



## GOVERNMENT OF KERALA

### Abstract

Local Self Government Department - Detailed Project Proposal submitted by BPCL for setting up Compressed Biogas Plant at Kochi - Approved - Orders Issued

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### LOCAL SELF GOVERNMENT (WM) DEPARTMENT

G.O.(Ms)No.206/2023/LSGD Dated,Thiruvananthapuram, 23-11-2023

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- Read:-
- (1) GO(Ms) No. 150/2023/LSGD dated 29.07.2023.
  - (2) Letter No. KR.ED(KR).13 dated 03.10.2023 from Executive Director (Kochi Refinery), Bharat Petroleum Corporation Limited.
  - (3) Minutes of meeting held with BPCL on 13.10.2023 to discuss modification suggestions on the DPR submitted
  - (4) Response of BPCL dated 19.10.2023
  - (5) Remarks of CE LSGD on the BPCL response

### ORDER

As per Government Order read as 1<sup>st</sup> paper above, in principle sanction was accorded to BPCL for setting up a Plant at Kochi for converting biodegradable waste into Compressed Bio Gas (CBG). BPCL was required to submit DPR of the project by 1<sup>st</sup> October, 2023. As per letter read as 2<sup>nd</sup> paper above, BPCL submitted Detailed Project Proposal for establishing Compressed Bio Gas (CBG) Plant at Brahmapuram, Kochi. A follow up meeting was held with BPCL to provide feedback on certain aspects of the DPR and to discuss and clarify the DPR. As per mail read as 4<sup>th</sup> paper above, BPCL submitted its response to the queries raised and observations made on 19.10.2023. The subsequent inputs of the CE LSGD were received on 4.11.2023 as per letter read as 5<sup>th</sup> paper above.

(2) Government have examined the matter in detail and are pleased to approve the Detailed Project Proposal submitted by BPCL as appended to this Government Order with the following modifications and conditions.

Section 15a Disposal of rejects	Disposal of rejects shall be done with the help of CKCL
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Section 15a Release of treated water into the STP	The plant at Brahmapuram is a 100 KLD FSTP. So it cannot take additional load of treated water which comes to approximately 100 MLD. Sale agreement of liquid organic fermented manure is to be arranged by BPCL for which there is adequate time. ETP conforming to PCB guidelines for management of waste water is to be ensured.
Section 15b Requirement of 10 acre land free of cost on a long term basis	The possession of land for the project by BPCL is limited to the project life period.
Section 15b Regarding the issue of 7m width road access to the site.	Kochi Municipal Corporation is to provide necessary support for providing road of 7m width for access to the site.
Section 15 c & d Power and Water for construction and operation work	Issue of supply of 1.5 MW power shall be considered by KMC. Work may commence by using the water of Kadambayar, and additional requirement (borewell) if needed, can be considered later.
Carbon credit	The matter shall be open for deliberation at a later stage as and when the need arises.

Conditions :

1. The approval is subject to the PCB's consent to operate
2. The decision of the regulatory commission on concessional tariff, will be binding.

(By order of the Governor)

SARADA MURALEEDHARAN I A S  
ADDITIONAL CHIEF SECRETARY

To:

The Principal Director, Local Self Government Department.

The Executive Director, BPCL, Kochi.

The Secretary, Kochi Municipal Corporation.

The Principal Accountant General (A&E) / (Audit I) / (Audit II), Kerala,  
Thiruvananthapuram.

General Administration (SC) Department (Item No.....dtd.....)

The Executive Director, Information Kerala Mission.

I&PR (Web & New Media) Department.

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Forwarded /By order

Signed by

M.k.pradeesh Kumar

Date: 24-11-2023 16:03:21

Section Officer

Copy to :- Private Secretary to Hon'ble Chief Minister.

Private Secretary to Hon'ble Minister LSGD

PA to Additional Chief Secretary, LSGD

3 October 2023

## Detailed Project Proposal MSW to Compressed Biogas (CBG) Plant at Brahmapuram, Kochi

### 1. Introduction & Background

The management of Municipal Solid Waste (MSW) in India has surfaced or continued to be a severe problem not only because of environmental and aesthetic concerns but also because of the enormous quantities generated every day. In Kerala also, especially in urban areas including Ernakulam, for many years, this remains a serious problem. As per the estimates, there has been a large quantity of legacy waste accumulated in Brahmapuram waste treatment plant, which is very near to Kochi Refinery. Frequent fires and odour issues over there have posed concerns to both safety of the Kochi refinery and health issues of public at large.

BPCL had a meeting on 3<sup>rd</sup> May 2023 with Hon'ble Minister for Industries, Hon'ble Minister for LSG and Chief Secretary, Government of Kerala (GoK) wherein BPCL proposed to set up 100 MT/D Municipal Solid Waste (MSW) to CBG plant. Hon'ble Ministers requested BPCL to increase the capacity of the plant to 240 MT/D as 180 MT/D MSW from Kochi Municipal Corporation and 60 MT/D MSW from nearby local bodies shall be made available for the plant by GoK. BPCL received the approved Minutes of the Meeting on 5<sup>th</sup> June 2023 where GoK provided in principal agreement for the proposal (Copy of the approved Minutes of Meeting attached as Annexure-1).

Subsequent deliberations happened through following meetings between GoK and BPCL:

- Meeting called by Additional Chief Secretary, LSGD on 15<sup>th</sup> May 2023
- Chief Secretary, GoK had status review meeting with Kochi Refinery on 10<sup>th</sup> July 2023.
- Discussion held on 12<sup>th</sup> July 2023 among Chief Secretary, GoK, Additional Chief Secretary, LSGD, GoK and CMD BPCL

### 2. Sanction accorded by GoK on BPCL Proposal and Order issued on 29<sup>th</sup> July 2023

GoK accorded sanction to BPCL's proposal for setting up the plant and issued the order on 29<sup>th</sup> July 2023. GoK has committed the following for successful installation and operation of the plant:

- a. **MSW Availability:** 150 MT/D MSW (organic fraction) shall be made available. The MSW may have 5-10% impurities. BPCL will install necessary facility for handling 5-10% impurities. Kochi Corporation will support the removal of rejects that cannot be processed. Sample analysis data of MSW will be provided to BPCL.
- b. **Disposal of Rejects:** Support for disposal of rejects in a sanitary landfill as BPCL does not have requisite expertise & experience will be provided.
- c. **Land for CBG Plant:** 10 acres of land at Brahmapuram site free of cost on long term basis.

- d. **Power & Water:** Power and water will be provided during construction & operation of the plant at concessional rate.
- e. **CBG Usage:** The proposed plant will produce 4 - 5 % of CBG that shall be utilized by BPCL. GoK will provide necessary permissions for laying the pipeline from CBG plant to the refinery, the alignment of which would be proposed by BPCL later.
- f. **Solid & Liquid Organic Manure:** BPCL will tie up the necessary forward linkage for offtake of solid and liquid manure produced in the plant.
- g. **Royalty Sharing:** GoK has decided that in view of the comparatively smaller size of the plant, royalty sharing with GoK would not be insisted upon.
- h. **Carbon Credit:** The matter of accrual of carbon credits is unclear and will be decided later.
- i. **Proposal submission:** The Detailed Project Report (DPR) for the plant will be submitted by BPCL by 1<sup>st</sup> October 2023.
- j. **Project Completion:** The plant would be completed and ready for commissioning within 15 months i.e. by December 2024.

Copy of GO dated 29<sup>th</sup> July 2023 enclosed as Annexure-II.

### 3. Consultant Selection by BPCL

BPCL floated the tender for selection of consultant on 14<sup>th</sup> July 2023 with bid submission date of 28<sup>th</sup> July 2023. M/s. APROX NIGEN EQUIPMENTS PVT LTD was selected as consultant on 4<sup>th</sup> August 2023 for carrying out PMC and EPCM services at a cost of Rs 2.90 crore excluding GST.

### 4. Major Activities of the Consultant for Detailed Feasibility Study

The Consultant was advised to carry out detailed feasibility study of the project and submit proposal along with cost estimate at  $\pm 10\%$  accuracy level. Consultant was advised to carry out following major activities for the same:

- a. **Finalize the capacity of the plant based on Cost-Benefit Analysis**
- b. **Evaluate and analyse different process options available in the market for CBG plant and recommend the best option in consultation with BPCL. Recommendations shall be in detail along with financial analysis.**
- c. **Carry out Quantitative and Qualitative analysis of the feedstock independently.**
- d. **Evaluate CBG usage options as fuel in Kochi Refinery, injection in city gas distribution network and Storage and transportation to CNG outlets using cascades at 250 bar.**
- e. **Conduct land survey, soil test, etc. to check the feasibility for setting up the plant and laying pipelines for products / effluents transportation etc.**
- f. **Analyze and recommend marketing of the products.**
- g. **Overall Plot plan and plant layout confirming statutory requirements.**

- h. Activity wise bar chart for the project.
- i. Process flow chart along with mass balance.
- j. Financial, profitability and sensitivity analysis for various scenarios.

