APPLICATION OF GIS IN CITY GAS DISTRIBUTION

A Project Report Submitted in Partial Fulfillment of the
Requirement for the Degree of

MASTER OF TECHNOLOGY
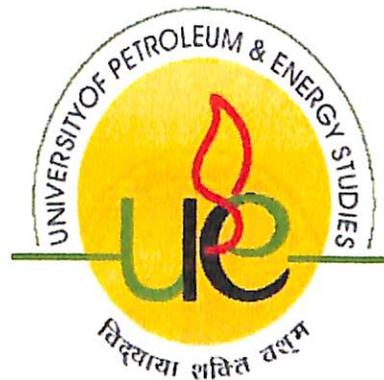## IN
PIPELINE ENGINEERING

Under the Guidance of

Dr.Neelu Jyothi Ahuja
Assistant Professor-Selection Grade
Centre for IT-COE
UPES

Submitter By

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(R150209036)

College Of Engineering
University of Petroleum & Energy Studies
Dehradun
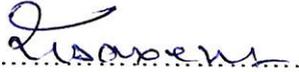**May, 2011**

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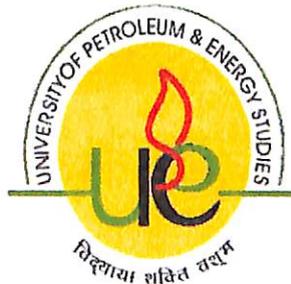(PIPELINE ENGINEERING)

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Approved

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Head of Department, ٩ ٢٠١١
College of Engineering
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May, 2011

INDRAPRASTHA GAS LIMITED

(A Joint Venture of GAIL (India) Ltd., BPCL & Govt. of NCT of Delhi)

IGL/HR/T&D/Gen

March 15, 2011

TO WHOMSOEVER IT MAY CONCERN

This is to certify that Mr. Srinath G.M. (Roll. No. R150209036) student of 4th Semester of M.Tech - Pipeline Engineering, session 2009 – 11 of University of Petroleum and Energy Studies, Dehradun has undergone Dissertation Project under the project title "City Gas Distribution" in our organization from January 20, 2011 to March 15, 2011.

Mr. Srinath G.M. has done Dissertation Project with great sincerity and successfully completed the same and has duly submitted a Dissertation Project Report.
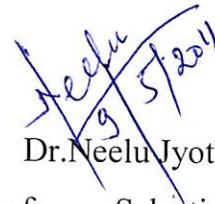
We wish him all the best for future endeavors.

P.R. Rajesh
Dy. General Manager – HR

CERTIFICATE

This is to certify that the work contained in this thesis titled "APPLICATION OF GIS IN CITY GAS DISTRIBUTION" has been carried out by "G.M.SRINATH" Under my supervision and has not been submitted elsewhere for a degree.

Dr.Neelu Jyothi Ahuja

Assistant Professor-Selection Grade

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Date: 09 . 05 . 2011

ACKNOWLEDGEMENT

ABSTRACT

$\overset{i}{lg}l$ INDRAPRASTHA GAS LIMITED

During my Dissertation Project at IGL Corporation, I learnt about opportunities where "CITY GAS DISTRIBUTION" could be effectively done using Network Analysis. I learnt ways to integrate company's technological and business objectives. The technologies I learnt were at various stages of development: Some are available today, but others are one to two years away from being commercially available. This report describes new and evolving technologies involved in the distribution of natural gas that can enhance the lifestyle of people by providing a cleaner, environment-friendly alternative fuel. This will considerably bring down the alarmingly high levels of pollution.

CGD-City Gas Distribution

The city gas distribution (CGD) business has grown at a rapid pace in India since the late 1990s on the strength of both a Supreme Court mandate for the conversion of commercial automotives in few cities from traditional liquid fuels to) Piped Natural Gas (PNG) and Compressed Natural Gas (CNG) and the favorable economics of such conversion for end-users.

PNG-Piped Natural Gas

PNG is mainly methane – CH_4 with a small percentage of other higher hydrocarbons. The ratio of carbon to hydrogen is least in methane and hence it burns almost completely making it the cleanest fuel. It is procured from the oil / gas wells and transported through a network of pipelines across the country.

CNG-Compressed Natural Gas

It is gaseous fuel and is a mixture of hydrocarbons mainly Methane CH_4. For use in Automobiles as fuel, it is compressed to a pressure of 200-250 Kg/cm² to enhance the vehicle on-board storage capacity.

SynerGEE Gas-Network Modeling and Analysis

SynerGEE® Gas models and analyzes closed conduit networks of pipes, regulators, valves, compressors, storage fields and production wells. SynerGEE serves as a general purpose-modeling tool for piping networks including, but not limited to natural gas, propane, steam, oxygen and air.

SynerGEE provides the features of the most advanced pipeline simulation software commercially available along with the ease and familiarity of a windows-based operating system. Licensing add-on modules can extend SynerGEE's functionality.

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NOMENCLATURE

AIM	Area Isolation Module
API	American Petroleum Institute
CGD	City Gas Distribution
CMM	Customer Management Module
CNG	Compressed Natural Gas
EDM	Estate Design Module
FMM	Facilities Management Module
GZB	Ghaziabad, Uttar Pradesh, India
HBJ	Hazira - Baijaipur - Jagdispur
HIG	High Income Group
IGL	Indraprastha Gas Limited
LIG	Lower Income Group
NMA	Network Modeling and Analysis
PNG	Piped Natural Gas
PNGRB Act.	Petroleum and Natural Gas Regulatory Board Act.
SAN	Storage Area Network

CHAPTER.1 INTRODUCTION

1.1 The Petroleum and Natural Gas Regulatory Board Act.

To regulate the refining. processing. storage. transportation. distribution. marketing and sale of petroleum. petroleum products and natural gas excluding production of crude oil and natural gas so as to protect the interest of consumers and entities engaged in specified activities and to ensure uninterrupted & adequate supply and to promote competitive markets.

1.2 HBJ-Pipeline :(Hazira (Gujarat) - Baijaipur (Madhya Pradesh) - Jagdispur (Uttar Pradesh)

The main trunk of the HBJ Pipeline consists of carbon steel pipe ranging in size from 18 to 36 in diameter running from Hazira on the west coast of India to Delhi in the north and has been constructed in conformity with API (American Petroleum Institute) engineering standards.

Although originally 1,700 km of pipeline was laid, subsequent extensions and spur lines have been added and the HBJ Pipeline is currently over 2,300 km in length. The HBJ Pipeline system also consists of receiving terminals, dispatch terminals for the supply of metered gas system, six compressor stations for boosting the pressure of the gas as it is transmitted, the SCADA system to provide central monitoring and control and a dedicated telecommunications system to provide reliable voice and data communication. The HBJ system had initial capacity of 18.2 MMSCMD of natural gas. Due to increased Gas availability and consumption, the system's gas handling capacity has been upgraded to 33.4 MMSCMD.

Purpose and Objectives:

The O&M arm of GAIL is constantly making efforts to improve upon its performance in its operations. In order to provide a highly efficient information storage and retrieval system, GAIL has embarked upon a project to prepare Functional Design Specifications (FDS), carry out a Survey and prepare as-built computerized route maps/ drawings, prepare database, test and commission the system for GAIL's Natural Gas pipelines in and around Delhi and integrating the same with a Geographical Information System (GIS).

Objectives:

• Effective Operation and Maintenance (O&M)
• Aid in emergencies like pipeline leak or burst.
• Disaster Management.
• Apart from GAIL the information from this system will be of use to other departments like Telecommunications, DDA, GDA (for laying water, sewage-lines), Delhi Electricity Supply Undertaking.

Mascon developed a Pipeline Regulation, Operation, Maintenance and Information System (PROMIS) in accordance with the specifications of GAIL. A desktop model involves users who are individuals or teams working in their application areas. The desktop GIS users need not be GIS specialists and shall use GIS to enhance their productivity and save precious time. Where necessary the users can take color printout of maps and data according to their requirements within the scope of the system.

CHAPTER.2 LITERATURE REVIEW

2.1 Introduction to Ghaziabad, Uttar Pradesh

Ghaziabad is a planned industrial city in the Indian state of Uttar Pradesh. It is 19 km east of Delhi and 46 km southwest of Meerut. The city houses the headquarters of the Ghaziabad district. It was initially part of the Meerut district after independence, till the time when — due to political intervention — Ghaziabad was separated and given a new district status.

The city gets its name from the founder Ghazi-ud-din, who called it Ghaziuddinnagar after himself. Later the name was shortened to Ghaziabad. It is a large industrial city well-connected by roads and railways. It has industries that Maintenance of electric locomotive & EMU Trains, manufacture railway Wagons, bicycles, tapestries, glassware, pottery, paint and varnish, heavy chains, etc. Also it has an ordnance factory at Muradnagar & Bharat Electronics Limited for manufacturing defense products.

Once notorious for the staggering rate of crime and law-and -order problem (it had been ranked third on the world's most crime infested cities sometime in the early 80's), the city today stands as one of India's most developed cities. The city has well planned roads, malls and flyovers. And the city has been listed in Top 10 dynamic city-lists by Newsweek.

The City of Ghaziabad

Post independence, Ghaziabad Gradually grew as an important industrial centre, its proximity to Delhi, always helping in this cause. The major industries to be established during that period include the Mohan Meakin Industrial estate (Mohan Nagar) and the International Tobacco Company (Guldhar). The Modinagar Industrial town built by the industrialist Gujarmal Modi, although was constructed much earlier in 1933. The years up to the formation of the district in 1976 saw steady growth of the town in terms of population and also in economic activity.

Formation of the District

The then chief minister Mr. N.D.Tiwari declared Ghaziabad as a district on 14 November 1976, on the birth anniversary of Pt. Jawaharlal Lal Nehru, the first prime minister of India. From then Ghaziabad has moved forward leaps and bounds on the social, economic, agriculture and individual front.

Ghaziabad, the headquarter of the district of the same name, lies on the Grand Trunk road about a mile east of the Hindon river in Lat. 280 40' North and Long. 770 25' East, 19 km east of Delhi and 46 km south-west of Meerut with which it is connected by a metalled road.

Other roads lead northwest to Loni and Baghpat and east to Hapur and Garhmukteshwar. Buses run at frequent intervals from here to Delhi, Meerut, Aligarh, Bulandshahar, Moradabad, and Lucknow and to other districts also. It is an important station on the Northern Railway where railway lines, from Delhi to Calcutta, Moradabad and Saharanpur meet, connecting it with many important cities of India. Raj vishwakarma.As its boundary is adjacent to Delhi, it acts as the main entrance of Uttar Pradesh and that is why it is also called the Gateway of U.P.

Geography

Situated about 2.5 km from the Hindon River, on the north it is bound by the district of Meerut, on the south by that of Bulandshahar and Gautambudh Nagar, on the south-west by Delhi and on

the east by the district Jyotibaphule Nagar. Ganges, Yamuna and Hindon are the main rivers flowing through the district and they are filled with water throughout the year.

Demographics

In the Post-Independence period, with the huge influx of displaced people from Pakistan (mostly people from Punjab), the city's population saw a rapid increase. Next, with the setting up of a good number of industrial units throughout the 1960s and 1970s, the population saw another boom. Apart from the native population, Ghaziabad, now had people from almost all of India, coming here to take up jobs with the industries being set up here. Also, small communities of Bengalis and South Indians set up base here. Similarly, there were other communities from different parts of the country coming here, most of them Blue-Collar and White-Collar professionals working with the industries in the area.

According to the census of 1991 the population of the district is 22, 47,434. The density of the population per km^2. Is 1,127 and the population is 464.7 % higher than what it was ninety years ago.

Rapid establishment of new industrial institutions were the main reason for it. Increase in the urban population of Ghaziabad can be attributed to the influx of people to the city for earning their bread and butter and secondly as the residential problem of the Delhi metropolis is increasing, a large number of people are leaving it to settle in the nearby areas.

In the last decade, the city has grown to be one of the most cosmopolitan cities of Uttar Pradesh, thanks to the Real estate boom.

Administration

There is one municipal corporation (Ghaziabad), five municipal councils (Muradnagar, Modinagar, Hapur, Garhmukteshwar and Pilkhuwa) and six town Panchayats (town area Loni, Niwari, Patla, Dasna, Babugarh and Faridnagar) in the district. Ghaziabad was given the status of Municipal Corporation on 31 August 1994.

Economy

Kaushambi Housing Society

Ghaziabad is primarily an industrial city with manufacturers in railway coaches, diesel engines, electroplating, bicycles, picture tubes, tapestries, glassware, pottery, vegetable oil, paint and varnish, heavy chains, automobile pistons and rings, steel pharmaceuticals, liquor, etc. It is one of the most industrialized cities in Uttar Pradesh. The new industry sector upcoming in Ghaziabad is of high tech plant growth boosters. Many companies like Shriram Pistons, Unichem, Dabur, International Tobacco, Bhushan Steels, Rathi Alloys, Crop Health Products Pvt. Ltd., Allied Nippon Ltd and Samtel Color are giving it a new dimension.

- Small Scale Industries
- Medium Scale Industries
- Large Scale / Heavy Industries

Small-scale industries functioning in the district are 14,160	Capital investment of Rs. 270.00 Crores.	Employing about 73,130 workers.
Medium/Heavy industries functioning in the district are 145	Capital investment of Rs. 2,930.86 Crores	Employment to about 31,200 workers.

There are a number of private hospitals and health-care centers in Ghaziabad that provide health care to the residents. There are a number of malls dotting the city. The Pacific and Shipra malls are amongst the largest in the National Capital Region. Ghaziabad is one of the largest railway junctions, handling more than 100 long distance trains every day, in addition to the numerous suburban trains to Delhi. It houses one of the largest and most modern Electric Locomotive Sheds. Ghaziabad is the city credited giving highest revenue in the state of Uttar Pradesh and second maximum in India. The city has 32 malls, second in India only to Bangalore.

