager, Cauvery Basin, ONGC, Chennai had requested to grant Petroleum Mining Lease in respect of L – II PML for an area of 824.30 Sq.Kms. in Thiruvarur District for 7 years with effect from the date of grant of Petroleum Mining Lease.

On knowing the fact that Tvl. ONGC has applied for the grant of mining lease for an area of 1542.02 Sq.Kms. for L – II Block falling in the Districts of Thiruvarur, Nagapattinam, Thanjavur and Pudukottai, Tvl. Great Eastern Energy Corporation Ltd., have given objections through their fax letter dated 07-03-2013 addressed to the Assistant Director of Geology and Mining, Nagapattinam / Thiruvarur with a copy to the Principal Secretary to Government, Industries Department, Secretariat, Chennai, stating that the mining lease applied for by Tvl. ONGC should not be entertained and should be summarily rejected, as it is contrary to the CBM contract signed with Ministry of Petroleum and Natural Gas and Environmental Clearance issued to them by the competent authorities.

Following the objections as stated above, remarks were called for from the ED-Basin Manager, Cauvery Basin, ONGC, Egmore, Chennai. In his letter No.SS/ED-BM, Cau./ LI & II / 2013 dated 08-07-2013, the ED-Basin Manager, Cauvery Basin, ONGC, Egmore, Chennai, has sent his remarks as follows :

"This is to inform that Cauvery Basin is a very prospective basin and ONGC is having two nomination blocks viz., L – I and L – II since 01-04-1986 and the current PELs valid upto March 2013 and now they have been converted to PMLs with validity upto 2019. ONGC's intensive exploration efforts in these PEL blocks have resulted in many discoveries with resultant conversion of the part areas to PMLs and production activities. The overlapping area also encompasses four ONGC operated PMLs viz., Mattur, Kuthalam, Kuthalam – 1 and Kuthanallur, which have production and transportation facilities and are currently on production. It is to be noted that ONGC has duly paid the stipulated levies for licenses as well as for leases, in compliance of the P&NG rules.

In view of the prospectivity and highly encouraging results obtained in these two PEL blocks in the recent past, ONGC has proposed to convert the entire existing PEL areas to PMLs for a limited period of seven years, to execute its intended drilling programme, appraise discovery / leads and complete the assessment of these areas to establish envisaged accretion of around 100 MMt (O+OEG).

It is in the knowledge of MoPNG and DGH that part areas of L – I and L – II PMLs in Cauvery on land basin are overlapping with block MG-CBM-2008 / 4 which was awarded under CBM round IV in the year 2010 to GEECL with an area of 667 Sq.Km. in the State of Tamil Nadu, of this, 27.70 Sq.Km and 266.02 Sq.Km overlap with L – I and L – II nomination PEL blocks (now PML blocks) respectively. The issue of overlapping was discussed in meetings organized by DGH and ONGC in which ONGC and GEECL had participated.

Subsequently after considering that ONGC was awarded the blocks in 1986 much earlier than that of the CBM block awarded to GEECL and the fact that ONGC is pursuing active exploration in the area along with hydrocarbon production, MoPNG has granted PML for an area measuring 1542.02 Sq.Km. in L – II block to ONGC in the national interest on 08-02-2013. In view of the above clarifications provided, it is requested to kindly grant PML for an area of 1542.02 Sq.Km. in L – II block to ONGC so that ONGC's activities are not jeopardised".

In the circumstances explained above, by the ED-Basin Manager, Cauvery Basin, ONGC, Egmore, Chennai, report has been sent to the Secretary to Government, Industries Department, Secretariat, Chennai through the Commissioner of Geology and Mining, Guindy, Chennai by the District Collector, Thiruvarur as per this office R.C.No.17/G&M/2013 dated 22-02-2014. This is submitted for favour of information. I send herewith a copy of the objections received from Tvl. Great Eastern Energy Corporation Ltd., and a copy of the remarks obtained from the ED-Basin Manager, ONGC, Chennai, for favour of reference.

Enclosures:- As above

Yours faithfully,

26.02.14

Assistant Director (I/C),
Geology and Mining,
Nagapattinam / Thiruvarur.

Copy to the District Environmental Engineer, Tamil Nadu Pollution Control Board, Nagapattinam.

Copy submitted to the Commissioner of Geology and Mining, Industrial Estate, Guindy, Chennai – 32,

GREAT EASTERN ENERGY CORPORATION LTD

March 7, 2013

Mr. S.B.R. Jayaseelan
The Assistant Director Mines
Directorate of Geology & Mining
Nagapattinam District
Tamil Nadu

Sub: Rejection of recommendation of Mining Lease to ONGC in our CBM Block

Dear Sir,

Please find below a note giving the details of the illegal encroachment of ONGC in our Mannargudi CBM Block.