#### 5. Quantitative Analysis of MSW

Following inputs have been received from Kochi Municipal Corporation (KMC):

- a. KMC consists of 74 wards covering around 98.5 sq km area. The projected population is 6,74,000 with individual households of around 1,61,000.
- b. KMC waste management system comes under corporation public health and environmental management wing. The wing is headed by corporation Health Officer. The immediate subordinates are two clean City managers (HS), 23 health inspectors (SPHI), 74 junior health inspectors (PHI), 18 junior public health nurse (JPHN).
- c. In the grassroots level 774 contingent workers and 885 Haritha karma sena (HKS) are engaged for door-to-door waste collection.
- d. In 2009, a 300 TPD windrow composting plant was commissioned in Brahmapuram which was processing biodegradable waste collected from households and commercial establishments. Corporation also allowed surrounding municipalities and panchayats to treat their solid waste by obtaining tipping fees.
- e. On 2<sup>nd</sup> March 2023, an unexpected fire accident flared up from the scientifically capped region /sector. After that incident the corporation council decided to stop receiving solid waste from the other local bodies.
- f. The KMC has initiated new steps to ensure 100 percent segregated door to door waste collection via Haritha karma sena (HKS). Around 885 HKS personal have been recruited from each ward's Kudumbashree SHG (Self Help Group) KMC has also formalized informal waste pickers from few wards as Haritha karma sena.
- g. The HKS members collect biodegradable waste from households at 5 AM onwards, and transport to collection centers which have been decided based on heavy vehicles accessibility. From there, the biodegradable waste is transported to the Brahmapuram plant.
- h. The HKS members collect the non-biodegradable waste weekly once from the households to avoid disruption in segregation and transported to collection points. From there, it goes to Material Collection Facility (MCF), Resource Recovery Facility (RRF), finally to cement factory for Refused Derived Fuel (RDF) by the agencies who have executed agreement with the Corporation.
- i. As per Swachh Bharat Mission (SBM) calculation, biodegradable and non-biodegradable waste generation in KMC is around 233 TPD and 54 TPD respectively. Wards no. 61 & 48 and around 175 apartments have implemented decentralized systems. Therefore, collection of biodegradable waste has reduced to 150 TPD. Around 30 TPD biodegradable waste is

being collected from commercial establishments w.e.f 18<sup>th</sup> September 2023. Therefore, total biodegradable waste reaching Brahmapuram waste plant is around 180 TPD.

- j. If Corporation allows surrounding local bodies to dump their waste in Brahmapuram, the estimated biodegradable waste will be around 400 TPD.
- k. The Corporation has executed agreement with two agencies to treat biodegradable waste using black soldier fly larvae (BSFL) method with 25 TPD each capacity. Target time for execution is 100 days.

#### 6. Qualitative Analysis of MSW

Both the KMC and our Consultant have done qualitative analysis of MSW independently. A total of 8 samples (4 samples by each) of MSW were collected from different locations viz. Brahmapuram Plant (2 samples), Yathra Circle (C-17), Fort Kochi (C-1), Vytilla (C-13), Ernakulam Market (C-18), North Circle (C-19) and Kaloor (C-16). 'C' stands for Circle.

All the samples have been analyzed in Cochin Test House (NABL Accredited Lab), Irumpanam, Kochi. Following are the observations:

- a. Moisture content is in the range of 54 – 79% which seems to be on lower side as compared to typical range of 70 – 85% in other cities. Considering the short duration of sample collection, variation is high. This may further vary based on seasonal change also.
- b. Volatile matter varies from 66% to 95% which indicates a different nature of food wastes. In sample no.7 collected from Kaloor circle, moisture content as well as volatiles are very low which infers presence of high amount of inert / sand. This is an area of concern as in such a small set of samples wide variation has been observed.
- c. Impurities like paper, textile, plastic & rubber, glass, etc. have not been there in 7 samples. Only in 1 sample, plastic & rubber was reported at 0.69%. This indicates good quality of sample and segregation is effective.
- d. Metal content like Cadmium, Chromium, Mercury, Nickel, Zinc, Manganese, Lead and Arsenic are found below detection limit in 5 samples. In 3 samples, only Lead presence was noticed at 0.04 ppm. This infers that leachate disposal will not be a problem.
- e. The suitable range for Carbon(C):Nitrogen(N) ratio in Anaerobic Digestion is 20-30:1. The samples range varies from 16-23:1, which is less than the suitable range. As N content is high, there are chances of Ammonia (NH<sub>3</sub>) toxicity which will be taken care while designing the plant. If the NH<sub>3</sub> toxicity is not addressed, it will impact the biogas yield.

Generally, while designing a CBG plant, samples are analyzed across the year to understand waste characteristics and the effect of seasonal variation. However, due to paucity of time, samples have been collected for a short period. Therefore, wide variation is not observed. Even inert matters are minimum. Hence, it is recommended that additional scientific waste

characterization and analysis are required to be done in parallel. Plant will be designed accordingly.

Consolidated summary of lab reports of different samples are attached as Annexure-III.

## 7. Land Survey and Sub Soil Investigation

BPCL along with KMC through Government surveyor has done the Physical survey of the land. A 10-acre area has been demarcated and boundary stones have been laid. This land is to be handed over to BPCL at the earliest for setting up the plant. Plot plan has been prepared and attached as Annexure-IV.

Consultant has completed the topographical survey and contouring of the land.

Consultant has also carried out the sub soil investigation of the 10-acre plot. Eight bore holes were taken. The condition of the plot is varied in nature. Around 2.5 acre is firm land with rocky strata varying from 2-8 metres. Remaining area is marshy and submerged in around 3 feet of water. Due to inaccessibility, only 2 bore holes could be taken wherein the rock was encountered at 8.2 m and 11.5 m. The samples have been sent to Geological Lab for analysis of soil bearing capacity and other geotechnical tests.

Since the major portion of the land is marshy, land development activity will incur significant expenditure. Further, pile foundations for the plant will have to be provided. The Consultant has estimated an expenditure of around Rs 9.15 crore (excluding GST) for the land development.

## 8. Process Technology for CBG Production

India has a diverse range of feedstocks available for biogas generation. The most common feedstocks include animal waste, agricultural residue, organic fraction of municipal solid waste (MSW) and sewage sludge. The process of anaerobic digestion uses various organic materials to create raw biogas, which is composed mostly of methane (40 - 60%) and carbon dioxide (30 - 35%), with small amounts of impurities such as Hydrogen Sulphide ( $H_2S$ ), ammonia and moisture. The generated raw biogas can either be utilized as a cooking fuel or processed further to remove Carbon Dioxide ( $CO_2$ ),  $H_2S$  and moisture content, resulting in a fuel of higher calorific value. If the methane content of the upgraded product is above 90%, it can be used directly as a transportation fuel to replace Compressed Natural Gas (CNG) or injected into gas grids as Compressed Bio Gas (CBG); which should meet IS 16087:2016 specifications of BIS.



Composition	Raw biogas	Bio-CNG/CBG
Methane	55-65%	>90%
Carbon dioxide	30-40%	<4%
Hydrogen sulphide	0.1-4%	<16 ppm
Nitrogen	3%	<0.5%
Oxygen	0.1-2%	<0.5%
Moisture	1-2%	0%
Calorific value	19.5 MJ/kg	47-52 MJ/kg

Another significant by-product is the biofertilizer, which can be separated into solid and liquid fragments. This is an excellent soil conditioner and can replace the use of toxic chemical fertilizers. BIS has defined following specifications under Fertilizer Control Order:

Parameters	Solid organic fertilizer	Liquid organic fertilizer
Moisture, per cent by weight	30-40	90-97
Particle size	Minimum 90 per cent material should pass through 4.0 mm IS sieve	Minimum 90 per cent material should pass through 4.0 mm IS sieve
Total organic carbon, per cent by weight, Min	14	14
NPK nutrients (Total N, P <sub>2</sub> O <sub>5</sub> and K <sub>2</sub> O, per cent), Min (For upgraded digestate-based organic fertilizer the numbers for P <sub>2</sub> O <sub>5</sub> and K <sub>2</sub> O are to be given)	1.2	1.2
C/N ratio	<20	<20
pH	6.5 to 8.0	6.5 to 8.0
Conductivity (35 ds/m), Max	4.0	4.0
Pathogens	Nil	Nil
Arsenic (As)	10	10
Cadmium (Cd)	5	5
Chromium (Cr)	50	50
Copper (Cu)	300	300
Mercury (Hg)	0.15	0.15
Nickel (Ni)	50	50
Lead (Pb)	100	100
Zinc (Zn)	1000	1000

Biogas is an excellent example of developing a circular, environment friendly economy where waste resources are transformed into clean energy and organic fertilizers.

## 2. Proposed Process Description

### a. Feed Receipt and Preliminary System

Kochi Municipal Corporation (KMC) shall ensure supply of source segregated organic fraction of MSW at plant site using waste collection trucks. The trucks shall unload MSW in the earmarked area at CBG plant site. Subsequently it will be loaded into the feeding hoppers followed by segregators.

Segregators separate large, bulky items and debris from the waste. The conveyor system uses magnets to attract and remove ferrous materials from the waste. The shredder machine breaks down the waste into smaller (< 30 mm) pieces. The bio grinders further break down the waste (< 5 mm) especially the organic materials. The combined conveyor brings together the finely shredded waste from both bio grinders into a single flow. The waste from the combined conveyor is directed into two separate unloading pits which serve as temporary storage to manage the waste flow.

Recycled water is added to the waste in the unloading pits. The screw lifter lifts the waste slurry and moves it to the slurry chamber. The screen mesh helps filter out larger particles from the slurry. The slurry chamber collects the waste slurry from the screw lifter for further processing. After that, slurry goes to mixing tank through screw lifter, wherein the slurry is thoroughly mixed with water. Two side entry agitators are installed for mixing. The well-mixed slurry is transferred to the digesters, wherein, anaerobic digestion takes place to generate raw biogas.