Transport
Ghaziabad can be reached by air, road and rail. The nearest airport is the Indira Gandhi International airport which is about 45 km away. By road, Ghaziabad is well-connected on all sides to Delhi, NOIDA, Hapur, Modinagar, Meerut, Saharanpur, Haridwar, etc. A large number of people commute to Delhi, Noida, Greater Noida and Gurgaon every day for work.
There are bus terminals at Mohan Nagar, Lohia Nagar, and Vasundhara and close to Meerut Road from where Uttar Pradesh State Road Transport Corporation (UPSRTC) buses serve cities all over the state. The Anand Vihar bus terminal of DTC is located on city's border.
Ghaziabad is a railway junction and several lines pass through the city. The main railway station is situated in the middle of the city. The city is well connected to Delhi and other neighboring cities through Fast Moving Local Trains called EMU. Several trains connect Ghaziabad to Meerut, Aligarh, Delhi, New Delhi, Faridabad, Palwal, Mathura, Indore, Ujjain, Loni and others. The Metro extends to Dilshad Garden station which is situated at the Apsara Border on the outskirts of the city. At present it serves the areas of Shalimar Garden and other neighboring colonies. This Line will be further extended to New Bus Stand Ghaziabad by 2012. Dwarka Sector-9 line was extended to Anand Vihar and is being extended to Vaishali in Ghaziabad.

Education
There are a number of private and government Engineering, PG Degree, Law colleges and Management institutes in Ghaziabad. There are about 80-100 Medical, Dental, Pharmacy colleges, and Physiotherapy institutes which makes Ghaziabad one of the most education friendly cities in India. The most prominent being IMT Ghaziabad, which consistently ranks among the Top 10 B-Schools in India and Indraprastha Dental College & Hospital which is ranked as the Best Private Dental College in Delhi NCR.

2.2 Ghaziabad Development Authority

Over three decades of experience and in-depth understanding of an integrated city planning make the Ghaziabad Development Authority a valuable resource for making your best location decision. Whether you are looking for a suitable residential option or an industrial site or simply a suitable business premises - we are here to provide the resources you need to make the most informed location decision possible.

There are several departments within GDA. An overview of how each department works can be found in the sections listed below:

GDA DEPARTMENTS

- Land Acquisitions.
- Planning.
- Engineering.
- Property.
- Finance.
- Master Plan.
- Enforcement.
- Computer.

GDA OBJECTIVES

- Preparation of Master Plan for Planned Urban Development.
- Development & Control as per Master Plan.
- Acquisition of Land and Management for Housing and Urban Development.
- Construction Housing and Development.
- Provision of Physical and Social Infrastructure.

SOCIAL FACILITIES

- **Parks:** There are in total 603 parks in Ghaziabad.
- **Mother Dairy:** There are fifteen Mother Dairy outlets.
- **Club:** There are seven clubs.
- **Police Stations:** There are nine police stations and eight police chowkis.
- **Electric Stations:** There are four stations and twenty-three sub-stations.
- **Telephone Exchanges:** There are nine telephone exchanges.
- **Health Centre:** There are twenty health centers.
- **Nursing Home:** There are thirty-six nursing homes.
- **Community Centers:** There are thirty-five community centers.
- **Gas Godowns:** There are ten gas Godowns (Warehouses).
- **Swarn Jayanti Park.**
- **Garden City.**

2.3 Ghaziabad City Maps-References

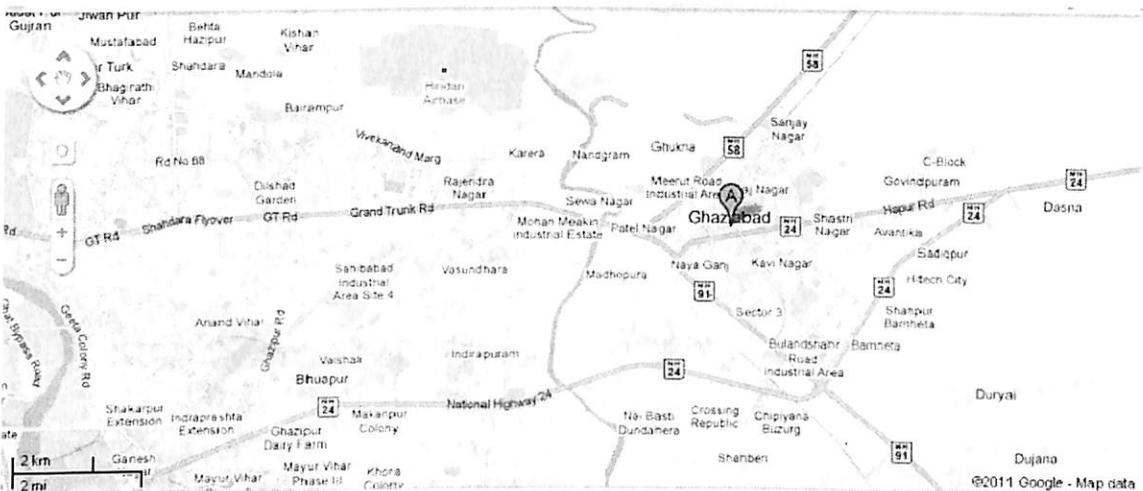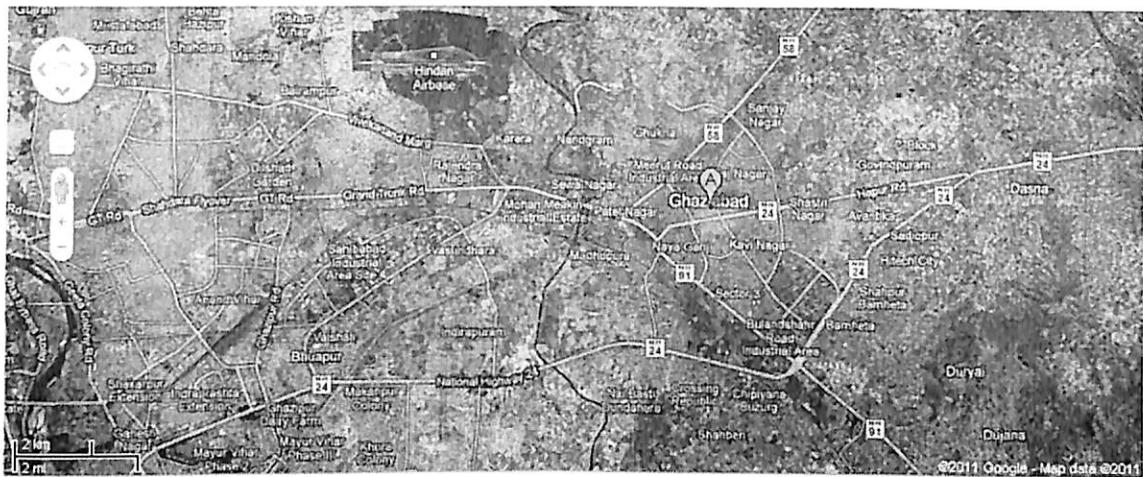**Figure: 1 GHAZIABAD CITY MAP-MAPS OF INDIA**
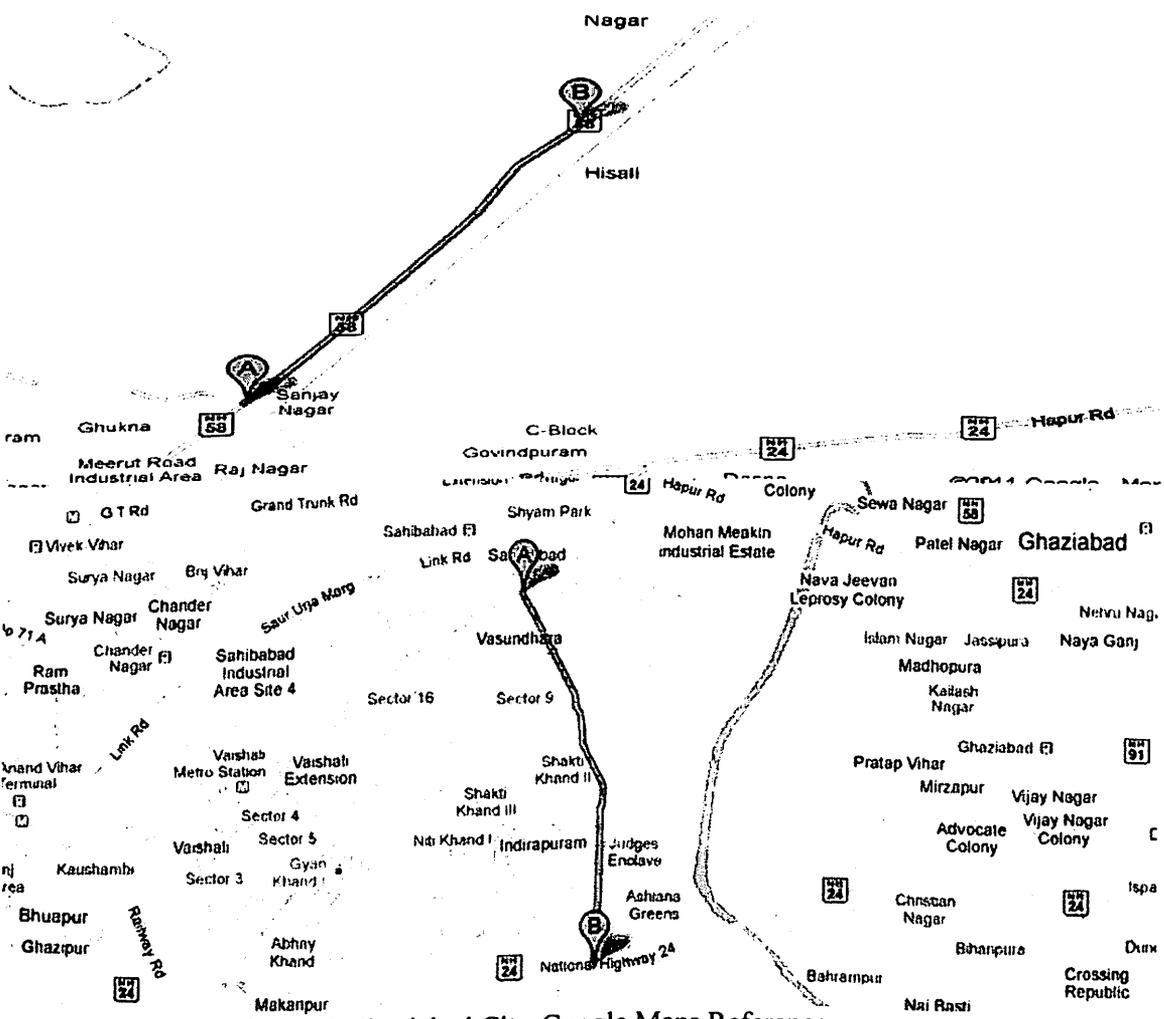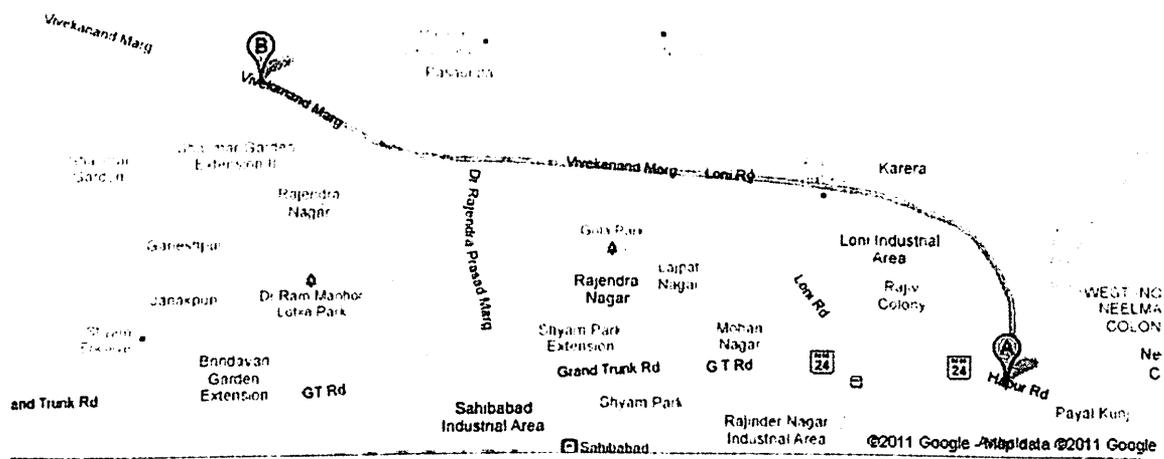
Figure: 2 Ghaziabad City-Google Maps Reference

Figure: 3 Ghaziabad City-Google Maps Reference

2.4 Need of Natural Gas Pipeline In Ghaziabad-A Report

From the year 1960 to 1977, the Improvement Trust and later on GDA has constructed about lacs of houses and plots of various categories i.e. site/services, EWS, MIG, LIG, HIG and apartments.

Kaushambi, Vashali, Indirapurm in T.H.A. and Govindpuram, Karpooripuram, Swarn Jayanti Puram and Partap Vihar in Hindon Area are the new upcoming residential colonies in Ghaziabad. The authority is constructing commercial complexes in these colonies to create to the needs of the people

Houses of various categories are being constructed in these schemes. Impetus is being given to the Regional Centers through the provision of adequate infrastructure and services in order to attract prospective residents. These infrastructure components i.e. Site development with Parking, Electricity, Road network, water Supply, Sewer, Drainage etc. are at the various stages of construction.

The **Ghaziabad economy** is heavily dependent on the industries, which are the real assets of the city. The many industries account for the economic growth of the Uttar Pradesh State. Also, these industries are the reason behind Ghaziabad drawing the huge number of skilled laborers for employment. Among all the industries, the most important sector is the steel sector. More than 500 steel organizations in the place employ more than 25,000 people. Also, there the manufacturing segment employs 53% of the non-agricultural jobs in Ghaziabad. The manufacturing industry is alone to be credited for an income, which is eight times the income of other industries taken together.

The Manufacturing Industry of Ghaziabad

The manufacturing segment in Ghaziabad other than the steel plant based companies include apparel, transportation equipments, dairy products, tobacco production, ceramics, pottery, Industrial machinery, equipments and all sorts of electrical and electronic goods. The other upcoming manufacturing sector is the Hi Tech plant growth boosters.