- Great Eastern Energy Corporation Limited (GEECL) bid for the Mannargudi block on the basis of the Notice Inviting Offer (NIO) issued by Directorate General of Hydrocarbons (DGH). Nowhere in the bid document it was mentioned that any operator is/was working in the said Block. On the contrary, it was clearly mentioned that *"No Operator" was working nearby the said block.*

- Thereafter, GEECL was allocated the said Block exclusively for CBM which spreads in an effective area of 667 sq. km and signed the CBM Contract on July 29, 2010 ("CBM Contract").

- On the recommendation of the Ministry of Petroleum & Natural Gas (MoPNG), district-wise Petroleum Exploration License (PEL) were issued to us by the Government of Tamil Nadu on entire area of 667 sq. km for exclusively carrying out the CBM operations (two separate PEL were issued for two different districts). Copies of the same were duly submitted with and accepted by MoPNG and DGH.

- When we started searching around the awarded block for identification of sites, to our utter dismay, we came across many sites already occupied by ONGC in our Block under their old PEL.

- On September 12, 2012, Ministry of Environment & Forest also issued Environment Clearance to us for conducting CBM operations in the Mannargudi Block.

We were given to understand that ONGC has applied for Mining Lease in our area which should not be entertained and should be summarily rejected as it is contrary to the CBM Contract signed with MoPNG and PEL and Environment Clearance issued to us by the Competent authorities.

Thanking you

For Great Eastern Energy Corporation Limited

Uday Chadha
DGM-Legal & Company Secretary

Great Eastern Energy Corporation Ltd.

Cc: Mr. N.S. Palaniappan, Principal Secretary, Ministry of Industries

YKM Holdings

Signature Towers - A, 14th Floor, South City, NH-8, Gurgaon 122 001 (Haryana)
T : +91 - 124 - 455 9900 F : +91 - 124 - 258 0467 www.geecl.com

Regd. Office : M - 10, ADDA Industrial Estate, Asansol 713 305 (West Bengal)

13928

OIL AND NATURAL GAS CORPORATION LTD.
(Regd. Office: Jeevan Bharti, Tower II, 124, Indira Chowk, New Delhi- 110 001)

DR.B.S. JOSYULU
ED-Basin Manager, Cauvery

Cauvery Basin
XI floor, East Wing, Thalamuthu Natarajan Maaligai,
No: 1, Gandhi-Irwin Road
Egmore, Chennai-600 008
Phone: 044-28542525, Fax: 044-28591279

No.SS/ED-BM, Cau./L1 & II/2013
8th July 2013

To

Thiru S.Natarajan, I.A.S.
District Collector
Thiruvarur.

Sub: Mines and Minerals – Thiruvarur District – Petroleum Exploration Licenses to Oil and Natural Gas Corporation Ltd., - Application for the grant of Petroleum Mining Lease (PML) for L-II for an area of 1542.02 Sq.Kms.- Reg.

Ref: District Collector, Thiruvarur, No.R.C.No.17/G&M/2013 dated 20.06.2013

Sir,

This has reference to your letter under reference above, wherein it is intimated that Great Eastern Energy Corporation Ltd. (GEECL) has raised an issue of overlapping area in the nomination PML block L-II of ONGC awarded by MOPNG.

This is to inform you that Cauvery Basin is a very prospective basin and ONGC is having two nomination blcoks viz. L-I & L-II since 01.04.1986 and the current PELs were valid upto March 2013 and now they have been converted to PMLs with validity upto 2019. ONGC's intensive exploration efforts in these PEL blocks have resulted in many discoveries with resultant conversion of the part areas to PMLs and production activities. The overlapping area also encompasses four ONGC operated PMLs viz., Mattur, Kuthalam, Kuthalam-13 and Kuthanallur, which have production and transportation facilities and are currently on production. It is to be noted that ONGC has duly paid the stipulated levies for licenses as well as for leases, in compliance of the P&NG rules.

In view of the prospectivity and highly encouraging results obtained in these two PEL blocks in the recent past, ONGC had proposed to convert the entire existing PEL areas to PMLs for a limited period of seven years, to execute its intended drilling programme, appraise discovery/leads and complete the assessment of these areas to establish envisaged accretion of around 100 MMt (O+OEG).

It is in the knowledge of MoPNG and DGH that part areas of L-I and L-II PMLs in Cauvery onland basin are overlapping with block MG-CBM-2008/4 which was awarded under CBM round IV in the year 2010 to GEECL with an area of 667 Sq.km. in the state of Tamil Nadu. Of this 27.70 Sq.km. and 266.02 Sq.km. overlap with L-I and L-II nomination PEL blocks (now PML blocks) respectively. The issue of overlapping was discussed in meetings organised by DGH and ONGC in which ONGC and GEECL had participated.