### b. Anaerobic Digestion

The anaerobic digestion system consists of main digester tanks and post digesters. The waste slurry is fed continuously from buffer tanks to the digesters to provide anaerobic bacteria along with nutrients to ensure steady production of biogas. The digesters are provided with central stirrers to prevent the formation of floating layers, sedimentation of inert material and to avoid a phase separation of the digestate. Recirculation pumps pump the digestate continuously through the heat exchangers to maintain the mesophilic process temperature of 38 – 42 deg C in the digesters. The digesters are equipped with over and under pressure valves. The hydraulic retention time inside the main digesters is dependent on organic loading.

Post digesters are equipped with top mounted double membrane and are used as a biogas storage. Air blowers regulate the biogas pressure. The post digesters are also equipped with stirrers and over & under pressure valves. The digestate is discharged from post digesters to the decanters where solids and liquids are separated. Liquid phase is reused in the system as process water.

Following are the four chemical processes to produce biogas:

**Hydrolysis:** Hydrolysis is a chemical procedure that decomposes intricate organic compounds like carbohydrates, fats and proteins into simpler substances such as glucose molecules, fatty acids and amino acids. To alter organic molecules, microbes require them to be soluble. Acid hydrolysis is aided by hydrolase, an enzyme secreted by microorganisms that converts insoluble polysaccharides into soluble molecules.

**Acidogenesis:** Following hydrolysis, bacteria convert glucose derivatives, fatty acids and amino acids into volatile fatty acids (VFAs) and alcohols.

**Acetogenesis:** The volatile fatty acids and alcohols are converted into hydrogen, carbon dioxide and ammonia via the acetogenesis pathway.

**Methanogenesis:** Methanogenesis is the final stage in which archaea—single-celled organisms convert hydrogen and acetic acid into methane and carbon dioxide. Maintaining the optimal pH range is critical for methanogens. The optimum pH range for methanogens has been found to be between 6.5 and 7.5, and any deviation from this range can cause delays or complete cessation of methane production.

#### c. Digestate treatment

The digestate treatment system consists of solid bowls screw-type decanters for solid liquid separation and fine screens to remove plastics, fibres from liquid digestate. In the inlet of the decanters, flocculant is added. Fresh water is used for mixing and for dilution of flocculant solution. Anti-foaming agents can be dosed into the outlet shafts of the decanters. Anti-scalant can be added to avoid salt precipitation in pipes. The solid digestate from the dewatering sump is transported through a screw-conveyor belt to containers and thereafter to a composting plant. Solid digestate has a total solid concentration of around 30%.

The liquid digestate flows by means of hydraulic height difference into the fine sieve separation units. Small impurities (e.g. plastics) are removed through fine sieve and transported through an integrated screw conveyor into separate containers for disposal.

The cleaned liquid digestate is collected in collection tank and pumped to liquid digestate storage tank. From there, it is used to feed pulpers, light fraction separation and as process water in the plant. No fresh water is required to produce the waste slurry in the waste pulpers. After reaching a fixed level in the tank, excess water is removed from there and treated in the Effluent Treatment Plant (ETP). The treated water shall be discharged into Corporation Sewage Treatment Plant (STP).

#### d. Biogas system

The biogas produced inside the main digesters is collected in a common biogas pipeline that transports the biogas to the biogas storage on top of the post digesters. In post digesters biogas is still produced and collected in the top mounted biogas storage. The biogas flow will be measured by a flowmeter. A biogas flare is installed to prevent over pressure in the biogas system.

e. **H<sub>2</sub>S / Moisture Removal System**

H<sub>2</sub>S is removed using caustic scrubber. The raw biogas enters the scrubber, wherein Caustic (Sodium Hydroxide-NaOH) washes the gas and removes the H<sub>2</sub>S from biogas. Some CO<sub>2</sub> may also be removed. The sulphide rich solvent passes through bio reactor, wherein sulphide is oxidized by aerobic microorganisms consisting of group of the colourless sulfur bacteria and convert into elemental sulphur and spent caustic is regenerated and reused in the scrubber. Biogas after H<sub>2</sub>S removal is transferred to CO<sub>2</sub> removal system. After H<sub>2</sub>S removal, biogas flows through the biogas cooler where moisture is separated. Two biogas blowers blow the dry biogas to activated carbon filters where all the impurities are removed before the biogas is further treated in a biogas upgrading plant.

f. **CO<sub>2</sub> Removal System**

Biogas typically contains a significant amount of carbon dioxide (CO<sub>2</sub>), which reduces its energy content. In the biogas upgradation section, CO<sub>2</sub> is removed from biogas and biomethane with a Methane (CH<sub>4</sub>) concentration of min 90% is produced as per specification. Following technologies are available for CO<sub>2</sub> removal from biogas:

- **Water Scrubbing:** Water scrubbing involves passing biogas through a water column to absorb CO<sub>2</sub> and remove other impurities. The CO<sub>2</sub>-rich water can then be regenerated to release the captured CO<sub>2</sub>.
- **Pressure Swing Adsorption (PSA):** PSA is a technology that uses adsorbents to selectively capture CO<sub>2</sub> from biogas under pressure. This method allows for the separation of CO<sub>2</sub> and methane.
- **Membrane Separation:** Membrane separation uses semipermeable membranes to selectively allow the passage of methane while blocking CO<sub>2</sub> and other impurities.
- **Chemical Absorption:** Chemical absorption employs specific chemical solutions, such as amines, to absorb CO<sub>2</sub> from biogas. After absorption, the CO<sub>2</sub> is released through a regeneration process.

Biomethane after biogas upgradation meets the quality as per IS16087-2016.

g. **Material Balance**

Details	Unit of Measurement	Value
Input		
Raw MSW along with impurities	MT/D	165
Less - Impurities @ 10% for plant design	MT/D	15
Organic fraction of MSW after removal of impurities	MT/D	150
Recycled Water to digester for making slurry	MT/D	190
<b>Total Input</b>	<b>MT/D</b>	<b>340</b>

Output		
CBG	MT/D	5.60
Liquid Slurry/ ETP treated Water discharge to Corporation STP	MT/D	100.00
Solid Organic Manure	MT/D	28.00
Vent Gas (CO <sub>2</sub> & H <sub>2</sub> S) rejects	MT/D	7.90
Evaporation Losses	MT/D	8.50
Recycled Water to digester for making slurry	MT/D	190.00
Total Output	MT/D	340.00

Process flow chart and Mass balance are given in Annexure V.

#### 10. Shortlisting of Process for the Proposed Plant

The proposed plant is divided into following sections:

- Feed Receipt & Pretreatment System
- Biogas generation (Mesophilic Mode) System
- Solid liquid Separation System
- Moisture & H<sub>2</sub>S removal System
- CO<sub>2</sub> Removal System
  - Option1: Through Water Scrubbing
  - Option2: Through Pressure Swing Adsorption
  - Option3: Through Membranes
  - Option4: Through Amines

Based on financial analysis, CO<sub>2</sub> removal through water scrubbing has been shortlisted (detailed analysis is given in subsequent sections).

- Biogas Compression and Transportation System
  - Option1: Compression upto 60 bar and transportation to Kochi Refinery
  - Option2: Compression upto 250 bar and transportation to Retail Outlets using cascades
  - Option3: Compression upto 30 bar and its injection in city gas distribution network

Since the project is conceived to use biogas as a fuel in refinery, option 1 has been considered for further evaluation.

- Solid Fertilizer Handling System (Drying, Bagging, Packing, transportation)
- Liquid Slurry handling system
  - Option1: Treatment of extra liquid slurry in Effluent Treatment Plant (ETP) and its discharge to Corporation STP
  - Option2: Liquid slurry as Liquid Fermented Organic Manure (LFOM) with zero liquid discharge. No requirement of ETP

Presently, there is no established market for LFOM, therefore, ETP will be required to treat the same. Proposed ETP can treat COD upto 70 PPM, BOD upto 20 PPM and TSS upto 30 PPM. This stream will be diverted to Corporation STP. Therefore, option 1 is considered for further evaluation.

#### Auxiliary Systems

- i. Land Development
- j. Civil & Infrastructure
- k. Fire Fighting System
- l. Electrical System
- m. Instrumentation System
- n. Digitalization System
- o. Safety & Flare System

Note 1: Currently 13.8% GST Applicable for all above components from a to o (considering 70% Materials with 12% GST and 30% Services with 18% GST).

#### Other Components

- p. Statutory and PMC Charges (18% GST Applicable)
- q. Expenses during Construction: BPCL's Staff Salary component (No GST applicable)

Note 2: Input Tax Credit (ITC) has been considered 16% for all the cases.

Out of components / steps a to o mentioned above, except e, f and n, all others are common facilities.

Based on the above facts, Consultant has evaluated the process for 4 options of CO<sub>2</sub> removal system mentioned in component e

#### 11. Basis & Assumptions for calculating Internal Rate of Return (IRR)

1. Project Life = 25 years (as per useful life Companies Act 2013 Sch II)
2. Cost of Power = Rs 6.33 per KWH (Purchase price for the year 2022-23 for the imported Power from KSEB)
3. Cost of Raw Water = Rs 27.4 per KL (based on audited cost records for the year 2022-23).
4. Price of Re-gasified Liquid Natural Gas (RLNG) = Rs 51636.67 per MT (based on 5 years average rate from 2018-19 till 2022-23. However, exchange and regasification rate have been taken as an average of 2022-23). This price has been taken for CBG for revenue calculation for the case of its usage in Kochi Refinery as a fuel.
5. Project CAPEX funding has been considered 100% from equity (as CAPEX will be less than RS 150 crore). No debt funding has been considered.
6. Depreciation is as per Companies Act 2013 (Schedule II) and Income Tax Act 1961.