The Railway Industry of Ghaziabad

Ghaziabad is important in terms of the railway junction. Over a hundred long distance trains traverse the Ghaziabad junction. Hence the railway industry too constitutes an important part of Ghaziabad economic development. An updated Electric Locomotive Shed has been arranged for in the city of Ghaziabad.

Miscellaneous Industries of Ghaziabad

Other important constituents of the **Ghaziabad economy** include bicycles, picture tubes, electroplating, glassware, vegetable oil, tapestry, paint and varnish products to name a few of them. Real Estate Business cannot stay far behind in an industrial city, especially when umpteen numbers of offices are mushrooming up all over the city.

METRO NETWORK EXPANSION AT GHAZIABAD
Figure: 4 Ghaziabad Metro Plan Map

PHASE I
RAJIV CHOWK - VAISHALI
(VIA ANAND VIHAR)

PHASE II
VAISHALI - INDIRAPURAM - MAHRAULI

PHASE III
ISBT (DELHI) - BUS STAND GHAZIABAD
(MEERUT ROAD TIRAHA)
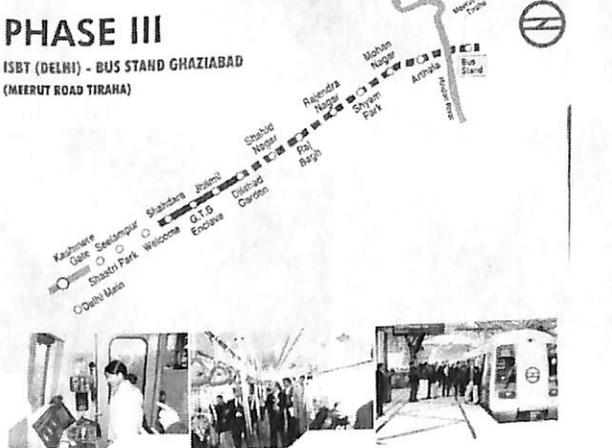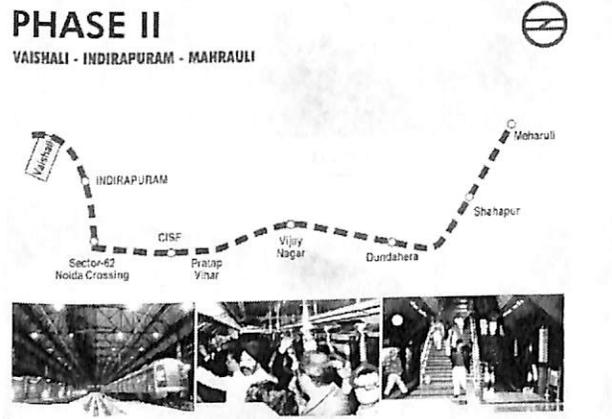
The Delhi Metro Rail Corporation and the Ghaziabad Development Authority have signed an agreement for extension of the Delhi Metro to Vaishali, Ghaziabad. Metro Extension to Vaishali would become a reality.

Today painful commuting and chaotic traffic have become a curse of Ghaziabad. Scores of people go through daily order while commuting to their workplaces in Delhi and other parts of NCR. The existing public transportation is in urgent need of an overhauling. With no other option people are forced to either rely on their private transport or go through the grind every day. But it seems that all this would become history soon. As in the year 2011 Metro-Vaishali extension would be ready. As a result it would be just 20 minutes journey to CP (Connaught Place) or ITO, whereas at present it takes about 45 minutes.

Under the proposed Phase-II of the metro rail, the Rajiv Chowk-Anand Vihar link has been extended from Anand Vihar to Vaishali. The Metro will pass through Kaushambi before reaching Vaishali. Two stations for the metro have also been finalized at Kaushambi and Vaishali.

Today Ghaziabad boasts of some of the great residential areas. No wonder over the years the place has become one of the most sort after addresses. Whenever someone starts a search for a house or for that matter even for an office space then Ghaziabad gets a fair amount of importance. The skyscrapers which have cropped all along the NH-24 and beyond bear testimony to this fact. City's skyline has been redefined.

Investment plans for Delhi-bound commuters. "We will build more flats in Indirapuram and double the Shipra Mall capacity to little less than a million sq ft. Two five-star hotels are also being planned in the area," to meet rising demand, developers are planning to pump huge amounts into various projects - residential and commercial.

Figure: 5 Facts Considered

Increased usage in CNG powered public transportation vehicles.
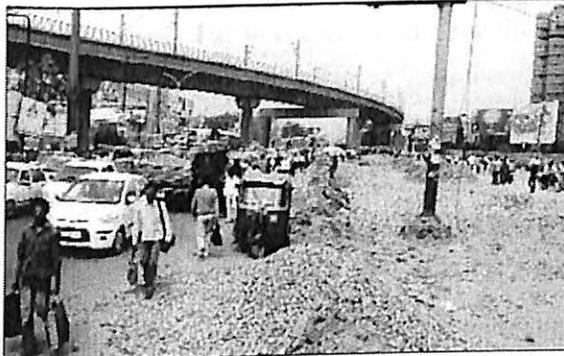
Delhi Metro Network extending up to Ghaziabad.   Traffic: Morning at Mohan Nagar, Ghaziabad.

Good development in Residential, Commercial and Industrial Sectors.

2.5 IGL at Ghaziabad-News at a Glance

IGL bags Ghaziabad city-gas license
BS REPORTER / NEW DELHI JULY 01, 2010, 1:47 IST
Indraprastha Gas Ltd (IGL) has bagged license to build and operate CNG stations and piped natural gas network in Ghaziabad.

"IGL is an 'authorized entity' to lay, build, operate or expand city-gas distribution (CGD) network in Ghaziabad," the petroleum ministry said in an order yesterday.

"We are extremely grateful to the Petroleum Ministry for having reposed its faith in IGL for undertaking city gas distribution project in another city in NCR," Rajesh Vedvyas, managing director of IGL, said in a release today.

In 2009, the Petroleum and Natural Gas Regulatory Board (PNGRB) had invited bids for city gas business in seven cities — Allahabad, Ghaziabad and Jhansi in Uttar Pradesh, Shahdol (Madhya Pradesh), Rajahmundry and Yanam (Andhra Pradesh) and Chandigarh.

IGL, which had pre-PNGRB authorization for CNG operations in Ghaziabad, had challenged PNGRB's move in the Delhi High Court. IGL had claimed that the board lacked powers to issue authorization for city gas business since Section 16 of the PNGRB Act was not notified.

Earlier this year, the high court had barred the board from issuing authorization. "In view of non-notification of Section 16... it is held that the board has no power to grant authorization to entities which applied to it for laying, building, operating or expanding city or local natural gas distribution networks... this is in consonance with the Central government's stand in the counter-affidavit filed before this court," the high court had said in January.

The central government also told the court that the board was "not currently empowered to issue authorizations". The board has challenged the high court order in the Supreme Court.

IGL gets Ghaziabad city-gas license
INDIAN EXPRESS, WEDNESDAY JUN 30 2010, 15:16 HRS
The government has given Indraprastha Gas Ltd (IGL) the license to retail CNG to vehicles and piped gas to households in Ghaziabad.

Petroleum and Natural Gas Regulatory Board (PNGRB), headed by L Mansingh, had previously ignored the government and the Supreme Court mandated committee's authorization to IGL, which sells CNG and piped gas in Delhi, for city gas operations in neighboring Ghaziabad.

PNGRB, last year, had put Ghaziabad on bidding and even after the Delhi High Court allowed IGL to "carry on their activities in Ghaziabad"; it opened the bids to name Gujarat-based Adani Energy-led consortia as preferred bidder.

"IGL is an 'authorized entity' to lay, build, operate or expand city-gas distribution (CGD) network in Ghaziabad," the Oil Ministry said in an order on Tuesday.

The order said that the Delhi High Court has ruled that PNGRB has no powers to issue CGD licenses and the power to do so vests in the ministry.

The Supreme Court-appointed Environment Pollution (Prevention and Control) Authority (EPCA) "had directed IGL to undertake CGD activities in Ghaziabad much before the commencement of PNGRB Act, 2006," it said.

EPCA has been given the powers of the Central Government under Environment Pollution (Prevention & Control) Act, 1986, in the National Capital Region (NCR).

"The Supreme Court has held that the directions of EPCA are final and binding on all persons and organizations concerned."

CHAPTER.3 MODEL DEVELOPMENT

3.1 Digital Mapping-Digitized Maps for Pipeline Route Planning

Digital mapping (also called digital cartography) is the process by which a collection of data is compiled and formatted into a virtual image. The primary function of this technology is to produce maps that give accurate representations of a particular area, detailing major road arteries and other points of interest. The technology also allows the calculation of distances from once place to another.

Though digital mapping can be found in a variety of computer applications, such as Google Earth, the main use of these maps is with the Global Positioning System, or GPS satellite network, used in standard automotive navigation systems.

From Paper to Paperless
The roots of digital mapping lie within traditional paper maps such as the Thomas Guide. Paper maps provide basic landscapes similar to digitized road maps, yet are often cumbersome, cover only a designated area, and lack many specific details such as road blocks. In addition, there is no way to "update" a paper map except to obtain a new version. On the other hand, digital maps, in many cases, can be updated through synchronization with updates from company servers.

Expanded Capabilities
Early digital maps had the same basic functionality as paper maps—that is, they provided a "virtual view" of roads generally outlined by the terrain encompassing the surrounding area. However, as digital maps have grown with the expansion of GPS technology in the past decade, live traffic updates, points of interest and service locations have been added to enhance digital maps to be more "user conscious." Traditional "virtual views" are now only part of digital mapping. In many cases, users can choose between virtual maps, satellite (aerial views), and hybrid (a combination of virtual map and aerial views) views. With the ability to update and expand digital mapping devices, newly constructed roads and places can be added to appear on maps.

Data Collection
Digital maps heavily rely upon a vast amount of data collected over time. Most of the information that comprises digital maps is the culmination of satellite imagery as well as street level information. Maps must be updated frequently to provide users with the most accurate reflection of a location. While there is a wide spectrum on companies that specialize in digital mapping, the basic premise is that digital maps will accurately portray roads as they actually appear to give "life-like experiences."

Functionality and Use

Computer Applications
Computer programs and applications such as Google Earth and Google Maps provide map views from space and street level of much of the world. Used primarily for recreational use, Google Earth provides digital mapping in personal applications, such as tracking distances or finding locations.

Scientific Applications

The development of mobile computing (PDAs, tablet PCs, laptops, etc.) has recently (since about 2000) spurred the use of digital mapping in the sciences and applied sciences. As of 2009, science fields that use digital mapping technology include geology (see Digital geologic mapping), engineering, architecture, land surveying, mining, forestry, environmental, and archaeology.

GPS Navigation Systems

The principle use by which digital mapping has grown in the past decade has been its connection to Global Positioning System (GPS) technology. GPS is the foundation behind digital mapping navigation systems.

How It Works?

The coordinates and position as well as atomic time obtained by a terrestrial GPS receiver from GPS satellites orbiting Earth interact together to provide the digital mapping programming with points of origin in addition to the destination points needed to calculate distance. This information is then analyzed and compiled to create a map that provides the easiest and most efficient way to reach a destination.

More technically speaking, the device operates in the following manner:

1. GPS receivers collect data from "at least twenty-four GPS satellites" orbiting the Earth, calculating position in three dimensions.
2. The GPS receiver then utilizes position to provide GPS coordinates, or exact points of latitudinal and longitudinal direction from GPS satellites.
3. The points, or coordinates, output an accurate range between approximately "10-20 meters" of the actual location.
4. The beginning point, entered via GPS coordinates, and the ending point, (address or coordinates) input by the user, are then entered into the digital map.
5. The map outputs a real-time visual representation of the route. The map then moves along the path of the planned pipeline route.
6. If the route drifts from the designated route, the navigation system will use the current coordinates to recalculate a route to the destination location.
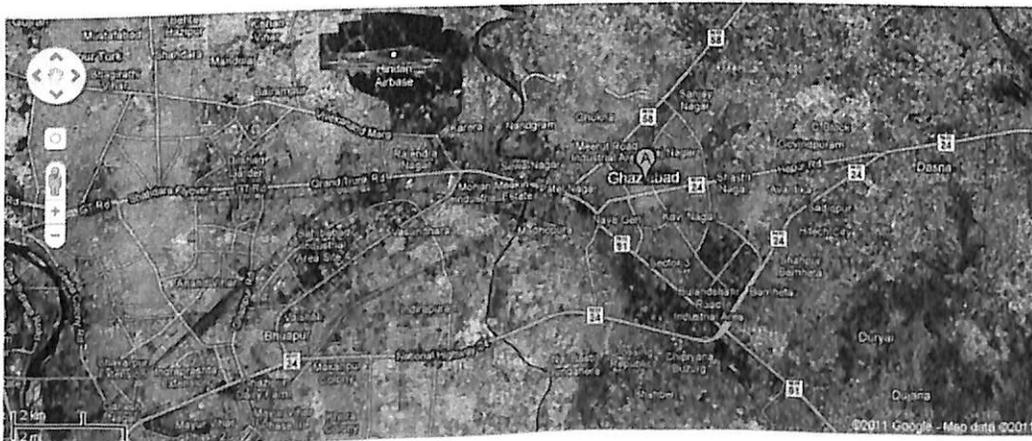
3.2 SynerGEE Gas-Network Modeling and Analysis:-
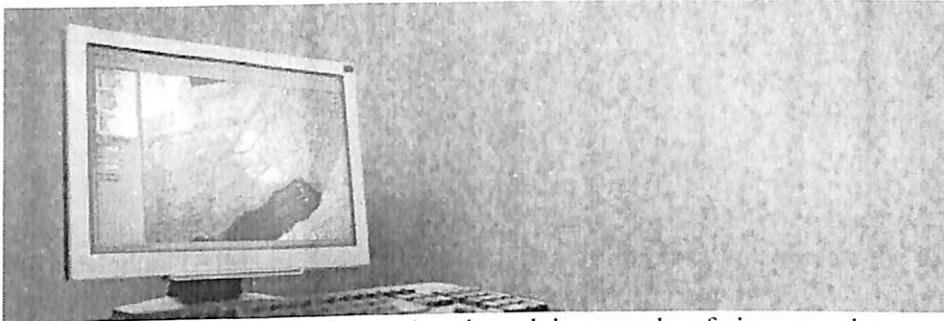
SynerGEE® Gas models and analyzes closed conduit networks of pipes, regulators, valves, compressors, storage fields and production wells.