Subsequently after considering that ONGC was awarded the blocks in 1986 much earlier that the CBM block awarded to GEECL and the fact that ONGC is pursuing active exploration in the area along with hydrocarbon production, MoPNG has granted PML for an area measuring 1542.02 Sq.km. in L-II block to ONGC in the national interest on 08.02.2013.

In view of the above clarifications provided, it is requested to kindly grant PML for an area of 1542.02 Sq.Km. in L-II block to ONGC so that ONGC's activities are not jeopardised.

Regards,

Yours sincerely,

08.07.2013

(Dr.B.S. Josyulu)
ED-Basin Manager, Cauvery

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06 AN 2015

From

Thiru C.Sampath, M.Sc.,
Assistant Director,
Geology and Mining,
Thanjavur.

To

The Commissioner of Geology and Mining,
Industrial Estate,
Guindy,
Chennai – 32.

R.C. No.767/ Mines / 2010, Dated 5 .01.2015

Sir,

Sub : Mines and Minerals – Petroleum Exploration License granted to Tvl. Great Eastern Energy Corporation Ltd., (GEECL) for Coal Bed Methane –Status report – Called for – Sent.

*****

Tvl.Great Eastern Energy Corporation Ltd., of Gurganon, Haryana vide letter dated 27.10.201 have applied for grant of PEL (Petroleum Exploration Licence) to exploit coal bed methane in Mannaugudi CBM Block MG-CBM-2008/IV measuring over an area of 667 sq.km falling in two District Thiruvarur 392.944 sq.km and Thanjavur 274.056 sq.km for 4 years as per Rule 5(1) of Petroleum & Natural Gas Rules, 1959.

The Petroleum Exploration License application preferred by Tvl.Great Eastern Energy Corporation Ltd., Gurgaon, Haryana Block MG-CBM-2008/IV over an extent of 274.052 sq.km in Thanjavur District is recommended and forwarded to the Government through Commissioner of Geology and Mining, Chennai for 4 years as per Petroleum and Natural Gas Rules, 1959 vide this office letter no.767/2010(Mines), dated 16.12.2010.

The Government have granted Petroleum Exploration License to Tvl.Great Eastern Energy Corporation Limited for exploration and production of Coal Bed Methane in Mannargudi Block No.MG-CBM/IV over an area of 661 sq.kms (effective area for operation is 667 sq.kms) (392.44 sq.kms in Thiruvarur Districts and 274.056 sq.kms in Thanjavur District) for a period of 4 years subject to certain conditions vide G.O.(3D)No.01/Industries (MMA1) Department, dated 01.1.2011.

Lease deed was executed on 04.11.2011 and the same was registered in Orathanad Sub Registrar's office vide Doc.No.63, dated 22.11.2011.

No Renewal application was submitted by Tvl. Great Eastern Energy Corporation Ltd., of Gurganon, Haryana till date.

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In this connection the following further details are submitted for favour of kind information in connection with the representation given by Tvl. Great Eastern Energy Corporation Limited objecting to the grant of mining lease to Tvl. ONGC.

Tvl. ONGC has given application for the grant of mining lease for an area of 948.16 Sq.Kms. in L1 Block (falling in the districts of Cuddalore, Nagapattinam, Thiruvarur, Thanjavur and Ariyalur) and for an area of 1542.02 Sq.Kms. in L11 Blcok (falling in the districts of Thiruvarur, Nagapattinam, Thanjavur and Pudukottai) stating that the existing 9th year of both PEL Blocks are expiring on 31-03-2013.

Aggrieved on the application of Tvl. ONGC for the grant of mining lease in LII Block for an area of 1542.02 Sq.Kms, Tvl. Great Eastern Energy Corporation Limited has now given representation stating that they have been allocated an area of 667 Sq. Kms. In the LII Block by the Government and the Environmental Clearance has also been issued by the Ministry of Environment and Forest on 12-09-2012. While such is the case, they were given to understand that Tvl. ONGC has applied for mining lease in their area which should not be entertained and should be summarily rejected as it is contrary to the CBM (Coal Bed Methane) contract signed with Ministry of Petroleum and Natural Gas and PEL and Environmental Clearance issued by the competent authorities.

In this connection it is submitted that the petroleum exploration license was granted to Tvl. Great Eastern Energy Corporation Ltd., by the Government in GO (3D) No.01, Industries (MMA-I) Department dated.01.01.2011 and the lease deed was executed by Tvl. Great Eastern Energy Corporation Ltd., on 04.11.2011. Tvl. Great Eastern Energy Corporation Ltd., have remitted the license fee of Rs. 7,67,357/- for IVth year on 17.11.2014.

Assistant Director,
Geology and Mining,
Thanjavur.

Copy To,
The District Environmental Engineer,
Tamil Nadu Pollution Control Board,
Thanajvur.