7. Corporate Tax Rate of 22% plus surcharge of 10% plus Health and Education Cess @ 4% has to be considered w/s 115 BAA.
  8. Operations & Maintenance (O&M) cost for CO<sub>2</sub> removal system has been considered based on replacement of water, adsorbents, membrane etc.
  9. Weighted average GST of 13.8% (12% GST for 70% of the CAPEX towards equipment and 18% GST for balance 30% towards services) has been considered for components from a to d and 18% GST for component e. Nil GST has been considered for component g.
  10. Input tax credit has been considered @ 16% on the total GST excluding GST on Land development and Civil & Infrastructure cost (for CBG usage as a fuel as a replacement of RLNG).
  11. Revenue towards CBG generation has been considered depending on the technology.
  12. Manpower Cost- Cost To Company (CTC) considering minimum wages as per Labour Ministry and 10% escalation
  13. Insurance Cost - 0.2% (on a conservative basis) of CAPEX excluding cost for Land development, Civil & Infrastructure and CO<sub>2</sub> removal.
  14. Cost for Spares per year - 2% (on a conservative basis) of CAPEX excluding cost for Land development, Civil & Infrastructure and CO<sub>2</sub> removal.
  15. Operating Margins - 15% of yearly OPEX
  16. Cost for Caustic - 70 kg per day consumption @ Rs 70 per kg ~ Rs 5000 per day
- 12 CAPEX, OPEX, Revenue, IRR and NPV with 4 options of CO<sub>2</sub> Removal System
- Financial evaluation has been done for following 4 cases:
- Case 1: Pretreatment + biogas generation + H<sub>2</sub>S Removal through Caustic + CO<sub>2</sub> removal through Water scrubbing + Compression @ 60 bar + transport to KR + ETP + Water Discharge to Corporation STP
- Case 2: Pretreatment + biogas generation + H<sub>2</sub>S Removal through Caustic + CO<sub>2</sub> removal through PSA + Compression @ 60 bar + transport to KR + ETP + Water Discharge to Corporation STP
- Case 3: Pretreatment + biogas generation + H<sub>2</sub>S Removal through Caustic + CO<sub>2</sub> removal through Membrane + Compression @ 60 bar + transport to KR + ETP + Water Discharge to Corporation STP
- Case 4: Pretreatment + biogas generation + H<sub>2</sub>S Removal through Caustic + CO<sub>2</sub> removal through Amines + Compression @ 60 bar + transport to KR + ETP + Water Discharge to Corporation STP

	CASE-1	CASE-2	CASE-3	CASE-4
<b>A. CAPEX Component with 12% GST</b>	<b>(In Rs. Lakhs)</b>			
Land Development	915	915	915	915
Civil & Infrastructure	448	448	448	448
Fire Fighting System	70	70	70	70
Electrical System	436	436	436	436
Instrumentation	210	210	210	210
Digitalization	30	30	30	30
Feed Pretreatment	825	825	825	825
Biogas generation	1060	1060	1060	1060
Solid liquid separation	115	115	115	115
H <sub>2</sub> S removal System	250	250	250	250
CO <sub>2</sub> Removal System	650	550	1250	1080
Analysers & Flowmeters	38	38	38	38
Biogas Compression and Transportation	460	460	460	460
Fertilizer Handling System	175	175	175	175
ETP	430	430	430	430
Flare and IA system	18	18	18	18
<b>Subtotal A without GST</b>	<b>6130</b>	<b>6030</b>	<b>6730</b>	<b>6560</b>
<b>GST @ 12.8%</b>	<b>845.94</b>	<b>832.14</b>	<b>928.74</b>	<b>905.28</b>
<b>B. CAPEX Component with 18% GST</b>				
Statutory and PMC Charges	301	301	301	301
<b>GST @ 18%</b>	<b>54.18</b>	<b>54.18</b>	<b>54.18</b>	<b>54.18</b>
<b>C. CAPEX Component without GST</b>				
Expenses during Construction (BPCL's Staff salary component)	86	86	86	86
Input tax credit (16% of GST)	113.92	111.72	127.17	123.42
<b>Total CAPEX, Rs Lakh</b>	<b>7303.20</b>	<b>7191.60</b>	<b>7972.75</b>	<b>7783.04</b>
<b>Monthly OPEX, Rs Lakh</b>				
Power	15.95	15.95	15.95	15.95
Manpower	10.29	10.29	10.29	10.29
CO <sub>2</sub> removal system	2.75	9.25	16.08	1.58
Spares	6.86	6.86	6.86	6.86
Insurance (0.20% of CAPEX)	0.69	0.69	0.69	0.69
Others	2.01	2.01	2.01	2.01
<b>Total Monthly OPEX, Rs Lakh</b>	<b>38.55</b>	<b>45.05</b>	<b>51.89</b>	<b>38.39</b>
<b>Yearly OPEX, Rs Lakh</b>	<b>462.63</b>	<b>540.63</b>	<b>622.63</b>	<b>460.63</b>
Operating Margin yearly, Rs Lakh (15% of OPEX)	69.39	81.09	93.39	69.09
<b>Total Yearly OPEX, Rs Lakh</b>	<b>532.02</b>	<b>621.72</b>	<b>716.02</b>	<b>529.72</b>



## Detailed Project Proposal on MSW to CBG Project at Brahmapuram by BPCL Kochi Refinery

	CASE-1	CASE-2	CASE-3	CASE-4
<b>Revenue Details</b>				
CBG, MT/D	5.6	5.04	5.32	5.656
Solid Manure, MT/D	28	28	28	28
Liquid Manure, MT/D	100	100	100	100
CBG Price, Rs/MT	51636.67	51636.67	51636.67	51636.67
Solid Manure Price, Rs/MT	4000	4000	4000	4000
<b>Total Yearly Revenue, Rs Lakh</b>	<b>1464.25</b>	<b>1358.71</b>	<b>1411.48</b>	<b>1474.81</b>
IRR, %	10.3	7.81	6.19	9.7
NPV, Rs Lakh	(-) 636.05	(-) 1502.35	(-) 2275.86	(-) 909.08

Based on the IRR, Case-1 has been shortlisted for selection of process technology.

Proposed Plant layout is attached as Annexure - VI

Based on the criticality from environment and safety point of view and having very stringent timelines, the project has been conceived considering CBG as a fuel in Kochi Refinery. Accordingly, Detailed feasibility study has been carried out. As CBG market is emerging in terms of its usage in vehicular, CNG (Transport) and PNG (Domestic) segments also, feasibility of the same shall be explored in due course of time.

### 13. Project Timelines

Project Approval from Government of Kerala	Zero Date (by 15 <sup>th</sup> October 2023)
Project Completion	15 months from Zero Date (December 2024)

Activity bar chart is attached as Annexure-VII.

### 14. Benefits to Kochi Municipal Corporation (KMC) through the proposed CBG project

- GoK and KMC will fulfill the directions of the Hon'ble High Court of Kerala towards providing facility for waste disposal. This will provide relief from pollution for the public at large.
- This project will provide an opportunity to KMC to synchronize several government programs like Swachh Bharat Mission, Smart / Sustainable Cities, Clean Air, Organic Farming, Energy Security, Make in India, etc.
- KMC will contribute towards making India an Energy Independent Country through this project. The project will reduce greenhouse gas emissions and thus air pollution. During monsoon, the leachate spoils the water bodies. This project will mitigate the water pollution problem also.
- It will give a boost towards fulfillment of National commitment in achieving climate change goals.

Support required from the Government of Kerala / KMC for setting up the plant

- a. **MSW Availability & Disposal of Rejects:** GoK have assured consistent supply of 150 TPD of organic fraction of MSW with maximum 5-10% impurities to the CBG plant site for minimum period of 25 Years. Kochi Corporation will arrange disposal of rejects from the plant site. Tripartite Agreement to be entered among GoK, KMC and BPCL for the same.

GoK is also requested to permit disposal of excess Treated Effluent (~ 100 TPD) from Effluent Treatment Plant (ETP) of CBG plant to the nearby Corporation Sewerage Network or Sewage Treatment Plant (STP) till the forward linkage of liquid organic fermented manure is established by BPCL.

- b. **Land for CBG Plant:** GoK have assured to provide 10-acre land free of cost on a long term basis for the CBG plant. Agreement to be signed for handing over 10-acre mutually demarcated land to BPCL. The land to be cleared from legacy waste before commencement of construction activity for safe and expeditious execution of the plant.

The condition of the approach road is not proper. GoK is requested to develop the asphalted road of minimum 7 meters width to facilitate movement of manpower and machinery.

- c. **Power:** GoK have assured to provide power at subsidized rate. To enable long term viability of the project, GoK is requested to sanction power tariff applicable for agriculture sector, as the proposed plant will promote organic farming by producing fermented organic manures. Kerala State Electricity Board (KSEB) may accordingly be advised for allocation and supply of about 1.5 MW power for plant construction and operation.

- d. **Water:** GoK have assured supply of water at concessional rate during construction and operation of the plant. Kerala Water Authority / Kochi Corporation may accordingly be advised to supply drinking water as well as water required for the plant construction and operation.