SynerGEE® Gas models and analyzes closed conduit networks of pipes, regulators, valves, compressors, storage fields and production wells. SynerGEE serves as a general purpose-modeling tool for piping networks including, but not limited to natural gas, propane, steam, oxygen and air.

SynerGEE provides the features of the most advanced pipeline simulation software commercially available along with the ease and familiarity of a windows-based operating system. Licensing add-on modules can extend SynerGEE's functionality.

Advanced modeling functionality:
SynerGEE provides an efficient steady-state solver that enables robust and reliable volumetric, thermal, and compositional balance capabilities.

You can model large, complex, integrated, multi pressure-level systems that include regulators and compressors. You have full control over the gas constraints (gravity, heating value and viscosity), friction factor calculations and heat transfer methods.

SynerGEE provides various flow equations (equations of state) and allows for each flow equation to be assigned as a session default or on a pipe-by-pipe basis.

SynerGEE's constraint interchange lets you model compressors and regulators as they operate in the field, allowing for an exchange of unknowns and reformulation of equation if a constraint condition is violated during the simulation.

Robust modules that meet expanding client needs:
SynerGEE has built a variety of additional modules which have been developed to meet specific customer requirements.

These modules include Customer Management Module to link SynerGEE with existing Customer Information Services, Model Builder which lets you import, filter and query data from multiple external GIS sources and Area Isolation Module which allows you to choose an area to isolate for emergency planning, maintenance or other scenarios.

FEATURES

Area Isolation Module
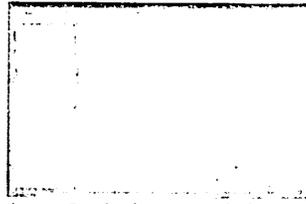
Area Isolation Module (AIM) provides you with the tools you need to simulate the isolation of user-selected areas of a gas network.

Prepare for an Emergency

Area Isolation Module (AIM) provides you with the tools you need to simulate the isolation of user-selected areas of a gas network for emergency planning, maintenance or other operational needs. AIM also enables you to analyze and generate detailed reports on the effect of area isolation on remaining network pressure and flow.

Accurate Isolation Analysis

Combined with SynerGEE's traditional steady-state functionality, AIM is useful in planning future system outages or determining what happens when an emergency valve is closed. You can also perform a complete analysis that isolates the system, and then hydraulically balances the modified model, to identify which customers are affected by an outage. AIM works within SynerGEE's user-friendly interface so you can use your model with customer information system (CIS) data.

Enhanced Features

AIM delivers value-added features, including:

- Quick identification of valves that isolate areas in your network
- Integrated isolation data in the model database
- Extensive graphical and tabular reporting options
- Enhanced load handling for modified load removal based on closed-valve locations
- Isolation polygons to select isolation areas over areas defined by regulating valves and facilities
- Better design to meet DOT and/or state utility commission requirements

Connect to Your CIS

AIM and the Customer Management Module (CMM) can work together to generate an easy link between isolated zones in your hydraulic model and your existing CIS data. The link allows you to quickly and graphically identify customers affected by an isolated region. The reporting capability allows you to quickly report to your field staff and customer service department.

Automated Design Module
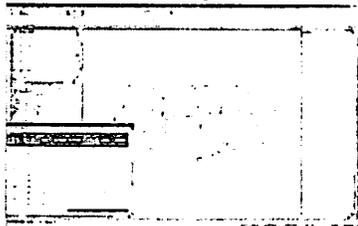
Automated Design Module (ADM) enables you to assess pipe size options for your model with specified loading conditions, material cost, installation cost and location.

Network Efficiency

Automated Design Module (ADM) enables you to assess pipe size options for your model with specified loading conditions, material cost, installation cost and location. ADM is designed to calculate and report the lowest possible pipe diameter capable of transporting sufficient quantities of gas to required delivery points safely and reliably. The module is particularly helpful when designing new systems or expanding and reconstructing existing networks.

Piping Solutions

ADM operates in single-pressure level networks on data and criteria you provide. Requirements include:
- Current and possible piping configurations.
- Load distribution including the design criteria of maximum and minimum allowable velocity for the decision pipes.
- Pipe installation parameters including internal diameter, material type and installation cost per unit length.

ADM Reporting

As you prepare for an ADM automated design run, you can select the level of detail in the results report produced at the conclusion of the run. You can specify one of the following:
- Full trail detail report displays a complete record of the design session recording each ADM procedure and displays it in chronological order as it occurs. A sub report of the full trail report is the pipe change report, which displays all of the pipes whose diameters changed during the design session.
- Velocity trail detail displays the best design solution for each maximum velocity ADM used, summarizing the best design scenarios.
- No report only displays the final design solution.

Benefits

ADM can provide many benefits to your organization, such as:
- Determining a low cost design for new service areas or major mains replacement efforts
- Quickly analyzing system design and avoiding over-design of your system.
- Clearly identifying the incremental cost by designing to a higher minimum pressure.

Cost of Service Module
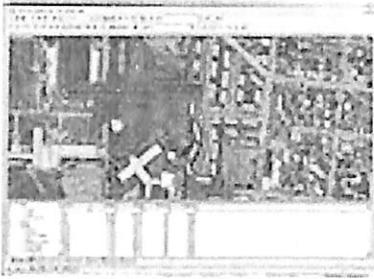
Cost of Service Module (COSM) extends the reporting functionality of the SynerGEE Gas steady state application.

Calculate Cost of Service Data

Cost of Service Module (COSM) extends the reporting functionality of the SynerGEE Gas steady state application. COSM is used with SynerGEE to report the cost of service for gas in a distribution system. Based on the pipe cost, the pipe capacity and customer demand on peak day, COSM calculates cost of service data.

Assess Financial Gain

The COSM reports associated costs by tracing the model from node to facility to node. These costs provide insight to the financial assessment of your pipeline system. Whether you are determining the supply cost from node-to-node or the cost of having stub nodes, COSM can help to eliminate or effectively determine the most financially sound method to add new facilities to your system.

Reporting Features

COSM's primary function is to report the costs associated with the nodes and facilities in your model. COSM take associated information from the CAP file and relates it to the nodes and facilities. Using the flow and concentration, it provides investment reports, including:

- Node cost trace report
- Facility cost trace report
- Node supply trace report
- Node stub report

Using a balanced model and a CAP file, COSM reports the cost of service data on nodes and elements.

The CAP files in an ASCII-format data file that lists each facility identifier (FID) in the model and an associated cost value usually, the cost of pipe installation with depreciation. The associated cost value can be book value or replacement value.

In the cost of service calculation, COSM takes flow, load and concentration, combines them with a rate set in the SynerGEE CAP file and provides cost values associated with your facilities and node.

Customer Management Module
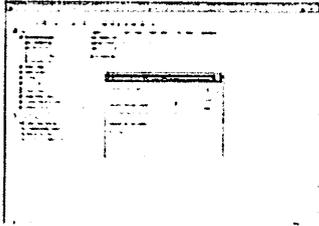
Customer Management Module (CMM) provides a link between SynerGEE Gas and your customer information system (CIS).

Link to Your Customer Information

Customer Management Module (CMM) provides a link between SynerGEE and your customer information system (CIS). Using information from your CIS database, CMM establishes a relationship among weather, individual customer load and customer location.

Assign Customer Location

CMM assigns customer location using customer X Y coordinates, service address, manual assignment or other sources such as a geospatial information system (GIS), where available. If the information is available from the CIS, CMM considers pressure codes, diameter or pipe material during the customer assignment process. CMM can use this data to identify the proper main when multiple mains are in close proximity to a customer coordinate.

The assignment process also uses logic so that customers are not assigned to regulators or other equipment. During customer assignment, you can use CMM's scheduling function to define multiple assignment passes. This enables you to quickly review a list of customers that were assigned during each pass.

Create Loads

CMM uses historic billing information from your CIS and weather data to calculate weather-dependent loading for each customer. Using proven regression techniques, CMM analyzes historical gas usage patterns for each customer to determine respective base and heating and cooling factors.

Display Customer Information

By accessing CMM's database in the SynerGEE environment, you can quickly obtain a list of customers assigned to pipes and nodes. When you have selected either individual or groups of pipes (or nodes), CMM will display a list of the assigned customers and customer information, including account number address, load factors and a rate code.

The ability to display customer data allows you to identify major loads in a selected area and identify customers affected by service interruptions or system changes.

An independently licensed module of SynerGEE Gas, CMM uses an Oracle® data repository that allows you to store significantly more customer data.

Other CMM benefits include:

- **Proven Forecasting Engine.** CMM's load factor engine is built on 20 years of experience in forecasting customer demand. CMM's load factors results are constantly benchmarked against recorded flow data.
- **Automated Customer Assignment.** CMM's customer assignment functions significantly reduce the effort required to link customers to model facilities.
- **Data Mining Tools.** CMM provides tools to query customer data and chart/report on customer data. You can investigate customer demand data load analysis results that let you accurately model your distribution system.
- **Custom SynerGEE Reporting.** By linking customer data with your SynerGEE model, you can create customer lists for outages, adjust model loading by temperature, reassign customers using drag and drop functionality and create custom reports for system planning designs.

Estate Design Module
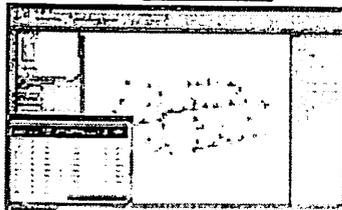
Estate Design Module (EDM) enables you to assess pipe size options for your model with specified loading conditions, material cost, installation cost and location.

Network Efficiency

Estate Design Module (EDM) enables you to assess pipe size options for your model with specified loading conditions, material cost, installation cost and location. EDM is designed to calculate and report the lowest possible pipe diameter capable of transporting sufficient quantities of gas to required delivery points safely and reliably. The module is particularly helpful when designing new systems with demand diversity.

Demand Modeling

EDM embodies the IGEM recommended formulae for the estimation of 1 in 20 peak 6 minute flows (IGE/GL/1). Diversity modeling is available. In this mode, demands can be specified in terms of numbers of customers, customer type and estimated annual consumption. When analyzing or designing a network, diversity formulae and a mixing formula are used. Diversity modeling is available for tree networks only (loops are not permitted).

Analysis and Design

EDM calculates steady state pressures and flow throughout the network, correcting if required for altitude effects. In design mode the program will automatically size pipes to give a near minimum cost while ensuring that all pressures are above a minimum design pressure.

Piping Solutions

EDM operates in single-pressure level networks on data and criteria you provide. Requirements include:

- Current and possible piping configurations.
- Load distribution including the design criteria of maximum and minimum allowable velocity for the decision pipes.
- Pipe installation parameters including internal diameter, material type and installation cost per unit length. Using this data and criteria, EDM determines which set of pipes satisfy your specified pressure constraints.

Data Requirements

Demand Data for point demands, node, and demand flow and demand tag are required. For diversified demands, node, number of customers, demand tag, customer type and annual consumption are required.

Factor data consists of: nominal diameter, material tag, efficiency factor, internal diameter and pipe cost per unit length.

Benefits

EDM can provide many benefits to your organization, such as
- Determining a low cost design for new estate areas.
- Quickly analyzing system design and avoiding over-design of your system.
- Network demand diversity.
- GIS Interaction. Ability to use scanned builders plans, CAD drawings as geo background for SynerGEE model build and design.

Facilities Management Module
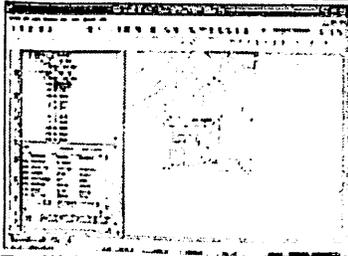
Facilities Management Module (FMM) enables you to synchronize your network models with GIS updates without rebuilding your model and losing valuable data.

Graphically Compare Models

Facilities Management Module (FMM) allows you to synchronize your gas distribution network models with GIS updates without rebuilding your model and losing valuable hydraulic data. You can review changes spatially and selectively accept or reject individual or groups of changes to merge into the model. While using FMM, you can perform routine SynerGEE functions such as adding, deleting and modifying nodes and facilities and running hydraulic analyses.

FMM offers you flexibility when comparing models. You can specify that FMM compare only pipes and regulators or only certain attributes of those pipes and regulators. You can also control the tolerances used for comparisons so differences that you consider insignificant are not flagged.

Synchronize Updates into a Model

When synchronizing changes into a model, you can graphically view each feature flagged and choose to accept or reject each change. Each change is classified as an add to, modification of or deletion from the base model.

Streamline Maintenance Tasks

FMM allows you too quickly and easily:

- Determine the differences between two models or between a GIS data set and a model
- View a list of proposed changes
- Selectively apply proposed changes you want to a base model
- Evaluate the impact of recent GIS updates to your SynerGEE model

New spatial detection functionality in FMM groups adjacent changes together. Deleted changes can then be viewed side-by-side with the existing model both graphically in the map and as a list of attributes. Easy-to-use tools enable you to accept or reject an entire group (e.g. subdivision or new development) or the individual changes in that group.

Leakage Management Module
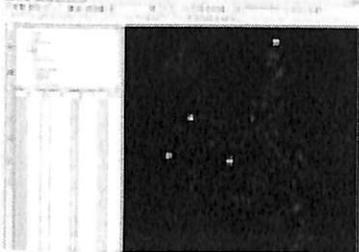
The Gas Leakage Management Module (LMM) allows you to minimize leakage in your gas distribution network while remaining within your model constraints.

Minimize Network Leakage

The Gas Leakage Management Module (LMM) allows you to minimize leakage in your gas distribution network while remaining within your model constraints.

SynerGEE Gas LMM enables the user to enter leakage factors, or coefficients, against the pipes within a model. This figure gives the expected rate of leakage from the pipes and is determined by the user. The module will then allow you to perform an analysis, for a single lower pressure tier, that will reduce the set pressures at supplies so that the pressure in the pipes with the highest leakage is preferentially reduced.