- e. **Permission for laying pipelines:** GoK is requested to provide required clearances / permissions for laying CDG, Water, any other pipelines from / to CBG plant and Kochi refinery.

- f. **Statutory Approvals / Clearances:** Considering strict timelines, GoK is requested to enable expeditious Approvals, Clearances and No Objection Certificates (NOCs) from the respective State Government departments on a single window basis.

We request Government of Kerala to favorably consider our request and grant concessions/incentives and support as proposed above so that BPCL can take a decision to go ahead with the CBG project. An early decision would be of great help in expediting the business viability of the project and thus enabling the final decision on the investment.



GOVERNMENT OF KERALA

Industries (S) Department

No. J1/83/2023/IND

31-05-2023, Thiruvananthapuram

From

The Principal Secretary to Government

To

The Executive Director, (Kochi Refinery),  
Bharat Petroleum Corporation Ltd.  
Kochi Refinery, Post Bag No.2,  
Ambalamugal, Ernakulam 682302.

Sir,

Sub: Industries Department - Meeting held on 03/05/2023 between Government of Kerala and BPCL to discuss the possibility of setting up a CBG plant for converting MSW to Compressed Bio-gas at Kochi - Minutes forwarding of - Reg.

Ref: Your letter No KR.ED (KR).13 dated 02.05.2023.

I am to invite your attention to the reference cited and to forward herewith the approved minutes of the meeting held on 03.05.2023 between Government of Kerala and BPCL for information and immediate necessary action.

Yours faithfully,

RAJEEV R

UNDER SECRETARY

for Principal Secretary to Government..

Approved for Issue.

Signed by

Arulkumar T.

Section Officer

Date: 31-05-2023 13:28:24

Copy to :- Private Secretary to Hon'ble Minister for Law, Industries & Coir

WMJ/96/2023-LSGD

00/2023/LOCAL SELF GOVT. (WMJ)

File No. IND-11/43/2023-IND (Computer No. 24388163)

5742143/2023

5742143/2023

Private Secretary to Hon'ble Minister (LSGD)

PA to the Chief Secretary.

PA to Additional Chief Secretary (LSGD)

PA to Principal Secretary - I (Industries)

Minutes of the Meeting held on 1<sup>st</sup> May 2023 between Government of Kerala and BPCL to discuss the possibility of setting up MSW to Compressed Biogas (CBG) plant at Kochi

A meeting was held on 1<sup>st</sup> May 2023 between Government of Kerala and BPCL to discuss the possibility of setting up MSW to Compressed Biogas (CBG) Plant at Kochi. The following were present from Government of Kerala and BPCL.

**Government of Kerala**

1. Shri P. Rajeev, Hon'ble Minister for Law, Industries and COIR
2. Shri M.B. Rajesh, Hon'ble Minister for Local Self Governments, Rural Development and Excise
3. Dr.V.P. Joy, IAS, Chief Secretary

**BPCL**

1. Shri Ajith Kumar K, Executive Director IC (Kochi Refinery)
2. Shri Abhai Raj Singh Bhandari, Executive Director (Kochi Refinery)
3. Shri George Thomas, General Manager (PR & Admin)
4. Shri Sasiprakash R, CIM, Technology Biofuels (Retail)
5. Shri Santosh Kumar Varshney, DGM (Environment)
6. Shri Vinod T Mathew, Manager (Administration)

1. At the outset, Executive Director IC (Kochi Refinery) welcomed the Hon'ble Ministers and Chief Secretary, Government of Kerala and briefed about the context of the meeting.
2. BPCL team made a presentation on setting up of MSW to CBG plant. Following are the salient points:
  - a. Government of India notified National Policy on Biofuels 2018 which promotes Advanced Biofuels including CBG or Bio-CNG. CBG can be produced from agricultural waste, animal and poultry waste, sewage sludge, press mud and the organic fraction of municipal solid waste (MSW).

- b. Frequent fires and odour issues at waste dumping site at Brahmapuram has been posing serious concerns to both safety of the BPCL Kochi refinery and health issues of their employees, CISF Personal and contract labours as the site is very nearby.
  - c. Since, organic fraction of MSW can be converted into CBG and Bio manure, BPCL is proposing to set up a CBG plant at Brahmapuram to mitigate the issue.
  - d. Municipal corporations of major cities in India have set up or planning to set up similar kind of CBG plants. References of Indore, Pune, Namakkal, etc. were given.
3. BPCL discussed that Government of Kerala as well as Municipal Corporation shall have the following advantages by setting up the CBG plant:
- a. Responsible waste management as per Solid Waste Management Rules 2016.
  - b. Improvement in Ranking under Swachh Survekshan.
  - c. Support to commitments in achieving climate change goals, Net Zero Target
  - d. Opportunity to sync several programs like Swachh Bharat, Smart / Sustainable Cities, Clean Air, Organic Farming, Fuel Security, Make in India etc.
  - e. Reduction in carbon emissions and pollution in the city (Currently, most of the energy needs in Transport sector are met through fossil fuels).
  - f. Production of Bio fertilizer for assisting organic farming.
4. After discussion, the consensus emerged that it is most feasible to convert organic fraction of MSW into CBG and Bio manure. It was informed that Kochi Municipal Corporation is currently generating 180 TPD of organic waste and nearby municipalities another 60 TPD of organic waste. Therefore, the proposal of BPCL to set up a plant with total capacity of 240 TPD is timely and most important for the State of Kerala.
5. BPCL requested for the following support to set up CBG plant:
- a. 10 acres of suitable land adjacent to Kochi Refinery in Brahmapuram to be allocated for setting up the plant.

- b. Assurance for supply of approximately 240 TPD of organic fraction of MSW to plant site for minimum 25 Years
  - c. Permission for pipeline connectivity from the plant to Kochi refinery for total usage of CBG.
  - d. Support to be given for offtake of Bio manure through FACT, Krishi Bhavans, Vegetable and Fruits Promotion Council, Agriculture Department, etc.
  - e. Allocation of Power & Process Water during construction and subsequent operation of the plant at subsidised rate.
  - f. Quantitative and Qualitative analysis of feedstock (organic fraction of MSW) to be provided for designing of the plant.
  - g. Fast clearance and NOCs from the respective State Government departments.
6. After extensive deliberations, following consensus was arrived at:-
- i. It was agreed to recommend in principle clearance for the project. In view of the urgency regarding waste disposal, the project may be fast tracked.
  - ii. It was recommended to allocate 10 acre land adjacent to BPCL-Kochi Refinery for setting up the CBG plant at Brahmapuram.
  - iii. For supply of approximately 240 TPD of organic fraction of MSW at the plant site, a Tripartite agreement may be signed among Government of Kerala, Kochi Municipal Corporation including other local bodies and BPCL indicating the responsibilities of all stakeholders.
  - iv. BPCL team to visit the Brahmapuram site along with a representative from Kochi Corporation to check the suitability of the land for setting up the plant.
  - v. BPCL to submit the detailed proposal for approval by the Government of Kerala.
  - vi. After the approval from Government of Kerala, BPCL to proceed for the necessary approvals for setting up the plant. BPCL indicated that after getting the investment approval as well as other statutory approvals, it would take around one year time for setting up the plant.



## GOVERNMENT OF KERALA

### Abstract

Local Self Government Department-Proposal for setting up a Compressed Bio Gas (CBG) Plant in Kochi by BPCL-Sanction accorded-Orders issued.

### LOCAL SELF GOVERNMENT (WM) DEPARTMENT

G.O.(Ms)No.150/2023/LSGD Dated,Thiruvananthapuram, 29-07-2023

Read 1 Letter No. KR.ED(KR)13 dated 02.05.2023 from the Executive Director (I/C),BPCL

2 Joint Meeting of Hon'ble Minister for Industries and Hon'ble Minister for Local Self-Government held on 03.05.2023

3 Order dated 23.05.2023, 08.06.2023 and 07.07.2023 of Hon'ble High Court in WP(C) 7844/2023.

### ORDER

In the wake of the cessation of operations at the Brahmapuram waste management site, Government have declared the launch of the Malinya Muktam Navakeralam campaign and have been looking for urgent, state of the art solutions to the issue of solid waste management, particularly for Kochi, where waste management operations have been very seriously affected. It was in this context that a proposal was received from BPCL for setting up a bio-methanation plant of 150 TPD capacity at Kochi by converting Biodegradable Waste into Compressed Bio Gas (CBG). The matter is under the scrutiny of the Hon'ble High Court of Kerala, who has instructed the State Government to take final decision in respect of the proposal and to expedite the modalities.

Consequent upon the deliberations held between the Government of Kerala and the BPCL, the following were proposed to confirm the



undertaking of the plant by BPCL, and the terms on either side that would be committed to, for the successful operation of the plant and the management of the biowaste portion of the municipal solid waste of Kochi Corporation:

BPCL would undertake to submit DPR following feasibility study that has already been initiated by October 2023. The plant would be completed and ready for commissioning within 15 months - ie by December 2024.

For the successful installation and operation of the bio CBG plant by BPCL, the State Government would commit to ensure

- **MSW availability** – 150 TPD MSW (organic fraction) shall be made available. The MSW may have 5-10% impurities. BPCL will install necessary facility for handling 5-10% impurities. Sample analysis data of MSW will be provided to BPCL.
- **Disposal of rejects** - Support for disposal of rejects in a sanitary landfill as BPCL does not have requisite expertise & experience in management of landfills will also be provided.
- **Land for CBG Plant** –Provide 10 acres of land to BPCL at the Brahmapuram site for setting up the plant, free of cost on long term basis.
- **Power & Water** –Power and water will be provided during construction & operation of the plant at concessional rate.
- **CBG yield** : BPCL indicated that the proposed plant will produce 4-5% of CBG that shall be utilized by BPCL. Necessary permissions will be provided for laying of the pipeline from CBG plant to the refinery, the alignment of which would be proposed by BPCL later.

BPCL has informed that they will tie up the necessary forward linkage for offtake of solid and liquid manure produced in the plant. It has also been decided that 5-10% impurities other than bio waste would also be processed, and the Kochi Corporation will support the removal of rejects, that cannot be processed. It has been decided that in view of the comparatively smaller size of the plant, royalty would not be insisted upon. The matter of accrual of carbon credits is unclear and will be decided later.

Kochi Corporation has welcomed the proposal for the commissioning of the plant at Brahmapuram by BPCL.

Government have examined the proposal in detail and are pleased to accord sanction to BPCL for setting up a Plant at Kochi by converting biodegradable waste into Compressed Bio Gas (CBG), agreeing to the request made by BPCL for providing land, water and electricity and to the laying of pipeline for the CBG yield, the alignment of which will be decided later. The terms and conditions as mutually agreed above will form the basis of the collaboration with BPCL for setting up the plant. The Detailed Project Report (DPR) for the Plant will be submitted by BPCL by the 1st of October, 2023.

(By order of the Governor)

SARADA MURALEEDHARAN I A S  
ADDITIONAL CHIEF SECRETARY

Principal Director, Local Self Government Department

Executive Director, BPCL, Kochi

Secretary, Kochi Municipal Corporation

Principal Accountant General(A/A&E),Kerala,Thiruvananthapuram

General Administration (SC)Department(Item No-----dtd -----)

Executive Director,Information Kerala Mission

I&PR(Web & New Media) Department

Stock File/Office Copy

Copy:

Private Secretary to Hon'Chief Minister

Private Secretary to Hon'Minister (LSGD)

PA to Additional Chief Secretary,LSGD

Forwarded /By order

Signed by

M.k.pradeesh Kumar

Date: 31-07-2023 13:44:11  
Section Officer

## Appendix - III

# CONSOLIDATED TEST REPORT FOR MSW CHARACTERISATION

Page 1 of 2

Sl. No.	Parameters	Unit	Method	Result							
				Sample 1	Sample 2	Sample 3	Sample 4	Sample 5	Sample 6	Sample 7	Sample 8
1	Physical Parameters										
	Density [Bulk Density]	Kg/m <sup>3</sup>	FAO Method	657.6	833	329	890.72	816	660	448	980.6
2	Moisture Content	%	CTH/CH/SOP/6 14	79.07	73.58	64.66	62.95	74.42	73.54	54	65.19
3	Calorific Value [Dry Basis]	Kcal/Kg	IS : 1350	3239.21	3704.59	2480.11	3298.96	2716.12	3110.16	2456.80	3298.96
II	Different Fractions										
4(a)	Paper	%	CTH/CH/SOP/6 15	ND	ND	ND	ND	ND	ND	ND	ND
4(b)	Textile	%	CTH/CH/SOP/6 15	ND	ND	ND	ND	ND	ND	ND	ND
4(c)	Plastic & Rubber	%	CTH/CH/SOP/6 15	ND	ND	ND	ND	0.69	ND	ND	ND
4(d)	Glass	%	CTH/CH/SOP/6 15	ND	ND	ND	ND	ND	ND	ND	ND
4(e)	Biodegradable matter	%	CTH/CH/SOP/6 15	100	100	100	100	99.31	100	100	100
III	Biochemical Parameters										
5	Carbohydrate	g	CTH/CH/SOP/6 22	13.69	19.72	23.35	23.12	18.51	12.82	23.1	15.24
	Proteins	g	CTH/CH/SOP/6 16	2.19	3.7	5.23	4.03	3.06	4.36	4.29	5.56
7	Natural Fiber [Crude Fiber]	g	CTH/CH/SOP/6 09	8.34	15.08	5.07	2.95	4.24	7.24	4.12	16.57
IV	Toxicity Profile										
8	Cadmium as Cd	mg/Kg	USEPA 3050 B	ND	ND	ND	ND	ND	ND	ND	BDL(M DL-0.035)
9	Chromium as Cr	mg/Kg	USEPA 3050 B	0.79	0.21	0.47	0.20	0.35	0.94	0.21	8.99
10	Mercury as Hg	mg/Kg	USEPA 3050 B	ND	ND	ND	ND	ND	ND	ND	ND
11	Nickel as Ni	mg/Kg	USEPA 3050 B	ND	ND	ND	ND	ND	ND	ND	3.33
12	Zinc as Zn	mg/Kg	USEPA 3050 B	5.39	5.58	12.37	5.53	6.48	4.25	2.91	5.38
13	Manganese as Mn	mg/Kg	USEPA 3050 B	7.46	4.53	4.76	3.35	1.61	7.56	1.82	6.18
14	Lead as Pb	mg/Kg	USEPA 3050 B	0.53	0.29	0.42	0.31	0.23	0.32	0.21	BDL(M DL-0.040)
15	Arsenic as As	mg/Kg	USEPA 3050 B	ND	ND	ND	ND	ND	ND	ND	BDL(M DL-0.040)
16	Pesticides	ppb	CTH/CH/SOP/4 99	ND	ND	ND	ND	ND	ND	ND	ND

Page 2 of 2

V	Parameter Analysis										
17	Ash Content	%	CTH/CH/SOP/615	3.32	2.49	6.27	7.52	2.70	3.14	15.57	1.87
18	Volatile Matters	%	ASTM D - 3175	15.92	24.99	27.84	29.16	21.31	22.34	50.20	29.13
19	Fixed Carbon	%	ASTM D - 3174	1.69	0.77	1.23	0.37	1.57	0.98	0.23	3.81
VI	Ultimate Analysis										
20	pH@25°C	---	IS : 2720 [Pt.26]	4.56	3.85	5.22	4.19	4.06	4.25	6.07	3.98
21	Nitrogen (N)	%	IS : 6092 (Pt.02)	0.35	0.59	0.84	0.64	0.49	0.69	0.69	0.85
22	Phosphorous (P)	%	IS : 6092 - 2004	0.05	0.001	0.002	0.001	0.004	0.12	0.08	0.04
23	Potassium (K)	%	Flame Photometry	0.19	0.14	0.11	0.19	0.11	0.17	0.09	0.14
24	Total Organic Carbon	%	IS : 2720 [Pt.22]	7.96	12.49	10.92	14.58	10.65	11.17	15.1	14.56
25	C/N Ratio	---	Calculation	22.74 : 1	21.17 : 1	16.57 : 1	22.78 : 1	21.73 : 1	16.19 : 1	21.88 : 1	17.11 : 1

BDL- Below Detection Limit, MDL-Minimum Detection Limit ND - Not Detected.

Particulars of the sample

: Waste Sample

Sample Quantity

: 2 Kg

Sample 1: Brannapuram Plant

Sample 2: Circle 17 - Yashre Circle

Sample 3: Circle 7 - Fort Kandi

Sample 4: Circle 13 - Vytla

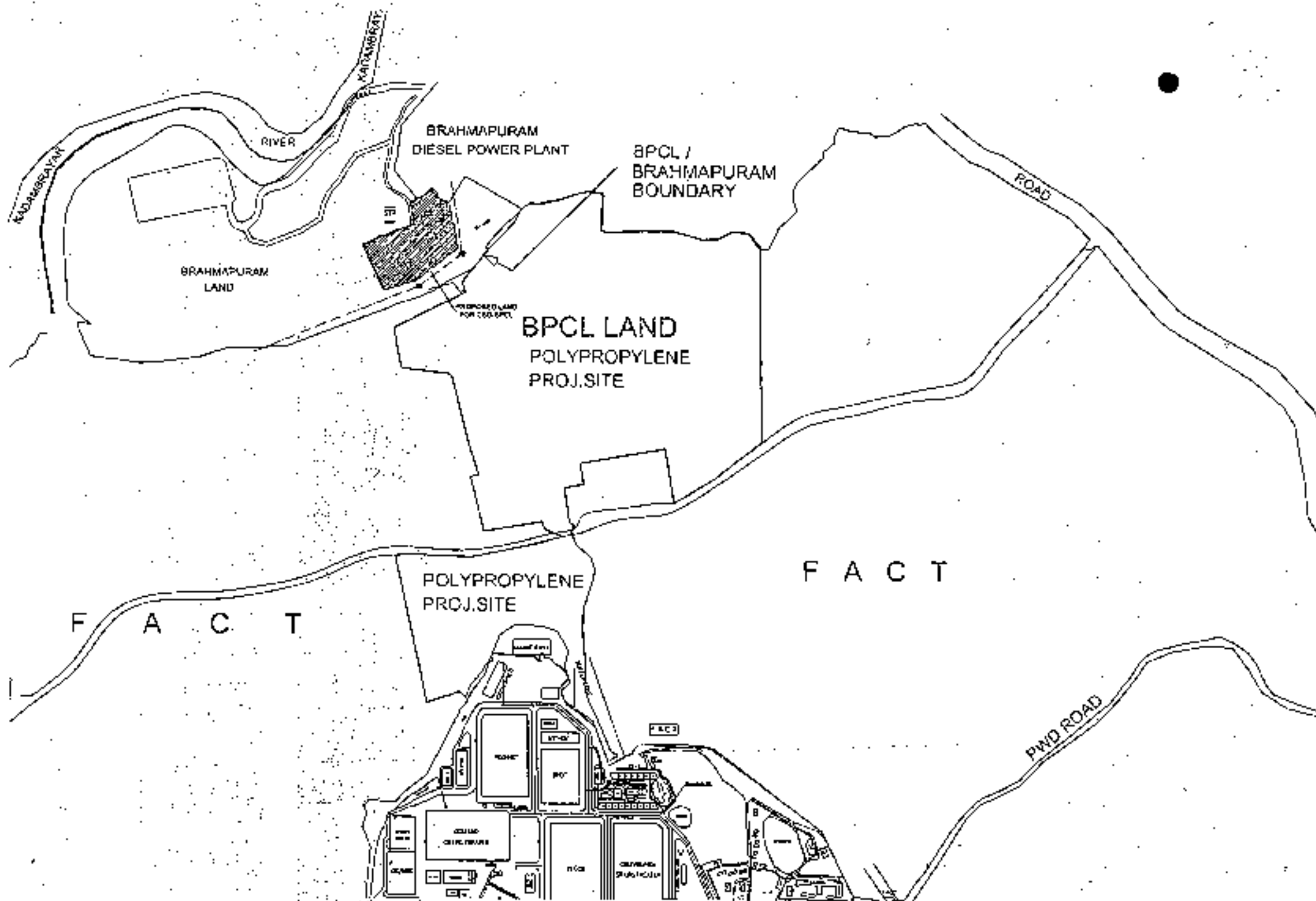
Sample 5: Ennakulam Market [C.18]