Minimum and maximum flow constraints can be applied at supplies, as well as the minimum and maximum pressure constraints varied throughout the single pressure tier model. Individual supplies may be included or excluded from the analysis as required.

- Determine the set pressures required at supplies that maintain the model within the flow and pressure constraints specified and set a single or default global value for minimum or maximum pressures throughout the network model.
- Assess the resulting average pressure within the individual pipes and the system as a whole for the condition analyzed. Pressure can be minimized by not taking the leakage coefficient into account.
- Assess the level of leakage from the individual pipes and the system as a whole for the conditions analyzed. Leakage can be minimized by taking the leakage coefficient into account.

Leakage Minimization Methodology
- Assumes the only known pressures in the model are at supplies.
- Does not optimize the settings of regulators and valves.
- Begins the process with the current network settings and then adjusts supply pressures to minimize leakage (or pressure if required).
- Supplies may be included or excluded from the minimization analysis.
- The maximum and minimum flow level from the supply may be set for inclusion in the analysis.

Model Builder

Model Builder enables seamless integration between SynerGEE Gas and your geospatial information system (GIS) data.

Integrate External Data

Model Builder provides a seamless integration between SynerGEE Gas and your geospatial information system (GIS) data.

Model Builder's robust and flexible data management capability allows you to import data into SynerGEE from a variety of external sources including shape files, CAD files and ArcInfoT coverage's, as well as personal and enterprise ArcGIS® geo-databases.

Model Builder converts GIS point data, such as valves and regulators, into linear, non-pipe facilities. Model Builder's GIS integration capability provides you with an automated process for efficient model maintenance and revision.

Control Your Model

Model Builder lets you filter and query data from external sources so that you can build your model using only the data you need from each source. You can import multiple pipe and facility source model layers at once, rather than importing each layer individually.

You can also map source file attributes to SynerGEE facility data and supplement any missing or incomplete GIS attributes with your model data. This includes regulator station details, internal pipe diameters, pipe roughness values, source node properties, customer demands and specific node names. Save your imported model attributes and configurations to rebuild your model whenever you choose, including weekly and monthly.

Validate and Enhance Data

Model Builder validates imported facility and node data and lets you make necessary corrections to ensure proper functionality. It's spatial and attribute tools can be used to clean topology, identify bottlenecks and report missing attribute data. Reported errors are saved to a browser file and can be viewed and corrected in GIS. **Model Builder** also drastically streamlines the time required to build your SynerGEE models. After converting your initial GIS data, SynerGEE Model Builder stores your settings so that you can re-build your models with the simple click of a mouse.

Optimization Module
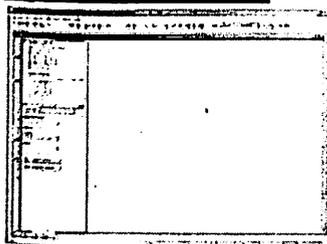
Optimization Module (Optimizer) provides the analytical capability to help understand and plan for the complex dynamics between pipeline operation and pipeline economics.

Optimize Asset Potential

Optimization Module (Optimizer) provides the analytical capability to help understand and plan for the complex dynamics between pipeline operation and pipeline economics. Optimizer provides fuel and cost of fuel optimization capabilities that allow you to minimize system-wide volumetric fuel consumption or system-wide fuel cost. Optimizer can calculate maximum throughput in various sections of your pipeline network and can select the most cost-effective mix of contracts when given access to contracts and transportation agreements. Optimizer incorporates a state-of-the-art optimization engine that has been developed and enhanced over 20 years. The optimization engine uses a suite of linear and non-linear techniques to find the optimum operating mode based on your objective, whether fuel, fuel cost or throughput. The mathematical engine not only performs the optimization, but also completes it within the constraints of pipeline hydraulics to ensure the operational integrity of the network.

The optimization engine considers the details of your system. including:
- Compressor operating envelopes
- Compressor discharge temperatures
- Minimum and maximum delivery pressures
- Maximum allowable operating pressure
- Regulator set points
- Receipt and delivery volumes

Optimizer determines the optimal combination of receipts and deliveries that maximizes capacity consistent with contractual and deliverability constraints. The economic and contractual components of system capacity are evaluated by reviewing revenues and costs associated with individual system sales, supply and transportation transactions on a bulk or individual contract basis.

Optimizer applications include throughput analysis and maximizations, transport feasibility and system bottleneck analysis. Optimizer is also used by pipeline facility groups to improve pipeline designs, expedite the design process and refine operational procedures.

Time Varying Module
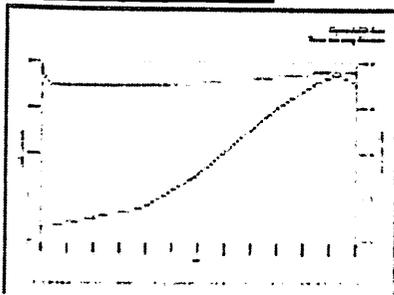
Time-Varying Module (TVM) allows you to perform a series of consecutive steady-state analyses to simulate the changes in your network over time.

Simulate Change over Time

Time-Varying Module (TVM) allows you to perform a series of consecutive steady-state analyses to simulate the changes in your network over time. Model your system over days, weeks, months or years to determine:

- System adequacy to meet anticipated requirements.
- Compressor fuel requirements over an extended period of time.
- Storage well or field injection and withdrawal requirements and schedules.
- System behavior based on starting conditions.

Each of these scenarios shares long-term time-varying effects. Linking individual steady-state simulations through time provides the time-varying continuity needed for tasks such as inventory tracking and compressor maintenance scheduling.

Leverage Unsteady-State Knowledge

TVM offers a broad selection of features essential to successfully handling the large volume of information a time-varying model can create, including:

- Comprehensive array of data that can be controlled via dimensioned or dimensionless profiles
- Numerous program-supplied and unlimited user-defined variables providing detailed information
- Extensive graphical and tabular reporting options

Extra Features

TVM is based on the same field-proven calculations used by SynerGEE to perform steady-state analyses and provides the supplemental controls and features you need to perform extended period simulation:

- Logical Operating Scripts expand TVM's functionality and control for automating model events. The scripts capability exposes virtually all modeling features, variables and attributes for greater modeling flexibility.
- A fully editable Results Plan allows you to interactively define charting variables before and during time-varying analyses. The plan is pre-populated with standard modeling attributes and enables you to add attributes including facilities, nodes, system variables, user-defined variables and profile information.
- TVM's Charting flexibility allows you greater control over model curve line colors, width and types and expands the number of plottable variables per axis.

TVM offers a more recognizable, customizable graphical environment focused on productivity and powered by a best-in-class steady-state engine. SynerGEE's map display and model explorer provide convenient access to model data including facilities, properties and an equipment warehouse. You can build models with ease using click-and-drag functionality, replacing traditional drawing and data entry combinations.

Unsteady-State Module
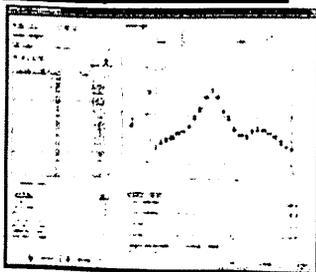
Unsteady-State Module (USM) performs off-line unsteady flow condition analysis in natural gas networks.

Unsteady Flow Condition Analysis

Unsteady-State Module (USM) performs off-line unsteady flow condition analysis in natural gas networks. Its ease-of-use and direct compatibility with steady-state networks make it the off-line transient module of choice for gas transmission planners and designers. While SynerGEE's

steady-state capabilities are appropriate for a variety of modeling and design needs. particularly for distribution systems. the unsteady-state (or transient analysis) is more applicable for analysis where time is a key factor. examples include:

- Time to failure analysis
- Assessment of lost gas through pipe failure
- Assessment of line pack variation in transmission system
- Assessment of within day pressure variations for plant design
- As with the steady-state the USM module is able to model gas composition, heat content and specific gravity as it varies with time as system supplies change.

Flexibility

USM lets you model simple or complex pipeline systems. Integrated models can include all facilities, including pipes, valves, regulators, compressors, storage fields and other special facilities. USM models complex regulator and compressor stations with multiple series elements on several parallel runs. With USM, you can model facilities as simply or in as much detail as you need.

Despite the rate of change in your transient scenario analysis, you can balance your network volumetrically or thermally. Thermal balancing options include both heat content tracing and component
tracing capabilities.

USM puts you in complete control of your simulation, allowing you to automatically or manually operate facilities during simulation. Each simulation can be paused and restarted as often as needed with the simple click of a mouse.

Enhanced Functionality

The key to off-line transient modeling is proper results management and interpretation. An unsteady state simulation can generate large amounts of data. USM lets you control data flow during simulation to make results interpretation easier. USM also offers features to enhance your overall modeling experience:

- **Logical Operating Scripts** expand USM's functionality and control for automating model events. The scripts capability exposes virtually all modeling features, variables and attributes for greater modeling flexibility.
- USM now offers **Fast and Slow Transient Modes**. The fast transient mode allows you to accurately simulate isothermal, time-varying events such as network line breaks and gas loss. The slow transient mode eliminates the unsteady-state momentum calculation to simulate slower network events occurring over time and saves considerable time and computations.
- A fully editable **Results Plan** allows you to interactively define charting variables before and during time-varying analysis. The plan is pre-populated with standard modeling attributes and enables you to add attributes including facilities, nodes, system variables and profile information.
- USM's **Charting** flexibility allows you greater control over model curve line colors, width and types and expends the number of plottable variables per axis. Hover over a point on the chart to view its associated information.

3.3 Individual Node to node Analysis-Ghaziabad

Table: 1 Break Point Consideration

1	Pipe Length (Meters)
2	Pipe Thickness (mm)
3	Pipe Diameter (Inches)
4	Pipe Type-Carbon Steel-"API 5L X60"
5	Pipe Roughness
6	Point of change in Pipe Size
7	Compressor-Load at Points (SCMH)
8	DRS/FRS-District/Field Regulating Stations
9	OMC's-Other Marketing Companies
10	Future-Tap off points
11	Tap off points

Table: 2 Individual Node Analyis In Pipeline Network

NODE	8"x 10KM PIPELINE FROM DASNA
A	IGL City Gate Station-Option 1.
B	Ram Avatar Tyagi CNG Station.
C	Future Tap Off 8" Pipeline.
	8"x 8KM PIPELINE FROM DASNA
A	IGL City Gate Station-Option 1.
D	Future Tap Off 8"x 8KM-Hapur Road.
	PHASE 1:18"x 7.5KM PIPELINE:MEERUT ROAD INDUSTRIAL AREA
E	IGL CNG Station.
F	IGL City Gate Station-Option 2.
G	OMC-Other Marketing Company.
H	OMC-Other Marketing Company.
I	OMC-Other Marketing Company.
J	IGL CNG Station.
K	16"x18" at Hapur Chungi-REDUCER.
	8"x9KM:LONI ROAD
L	12"x8" Reducer (Loni Road)-Start Point.
M	IGL CNG Station: Adj. to Ashoka Paper Mill.
N	IGL CNG Station: Adj to HPCL Petrol Pump, Opp. Hindon Airbase.
O	IGL CNG Station: To Tulsi Niketan, GZB,U.P.
P	IGL CNG Station: Opp. To Bharat gas bottling plant.
Q	OMC-Other Marketing Company- Mayank HP.
	8"x4.4 KM:GT ROAD
R	12"x8" Tap Off-Start Point
S	IGL CNG Station: Opp. MMX Mall, GZB, GT Road.
T	IGL CNG Station: Opp. Devi Dayal Apts.GT Road.
U	OMC-Other Marketing Company,Janakpuri
V	8"x4" Future Tap Off

	8"x4KM PIPELINE:INDIRAPURAM
W	12"x8" Indirapuram: Reducer
X	IGL CNG Station: Opp. Vasundhara Sect-6. Road from Sahibabad to Indirapuram
Y	DRS
Z	12"x8" Tap Off - NH-24
	18"x5KM, 16"x10.5KM,12"x11.5KM,12"x3KM,18"x12KM
A1	GAIL City Gate Station.
A	IGL City Gate Station-Option 1.
B1	OMC-Other Marketing Company, Arihant HP.
C1	IGL CNG Station: Opp. BSNL Tel. Exchange.
D1	18"x16" REDUCER.
E1	OMC-Other Marketing Company, Douji on NH-24.
F1	IGL CNG Station: Opp. To DDPS, Main Govindpuram Road.
G1	OMC-Other Marketing Company: Sohna BPCL.
H1	IGL CNG Station: Sanjay Nagar CNG Station.
I1	DRS.
J1	OMC-Other Marketing Company, Bajaj Motors HPCL.
K1	IGL CNG Station.
L1	OMC-Other Marketing Company, Jankinath BPCL.
M1	OMC-Other Marketing Company, Near Shri Ganesh Institute.
N1	IGL CNG Station: Opp. To Worthington pump on NH-58.
O1	OMC-Other Marketing Company, After Sahani Chowk.
P1	OMC-Other Marketing Company, Saibham BPCL.
Q1	IGL CNG Station, Adj. to Tata Commercial Vehicle Parts, Patel Nagar Phase 2 NH-58.
R1	16"x12" REDUCER, Mahamaya stadium.
S1	IGL CNG Station: Opp. To Indira, Priyadarshini Udyan, GT Road.
T1	IGL CNG Station: Opp. To IOCL Petrol Pump.
U1	IGL CNG Station: Opp. To Vasundara Sect-6, Road from Sahibabad to Indirapuram.
V1	OMC-Other Marketing Company: Sharma Automobiles.
W1	OMC-Other Marketing Company
X1	OMC-Other Marketing Company: Tyagi S/S.
Y1	OMC-Other Marketing Company: Raj Drass HPCL.
Z1	DRS, Vaishali Extension.
A2	OMC-Other Marketing Company: Shriram HPCL.
B2	OMC-Other Marketing Company: Suman Petroleum.
C2	IGL CNG Station: Adj. to Angel Mega Mall.
D2	IGL CNG Station: Adj. to Suman Petroleum Pump.
E2	SV at IFC-3.
	PHASE-2
F2	12"x18" Tap Off
G2	IGL CNG Station: Adj. to DPS,Indirapuram
H2	IGL CNG Station: Adj. to Santhosh Medical College, Pratap Vihar.
I2	IGL CNG Station: Adj. to Military Area.
J2	OMC-Other Marketing Company:Mawai
K2	IGL CNG Station: Mawai

L2	DRS.Mawai
M2	OMC-Other Marketing Company: Sharma filling station
N2	OMC-Other Marketing Company: Bulandshah Industrial Area
O2	Future Tap Off on NH-24
8"x10KM:NH-91	
P2	18"x8" Tap Off.
Q2	OMC-Other Marketing Company: Nadini Fuels.
R2	IGL CNG Station: Between BPCL & Reliance Petrol Pump.
S2	OMC-Other Marketing Company: Sahil Auto HPCL.
T2	IGL CNG Station: Adj. to IOCL Petrol Pump,GT Road
U2	OMC-Other Marketing Company: Quality Fills HPCL
V2	OMC-Other Marketing Company: Tyagi Brothers
W2	Future Tap Off.