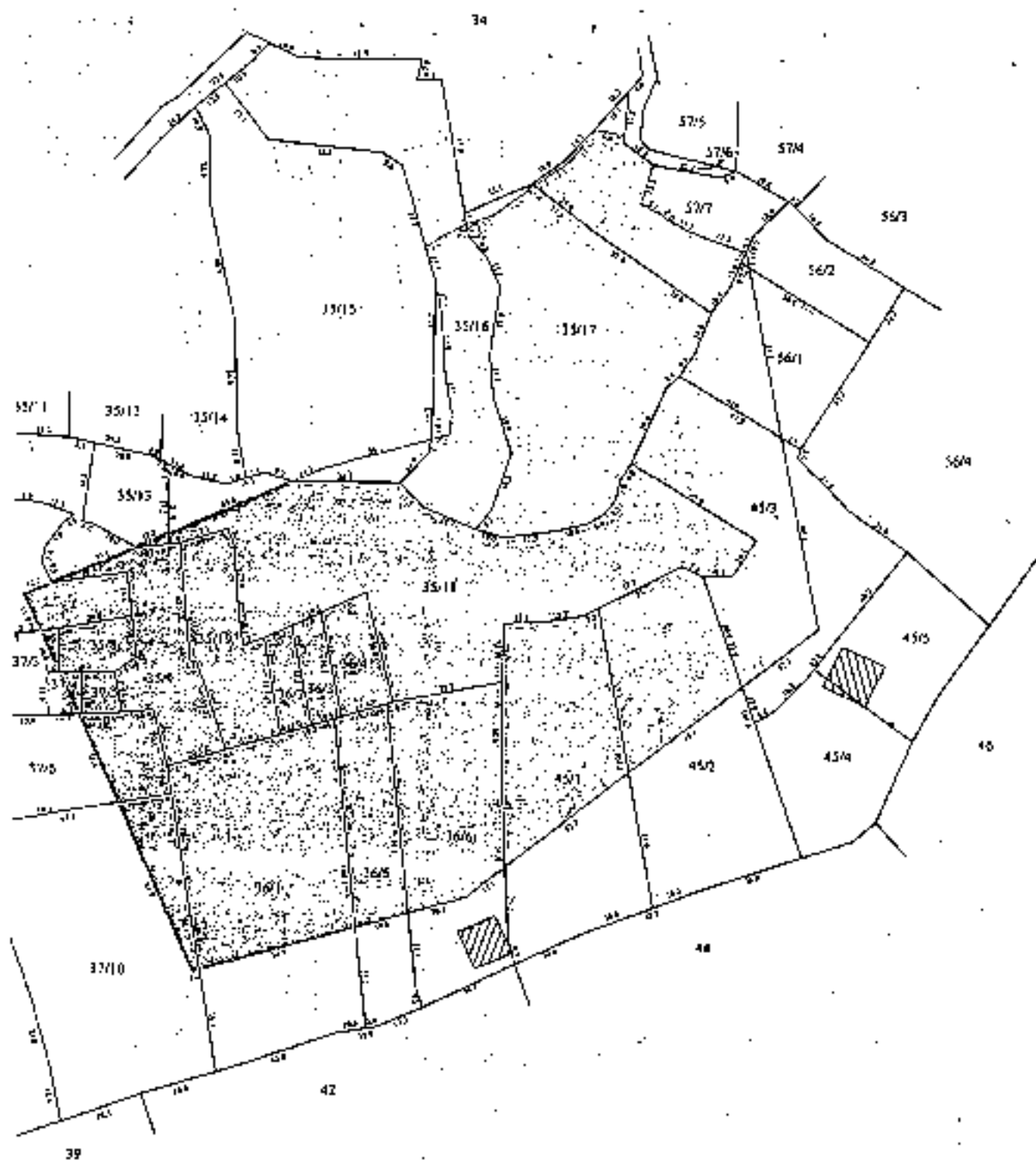
Sample 6: North Circle [C.19]

Sample 7: Karoor Circle [C.16]

Sample 8: Brannapuram Plant

Samples 1 to 4 have been given by KMC and Samples 5 to 8 by M/s. Airoz Nigam





35

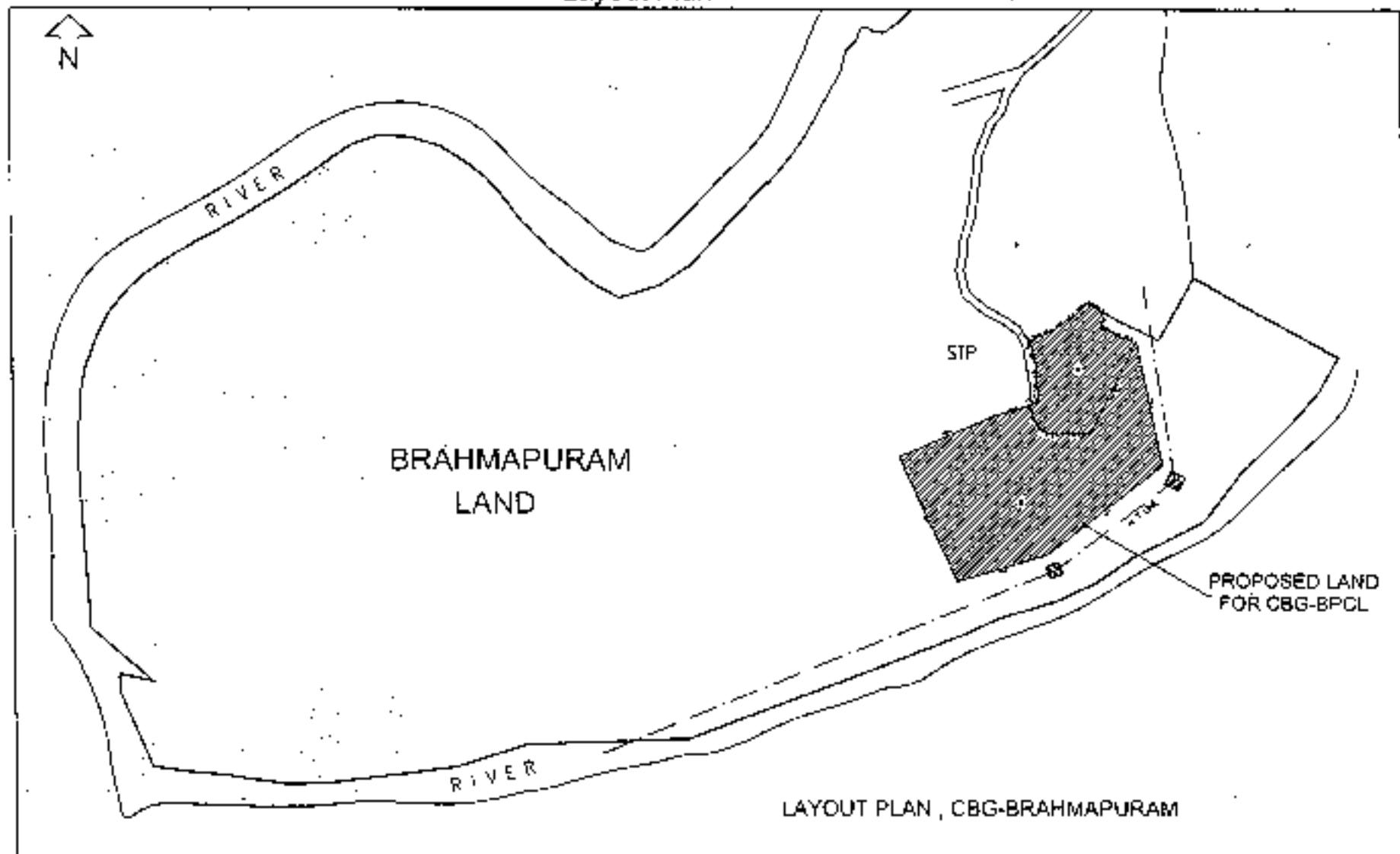
36

37

45

56

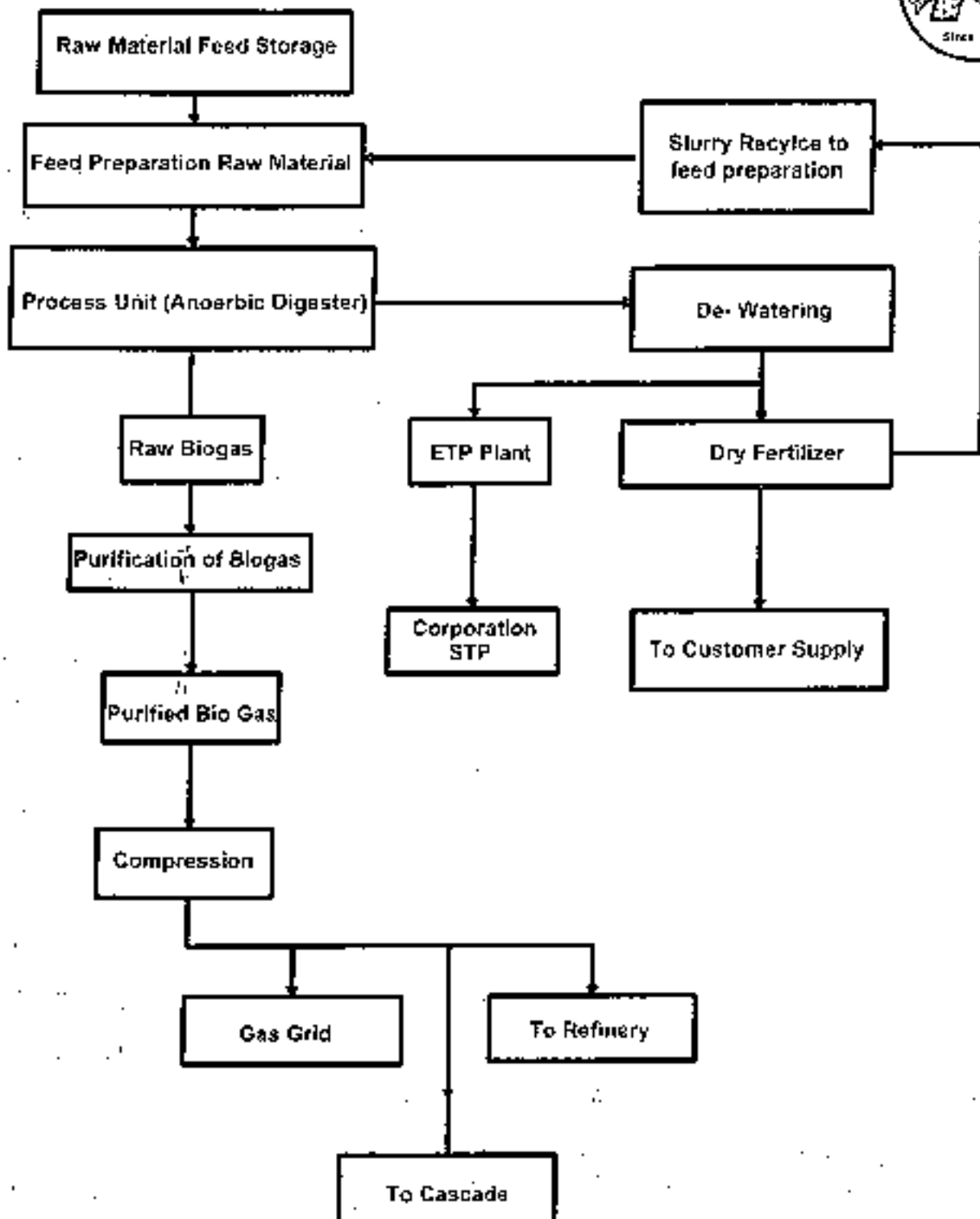
Layout Plan







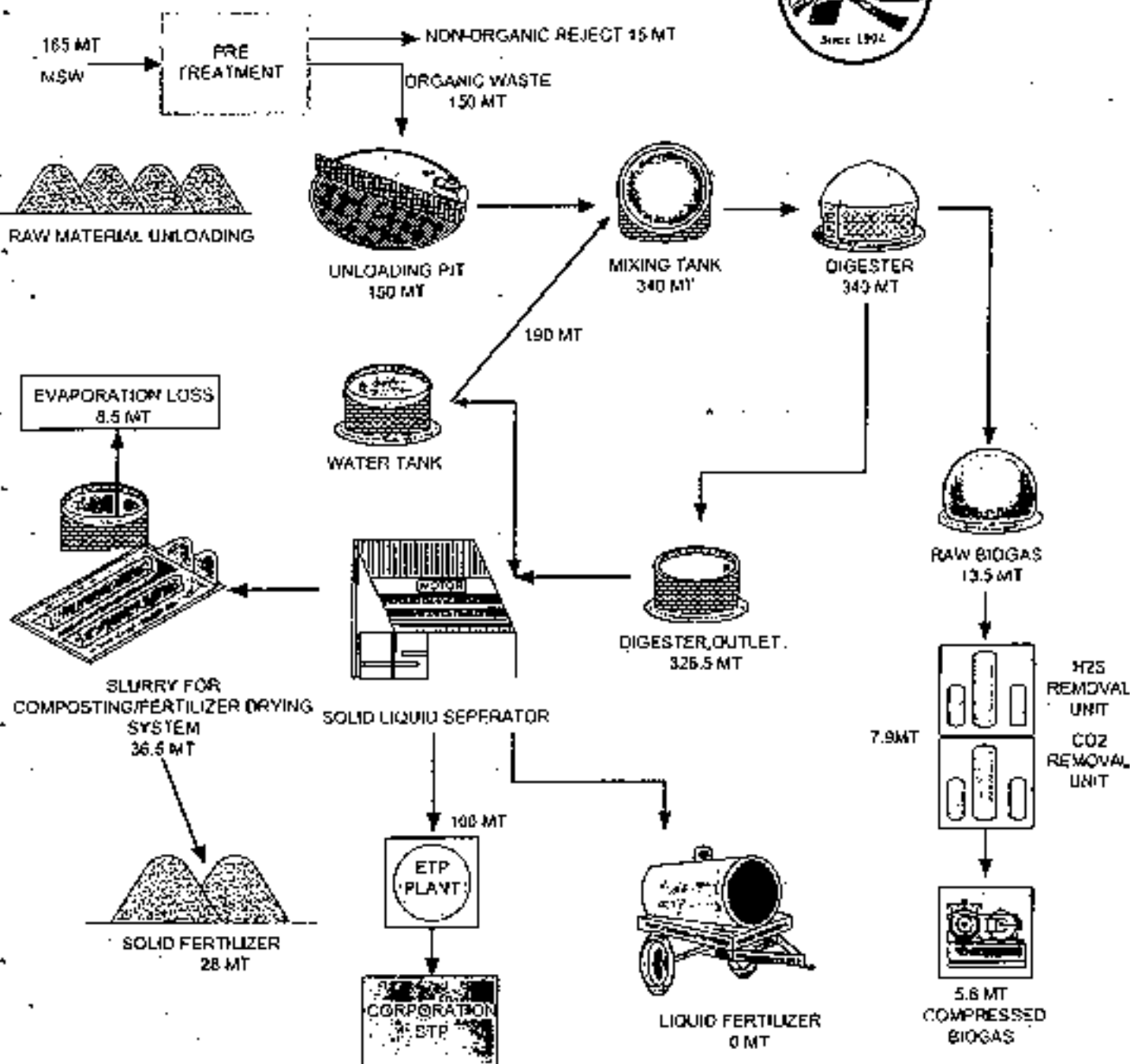
## Process Flow Chart of the Proposed plant



## MASS BALANCE




Approx 10%  
RAW MATERIAL LOSS  
DURING SEGREGATION



MATERIAL BALANCE DETAILS

INPUT	MT	OUTPUT	MT
RAW MATERIAL	150	VENT GAS (CO <sub>2</sub> +H <sub>2</sub> S)	7.9
RECYCLE WATER	190	SOLID FERTILIZER	28
		RECYCLE WATER	190
		ETP PLANT	100
		SLURRY FERTILIZER	0
		EVAPORATION LOSS	8.5
		CBG COMPRESSION	5.6
TOTAL	340	TOTAL	340

[illegible]

TO: APPROVED BY	TO: CHECKED BY	TO: APPROVED BY
EMPLOYEE	ENGINEER	
 CONSULTANT AND ENGINEER EQUIPMENTS PVT LTD H-1418, 4th Floor, Sector 46, Saket 1 Fresh Point Sector 49, Conna Road Gurgaon 122001 Email <a href="mailto:sales@equips.com">sales@equips.com</a>		
PROJECT: 150 TPD MSW INCUBU AT BRAD PLANT COCHIN		
PROJECT NUMBER: 45018845		
TITLE: HULL-PROPOSED LA YOUT PLANT		
DATE: 20/06/2017		
CONTRACT NO: 150 TPD MSW INCUBU AT BRAD PLANT		
ANG-DPC-50-001	REV: 00	PAGE: 00

### Annexure - VII: Project Schedule