3.4 Pipe Details-Node to Node Analysis

Table: 3 Pipe Details-Node To Node Analysis

PIPE NAME	FROM NODE	TO NODE	LENGTH (meters)	PIPE TYPE	THICKNESS (mm)	LOAD AT POINT (SCMH)
Pipe1	A	B	1205	API 5L X60	8"x8.2	2400
Pipe2	B	C	6795	API 5L X60	8"x8.2	1200
Pipe3	A	D	8000	API 5L X60	8"x8.2	2400
Pipe4	A1	A	20	API 5L X60	18"x8.2	-
Pipe5	A	B1	4800	API 5L X60	18"x8.2	1200
Pipe6	B1	C1	300	API 5L X60	18"x8.2	2400
Pipe7	C1	D1	180	API 5L X60	16"x7.9	REDUCER
Pipe8	D1	E1	130	API 5L X60	16"x7.9	1200
Pipe9	E1	F1	350	API 5L X60	16"x7.9	2400
Pipe10	F1	G1	3300	API 5L X60	16"x7.9	1200
Pipe11	G1	H1	1560	API 5L X60	16"x7.9	2400
Pipe12	H1	I1	400	API 5L X60	16"x7.9	10000
Pipe13	I1	J1	190	API 5L X60	16"x7.9	1200
Pipe14	J1	K1	200	API 5L X60	16"x7.9	2400
Pipe15	K1	L1	550	API 5L X60	16"x7.9	1200
Pipe16	L1	M1	1300	API 5L X60	16"x7.9	1200
Pipe17	M1	N1	1200	API 5L X60	16"x7.9	2400
Pipe18	N1	O1	400	API 5L X60	16"x7.9	1200
Pipe19	O1	P1	280	API 5L X60	16"x7.9	1200
Pipe20	P1	Q1	1100	API 5L X60	16"x7.9	2400
Pipe21	Q1	R1	1100	API 5L X60	12"x6.4	REDUCER
Pipe22	R1	S1	1100	API 5L X60	12"x6.4	2400
Pipe23	S1	T1	900	API 5L X60	12"x6.4	2400
Pipe24	T1	U1	2700	API 5L X60	12"x6.4	2400

PIPE NAME	FROM NODE	TO NODE	LENGTH (meters)	PIPE TYPE	THICKNESS (mm)	LOAD AT POINT (SCMH)
Pipe25	U1	V1	550	API 5L X60	12"x6.4	1200
Pipe26	V1	W1	700	API 5L X60	12"x6.4	1200
Pipe27	W1	X1	750	API 5L X60	12"x6.4	1200
Pipe28	X1	Y1	130	API 5L X60	12"x6.4	1200
Pipe29	Y1	Z1	1000	API 5L X60	12"x6.4	10000
Pipe30	Z1	A2	1000	API 5L X60	12"x6.4	1200
Pipe31	A2	B2	1000	API 5L X60	12"x6.4	1200
Pipe32	B2	C2	650	API 5L X60	12"x6.4	2400
Pipe33	C2	D2	600	API 5L X60	12"x6.4	2400
Pipe34	D2	E2	1000	API 5L X60	12"x6.4	SV
Pipe35	E2	F2	3000	API 5L X60	12"x6.4	REDUCER
F2 – TOWARDS NOIDA NETWORK						60000
Pipe36	F2	G2	1400	API 5L X60	12"x6.4	2400
Pipe37	G2	H2	1500	API 5L X60	12"x6.4	2400
Pipe38	H2	I2	1700	API 5L X60	12"x6.4	2400
Pipe39	I2	J2	170	API 5L X60	12"x6.4	1200
Pipe40	J2	K2	20	API 5L X60	12"x6.4	2400
Pipe41	K2	L2	20	API 5L X60	12"x6.4	10000
Pipe42	L2	M2	140	API 5L X60	12"x6.4	1200
Pipe43	M2	N2	2500	API 5L X60	12"x6.4	1200
Pipe44	N2	O2	2500	API 5L X60	12"x6.4	2400
Pipe45	02	P2	100	API 5L X60	18"x8"	REDUCER
Pipe46	P2	Q2	500	API 5L X60	8"x8.2	1200
Pipe47	Q2	R2	500	API 5L X60	8"x8.2	2400
Pipe48	R2	S2	600	API 5L X60	8"x8.2	1200
Pipe49	S2	T2	1000	API 5L X60	8"x8.2	2400
Pipe50	T2	U2	1000	API 5L X60	8"x8.2	1200
Pipe51	U2	V2	1000	API 5L X60	8"x8.2	1200
Pipe52	V2	W2	5900	API 5L X60	8"x8.2	2400
Pipe53	F	E	500	API 5L X60	18"x8.2	2400
Pipe54	F	G	3400	API 5L X60	18"x8.2	1200
Pipe55	G	H	900	API 5L X60	18"x8.2	1200
Pipe56	H	I	400	API 5L X60	18"x8.2	1200
Pipe57	I	J	900	API 5L X60	18"x8.2	2400
Pipe58	J	K	1400	API 5L X60	18"x8.2	REDUCER
Pipe59	L	M	1700	API 5L X60	8"x8.2	2400
Pipe60	M	N	5600	API 5L X60	8"x8.2	2400
Pipe61	N	O	300	API 5L X60	8"x8.2	2400
Pipe62	O	P	450	API 5L X60	8"x8.2	2400
Pipe63	P	Q	950	API 5L X60	8"x8.2	1200
Pipe64	R	S	200	API 5L X60	8"x8.2	2400
Pipe65	S	T	1900	API 5L X60	8"x8.2	2400
Pipe66	T	U	2000	API 5L X60	8"x8.2	1200

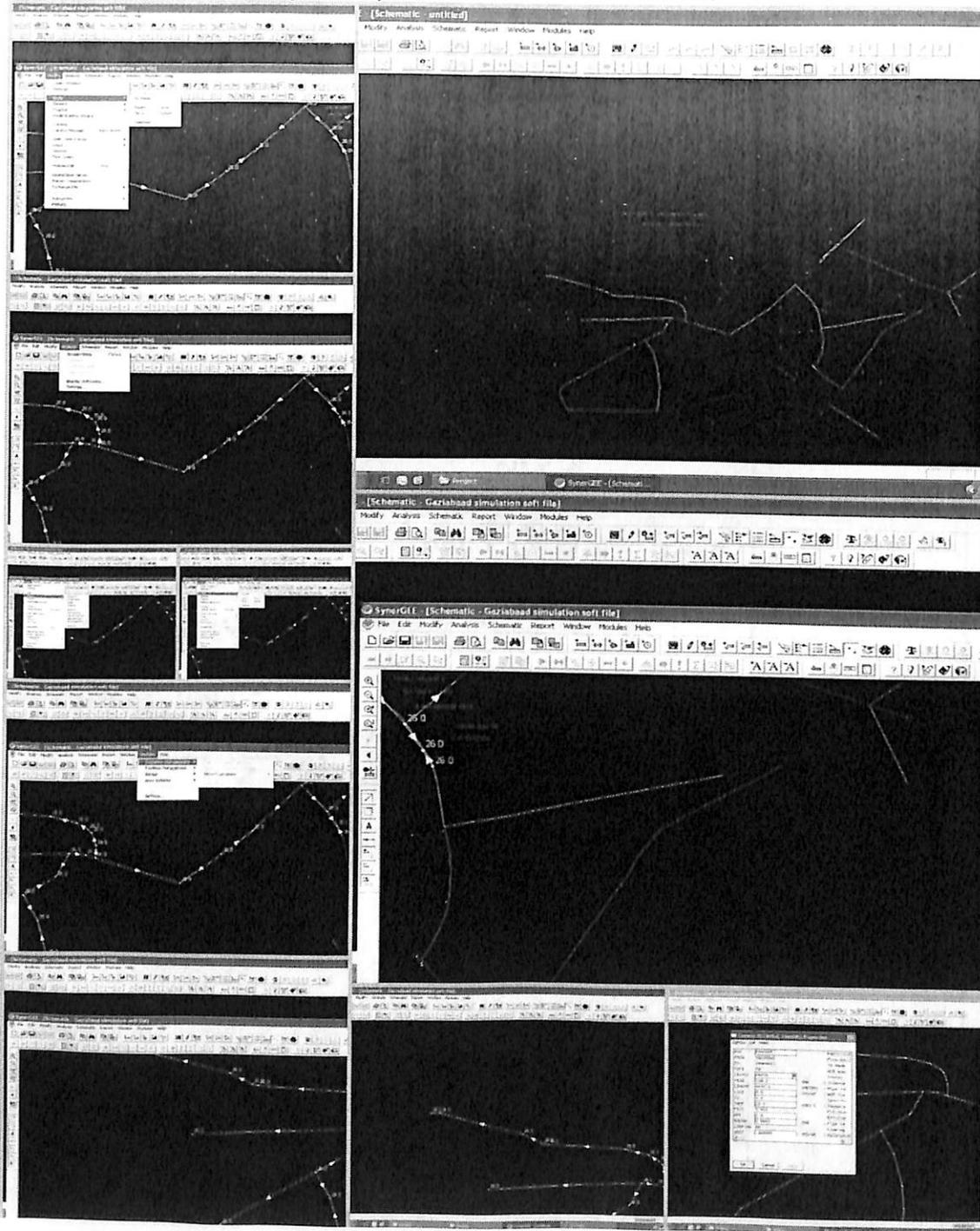| PIPE NAME	FROM NODE	TO NODE	LENGTH (meters)	PIPE TYPE	THICKNESS (mm)	LOAD AT POINT (SCMH)
Pipe67	U	V	2000	API 5L X60	8"x8.2	2400
Pipe68	W	X	450	API 5L X60	8"x8.2	2400
Pipe69	X	Y	2500	API 5L X60	8"x8.2	10000
Pipe70	Y	Z	1050	API 5L X60	8"x8.2	1050

3.5 AUTOCAD FILE-GHAZIABAD NETWORK

Figure: 6 AutoCAD File-Ghaziabad Networks
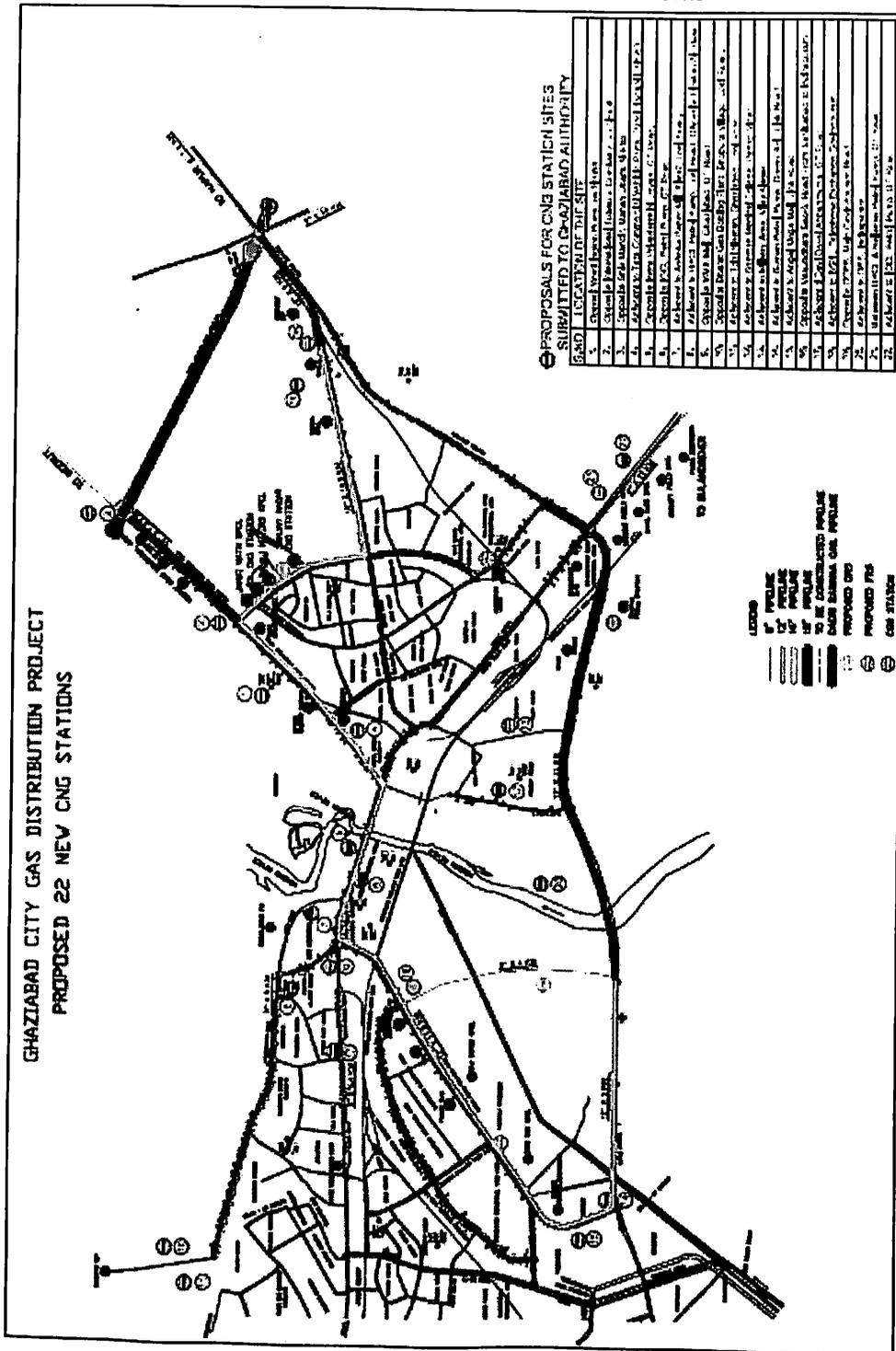
CHAPTER.4 RESULTS AND DISCUSSIONS

4.1. Work Time – Screenshots

Figure: 7 SynerGEE Work Time Screenshots

4.2 SynerGEE-ANALYSIS
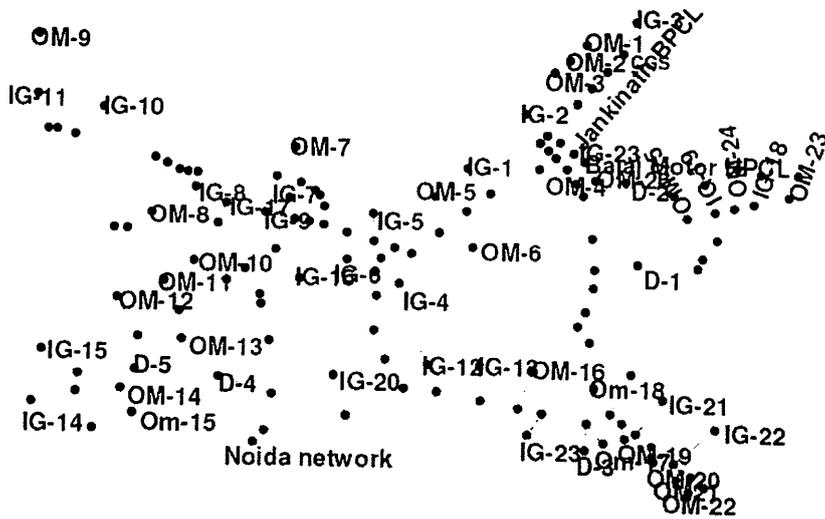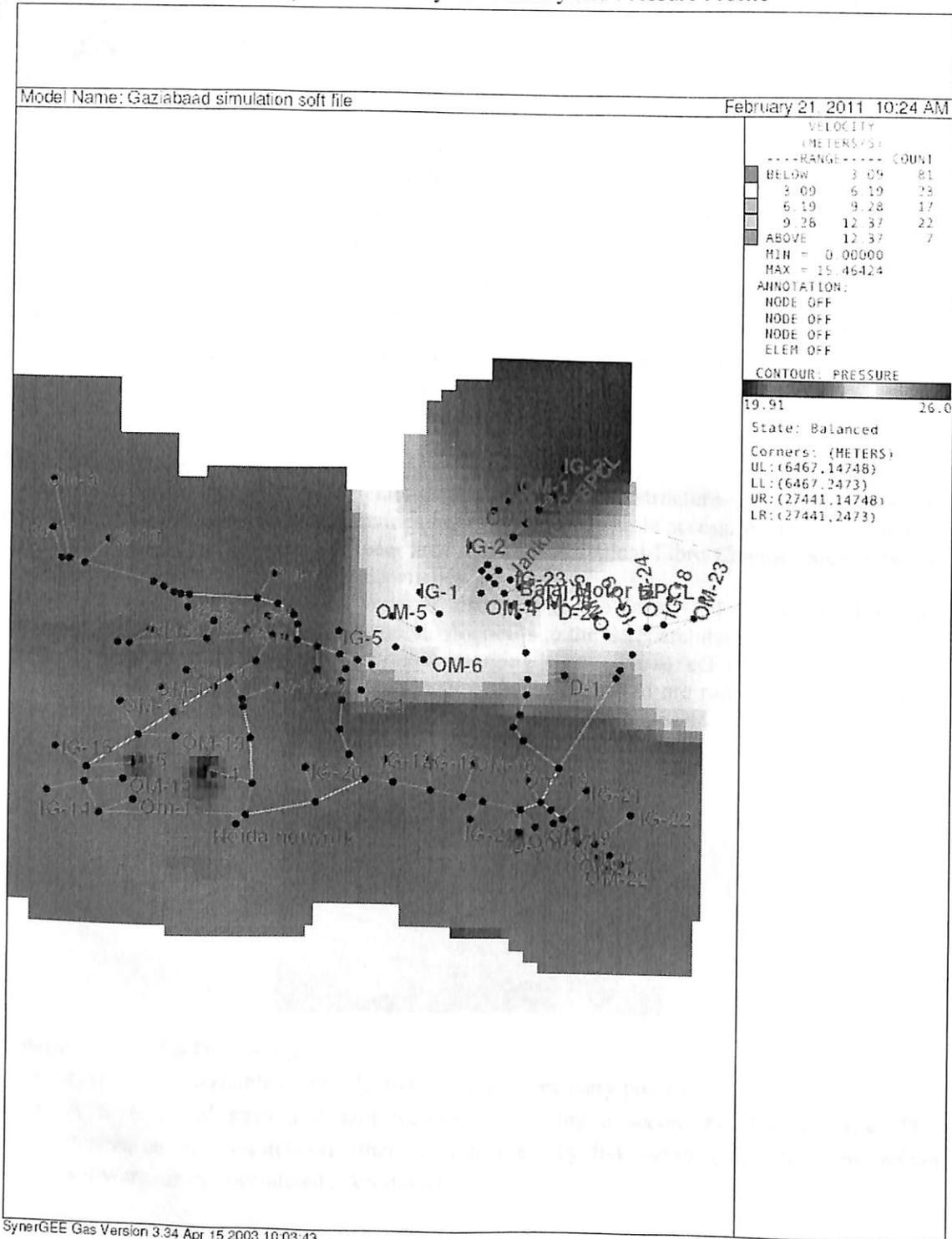### Figure: 8 SynerGEE Analysis: Pipe Diameter Profile

Figure: 9 SynerGEE Analysis- Velocity and Pressure Profile

CHAPTER.5 APPLICATIONS OF SAN IN CITY GAS DISTRIBUTION

5.1 SAN: Storage Area Network: High performance, flexible, scalable midrange and enterprise multiservice switch designed to help you expand and adjust to changing business needs

Introduction:

A storage area network (SAN) is a dedicated storage network that provides access to consolidated, block level storage. SANs primarily are used to make storage devices (such as disk arrays, tape libraries, and optical jukeboxes) accessible to servers so that the devices appear as locally attached to the operating system. A SAN typically has its own network of storage devices that are generally not accessible through the regular network by regular devices. The cost and complexity of SANs dropped in the early 2000s, allowing wider adoption across both enterprise and small to medium sized business environments.

SAN Infrastructure:

SANs often utilize a Fibre Channel fabric topology - an infrastructure specially designed to handle storage communications. It provides faster and more reliable access. A fabric is similar in concept to a network segment in a local area network. A typical Fibre Channel SAN fabric is made up of a number of Fibre Channel switches.

Today, all major SAN equipment vendors also offer some form of Fibre Channel routing solution, and these bring substantial scalability benefits to the SAN architecture by allowing data to cross between different fabrics without merging them. These offerings use proprietary protocol elements, and the top-level architectures being promoted are radically different. They often enable mapping Fibre Channel traffic over IP or over SONET/SDH.
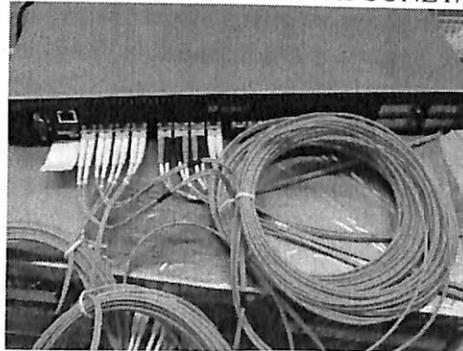

Benefits :(City Gas Distribution)
- SAN's tend to enable more effective in disaster recovery processes.
- A SAN could span a distant location containing a secondary storage array. This enables storage replication either implemented by disk array controllers, by server software, or by specialized SAN devices.

5.2 SAN Device: Indraprastha Gas Limited, New Delhi

Cisco MDS 9222i for IBM System Storage
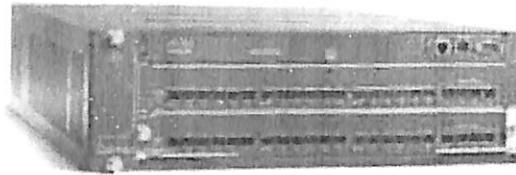
SAN Infrastructure :(Cisco MDS 9222i for IBM System Storage)
Multiservice designs with four SAN extension over IP ports and up to 66 1, 2, 4, 8 and 10Gbps Fibre Channel ports in 3U rack height.

Cisco MDS 9222i for Large Retail Enterprises:
The Cisco MDS 9222i for IBM System Storage™ is designed to address the needs of large retail enterprises with a wide range of Storage Area Network (SAN) capabilities. It can be used as a cost-effective high performance SAN extension over IP router switch for midrange customers in support of IT simplification and business continuity solutions. It can also provide remote site device aggregation and SAN extension connectivity to large customer data center directors.

Applications in City Gas Distribution:
Server virtualization helps SAN in concurrently supporting thousands of diverse, tiered applications, each with unique performance requirements. These applications and the virtual machines (VMs) they run on are not bounded by physical servers and net-work ports.

Ideal for efficient, secure SAN consolidation, VSANs allow more efficient storage network utilization by creating hardware-based isolated environments within a single physical SAN fabric or switch. Each VSAN can be zoned as a typical SAN, maintaining its own fabric services for added scalability and resilience.

VSANs allow the cost of SAN infrastructure to be shared among more users, while ensuring absolute segregation of traffic and retaining independent control of configuration on a VSAN-by-VSAN basis. Through unique virtualization features, VSAN benefits can be extended to virtualized servers, providing the foundation for an end-to-end virtualized data center. VSANs also greatly reduce the probability that a miss-configuration or component failure in one VSAN will affect other VSANs. VSAN-based management access controls enhance security by simplifying partitioning of SAN management responsibilities between mainframe and open systems environments.

5.3 PHYSICAL DATA COLLECTIONS AND VERIFICATIONS

Table: 4 Physical Data Collections And Verifications

PIPE NAME	FROM NODE	TO NODE	LENGTH (METERS)	PIPE TYPE	THICKNESS (mm)	LOAD AT POINT -SCMH
A	18"x12" GAIL CGS	IGL "CGS " DASNA	20	API 5L X60	8.2	
B	IGL "CGS " DASNA	CNG St. SRIRAM AVATAR TYAGI	1204.635	API 5L X60	8.2	1200
F2	CNG St. SRIRAM AVATAR TYAGI	Future TAP OFF 8"x4" TOWARDS MASURI INDUSTRIAL AREA.	6795	API 5L X60	8.2	1200
G2	IGL "CGS " DASNA	8" FUTURE TAP OFF TOWARDS HAPUR ROAD	8000	API 5L X60	8.2	1200
B1	IGL "CGS " DASNA	18"x8" TAP OFF "SAGAR VATIKA" CNG.St.	1204.635	API 5L X60	8.2	1200
C	18"x8" TAP OFF "SAGAR VATIKA"	18"x4" TAP OFF "IMS COLLEGE"	2854.95	API 5L X60	8.2	1200
D	18"x4" TAP OFF "IMS COLLEGE"	18"x16" REDUCER	1370.181	API 5L X60	8.2	
E	18"x16" REDUCER	16"x4" TAP OFF NEAR RELIANCE SHOWROOM	503.31	API 5L X60	7.9	2400
F	16"x4" TAP OFF NEAR RELIANCE SHOWROOM	16"x6" TAP OFF GOVINDPURAM "MISRA HOSPITAL"	420.01	API 5L X60	7.9	1200
G	16"x6" TAP OFF GOVINDPURAM "MISRA HOSPITAL"	16"x4" (Opp. TO IOCL PETROL PUMP)	212.64	API 5L X60	7.9	2400

H	16"x4" (Opp. TO IOCL PETROL PUMP)	16"x6" TAP OFF (POLICE CHOWKI)	376.495	API 5L X60	7.9	2400
I	16"x6" TAP OFF (POLICE CHOWKI)	16"x4" TAP OFF (IOCL PETROL PUMP) SASTRI NAGAR	1151.1	API 5L X60	7.9	2400
J	16"x4" TAP OFF (IOCL PETROL PUMP) SASTRI NAGAR	16"x6" TAP OFF (CBI ACADEMY ROAD)	225.626	API 5L X60	7.9	2400
K	16"x6" TAP OFF (CBI ACADEMY ROAD)	16"x4" SASTRY NAGAR BLOCK-B	46.931	API 5L X60	7.9	1200
L	16"x4" SASTRY NAGAR BLOCK-B	16"x8" TAP OFF HAPUR CHUNGI (REDUCER)	1234.855	API 5L X60	7.9	
M	16"x8" TAP OFF HAPUR CHUNGI (REDUCER)	8"x4"TAP OFF (RAZAPUR)	1000	API 5L X60	8.2	1200
N	8"x4"TAP OFF (RAZAPUR)	8"x6" TAP OFF (KAVI NAGAR INDUSTRIAL AREA)	1100	API 5L X60	8.2	1200
O	8"x6" TAP OFF (KAVI NAGAR INDUSTRIAL AREA)	8"x4" TAP OFF (MAHARANA PRATAP/TULSI DAS MARG)	1000	API 5L X60	8.2	1200
P	8"x4" TAP OFF (MAHARANA PRATAP/TULSID AS MARG)	CNG St. (MAHARANA PRATAP/TULSI DAS MARG)	850	API 5L X60	8.2	2400+ 10000 =12400
Q	CNG St. (MAHARANA PRATAP/TULSIDAS MARG)	18"x8" TAP OFF NH24	550	API 5L X60	8.2	2400
R	16"x8" TAP OFF HAPUR CHUNGI	16"x4" TAP OFF PASSPORT OFFICE/SBI ATM	480.375	API 5L X60	7.9	1200
S	16"x4" TAP OFF PASSPORT OFFICE/SBI ATM	"CNG STATION" BPCL PETROL PUMP "HAPUR ROAD"	1192.28	API 5L X60	7.9	2400

T	"CNG STATION" BPCL PETROL PUMP "HAPUR ROAD"	16"x8" TAP OFF HAPUR ROAD	1129.97	API 5L X60	7.9	1200
U	16"x8" TAP OFF HAPUR ROAD	16"x6" TAP OFF UTTAM TOYOTA	676.84	API 5L X60	7.9	2400
V	16"x6" TAP OFF UTTAM TOYOTA	16"x4" BPCL PETROL PUMP	443.68	API 5L X60	7.9	1200
W	16"x4" BPCL PETROL PUMP	16"x4" SHRIRAM PISTONS	329.52	API 5L X60	7.9	1200
X	18"x16" REDUCER AT HAPUR CHUNGI	GHAZIABAD "CNG" PETROLUEM	1700	API 5L X60	8.2	3600
Y	GHAZIABAD PETROLUEM	BAJAJ PRIME FUELS"CNG"	3300	API 5L X60	8.2	3600+ 10000 =13600
Y/1	BAJAJ PRIME FUELS"CNG"	IGL "CGS-2"- MEERUT Rd. GZB.	3000	API 5L X60	8.2	
Z	16"x4" SHRIRAM PISTONS	16"x6" TAP OFF BUSHA MANDI	1099.405	API 5L X60	7.9	2400
A1	16"x6" TAP OFF BUSHA MANDI	16"x12" REDUCER MAHAMAYA STADIUM	1390.775	API 5L X60	7.9	
B1	16"x12" REDUCER MAHAMAYA STADIUM	12"x8" TAP OFF MAHAMAYA STADIUM	210.767	API 5L X60	7.9	1200
C1	12"x8" TAP OFF MAHAMAYA STADIUM	CNG STATION NEAR LONI INDUSTRIAL AREA	1200	API 5L X60	6.4	2400
D1	CNG STATION NEAR LONI INDUSTRIAL AREA	12"x4" TAP OFF NEAR LONI ROAD/VIVEKA NANDA ROAD	1000	API 5L X60	6.4	1200
E1	12"x4" TAP OFF NEAR LONI ROAD/VIVEKANAND A ROAD	12"x4" TAP OFF AT RAJENDRA PRASAD MARG	1600	API 5L X60	6.4	2400

F1	12"x4" TAP OFF AT RAJENDRA PRASAD MARG	VIVEKANANDA MARG/ SHALIMAR GARDEN CNG St.	1300	API 5L X60	6.4	2400+ 10000 =12400
G1	12"x8" TAP OFF MAHAMAYA STADIUM	12"x4" TAP OFF MAZAR FUTURE	1901.303	API 5L X60	6.4	1200
H1	12"x4" TAP OFF MAZAR FUTURE	12"x4" TAP OFF BP PETROL PUMP	384.34	API 5L X60	6.4	2400
I1	12"x4" TAP OFF BP PETROL PUMP	12"x8"TAP OFF LONI	170.3	API 5L X60	6.4	1200
J1	12"x8"TAP OFF LONI	CNG St. KUNDAN LAL 8"x4" TAP OFF	3600	API 5L X60	6.4	3600+ 10000 =13600
K1	CNG St. KUNDAN LAL 8"x4" TAP OFF	CNG St. SINGH S/S 8"x4" TAP OFF	900	API 5L X60	6.4	3600
L1	12"x8"TAP OFF LONI	12"x8" (REDUCER))IN DRAPURAM RED LIGHT	2383.725	API 5L X60	6.4	
M1	12"x8" (REDUCER)IND RAPURAM RED LIGHT	8"x4" TOWARDS MAHARAJA AGARSAIN MARG Via NIRALA	3400	API 5L X60	8.2	1200
N1	8"x4" TOWARDS MAHARAJA AGARSAIN MARG Via NIRALA	8"x6" TAP OFF Dr.SUSHILA NAIYAN ROAD	800	API 5L X60	8.2	1200
O1	12"x8" INDRAPURAM RED LIGHT(REDUCER)	12"x6" TAP OFF SAHIBABAD RED LIGHT SITE 4	165.68	API 5L X60	6.4	2400
P1	12"x6" TAP OFF SAHIBABAD RED LIGHT SITE	TAP OFF TIRUPATI STEEL ROAD	1076.92	API 5L X60	6.4	1200

Q1	TAP OFF TIRUPATI STEEL ROAD	12"x4" TAP OFF SHRIRAM	682.59	API 5L X60	6.4	1200
R1	12"x4" TAP OFF SHRIRAM	12"x4" CNG.VAISHALI	617.59	API 5L X60	6.4	2400+ 10000 =12400
S1	12"x4" CNG,VAISHALI	12"x8" TAP OFF DABUR TO ANAND VIHAR	2047.44	API 5L X60	6.4	2400
T1	12"x8" TAP OFF DABUR TO ANAND VIHAR	12"x4" TAP OFF BP PETROL PUMP	1383.53	API 5L X60	6.4	2400
U1	12"x4" TAP OFF BP PETROL PUMP	IFC-3 CNG STATION	1441.035	API 5L X60	6.4	2400
V1	18"x4" TAP OFF "IMS COLLEGE"	18"x4" TAP OFF NEAR SAHEED NAYAK KRISHNAN KUMAR MARG	4700	API 5L X 60	8.2	1200
W1	18"x4" TAP OFF NEAR SAHEED NAYAK KRISHNAN KUMAR MARG	LOHA MANDI CNG STATION	950	API 5L X 60	8.2	3600
X1	LOHA MANDI CNG STATION	18"x8" TAP OFF ON NH-24	350	API 5L X 60	8.2	1200
Y1	18"x8" TAP OFF ON NH-24	18"x8" GT ROAD & NH24 INTERSECTION	800	API 5L X 60	8.2	1200
Z1	18"x8" GT ROAD & NH24 INTERSECTION	18"x4" TAP OFF CONTINENTAL CARBON INDIA-CNG-St.	1300	API 5L X 60	8.2	1200
A2	18"x4" TAP OFF CONTINENTAL CARBON INDIA	18"x4" St.THERESAS CONVENT	650	API 5L X 60	8.2	1200
B2	18"x4" St.THERESAS CONVENT	18"x12" REDUCER NEAR MOHAN NAGAR LINK ROAD	3800	API 5L X 60	8.2	

C2	18"x12" REDUCER NEAR MOHAN NAGAR LINK ROAD	12"x8" TAP OFF(NEAR NOIDA ENTRANCE)	400	API 5L X 60	6.4	1200
D2	12"x8" TAP OFF(NEAR NOIDA ENTRANCE)	12"x8" TAP OFF ON NH24 TOWARDS IBP	1800	API 5L X 60	6.4	2400
E2	12"x8" TAP OFF ON NH24 TOWARDS IBP	IFC-3	2300	API 5L X 60	6.4	1200

IGL Benefits-Implementation of SAN:

Helps improve storage utilization:

Control growth and combine storage capacity into a single resource

Designed to improve application availability:

Make changes to storage and move data without taking applications down and auto-allocates more storage to applications

Helps to reduce the cost and complexity of managing storage:

Greater efficiency and productivity for storage management staff and enables multivendor strategies
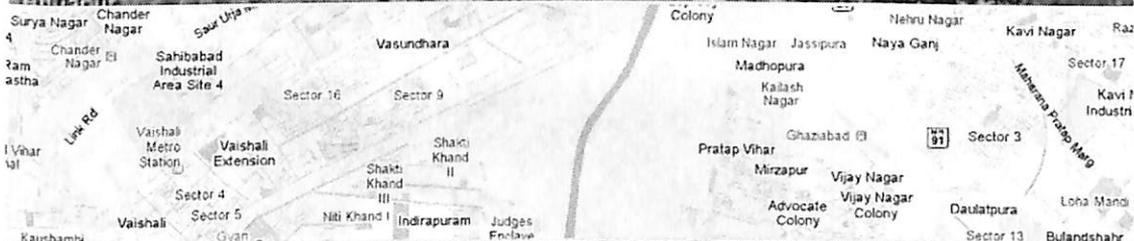
Offers network-based replication:

Helps enable greater choice when buying storage

Helps to reduce server cost with host attachment and supports multi operating systems
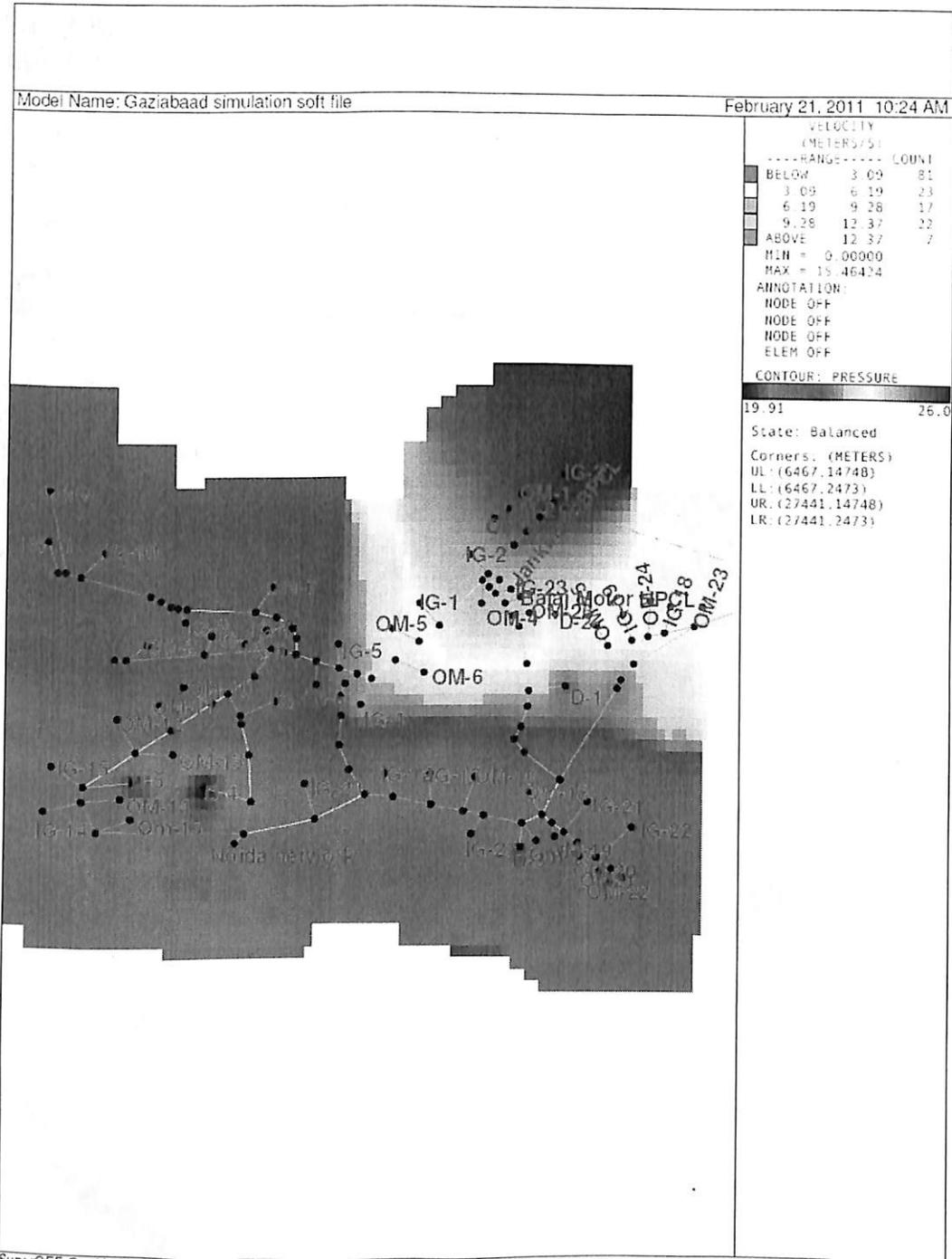
5.4 Integration of SAN with SynerGEE version 3.34

Figure: 10 Work Screenshots & Maps
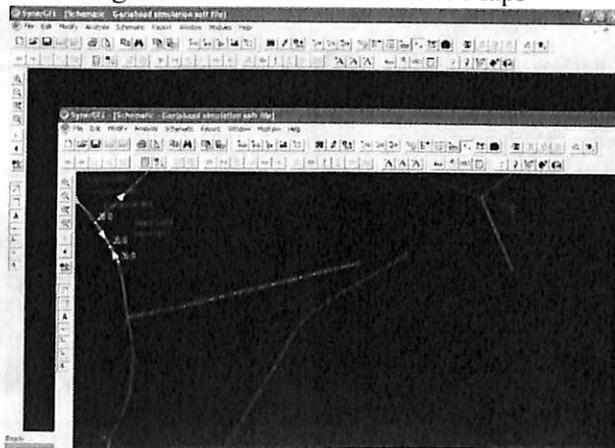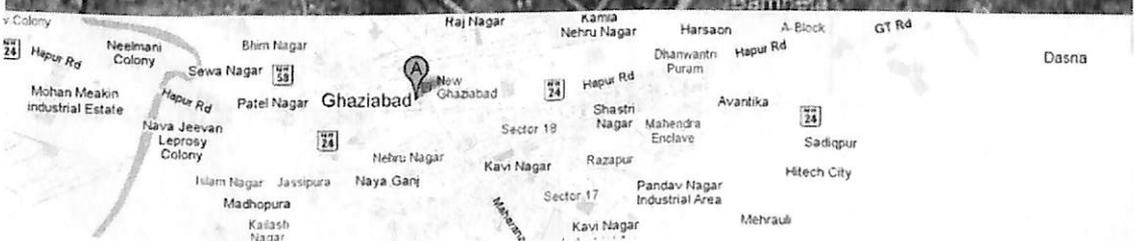
RESULT:

Figure: 11 Results

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www.delhimetrorail.com/
- *Eicher- Delhi City Map.*
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- IBM
http://www-03.ibm.com/systems/storage/

APPENDIX