Mindanao Natural Gas Market Development Strategy
Final Report

The World Bank

Canadian Gas Services International

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Canadian Gas Services International

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1.0 Executive Summary

The World Bank East Asia and Pacific Sustainable Development Department engaged Canadian Gas Services International ("CGSI") to complete a Natural Gas Market Development Strategy for the Island of Mindanao in the Southern Philippines. There were three components to CGSI's work on this project consisting of a market demand assessment, identifying, analyzing and recommending options for distributing the natural gas on the Island, and identifying key policy and regulatory framework requirements to enable the implementation of the project. This final report addresses all components of this work.

The World Bank provided CGSI a starting reference point in identifying the location for the LNG import terminal and anchor load power plant. Both these facilities were identified as being located in or near the PHIVIDEC Industrial Park near Cagayan de Oro. A Google Earth map at the back of this report highlights the approximate location of the LNG import terminal.

CGSI's market demand assessment efforts focused on the PHIVIDEC Industrial Park and cities of Cagayan de Oro, Iligan, Davao and General Santos. Over 50 of the largest customers were assessed and surveyed to determine the likelihood of them converting to natural gas. The analysis showed that 22 customers were likely candidates to convert to natural gas immediately upon it becoming available. This translates into an aggregate annual LNG load of approximately 110,000 tonnes. The natural gas distribution system options considered in this report focus on supplying gas to those 22 customers while allowing for expansion and future load growth. The table below provides summary data on aggregate demand, capital costs and operating costs for the areas of both northern and southern Mindanao targeted for the introduction of natural gas to Mindanao.

Table 1. Summary Results of Market Survey and Infrastructure Recommendations

Area	Aggregate Annual Load (GJ)	NG Distribution Mode	Capital Costs (USD)	Annual Operating Costs (USD)
Northern Mindanao				
Cagayan de Oro	2,439,653	Pipeline	7,216,380	280,000
Iligan	440,513	Pipeline, LNG Truck and 2 satellite LNG Facilities	3,463,000	477,000
Southern Mindanao				
Davao & General Santos	3,291,292	LNG Trucks and pipeline	11,824,000	6,200,000

The two major load centres, located in the north and south further lend themselves to a two phased approach for the introduction of natural gas. The PHIVIDEC Industrial Park and the cities of Cagayan de Oro and Iligan, given their proximity to the LNG Import Terminal and proximity to each other could comprise the scope of a phase 1 introduction of natural gas to the Island of Mindanao. Phase 2 could

see the expansion natural gas to General Santos and Davao. The two separate phases are not dependent on each other and can either occur simultaneously or separately depending on the desires of the project proponents. It is the recommendation of CGSI to make natural gas available to the customers in northern Mindanao as soon as practical following the construction and commissioning of the LNG import terminal and that providing natural gas to southern Mindanao be considered as a separate option.

It is recommended that the Philippine government establish a Project Driven Regulatory Model that will facilitate the introduction of natural gas to Mindanao. Many aspects of the Project Driven Regulatory Model can be built into the initial contracts that are used to develop the required infrastructure. Aspects of a formal regulatory model can then be developed over time in a manner appropriate to the evolving marketplace. It is neither necessary nor practical to think that the Philippines should develop a Formal Regulatory Model for the distribution of natural gas for either Mindanao or the entire country in advance of moving forward with such a relatively small distribution network as is envisioned for Mindanao.

2.0 Introduction

2.1. General

The Philippine government's Department of Energy with technical assistance from The World Bank Group and financial assistance from The Public-Private Infrastructure Advisory Facility has engaged Canadian Gas Services International ("CGSI") to complete a Natural Gas Market Development Strategy for the island of Mindanao in the southern Philippines. The initial focus of this work was a market assessment of natural gas potential demand in Davao City, Iligan City, Cagayan de Oro, and General Santos. This market assessment included a load survey that was conducted with large industrial customers. The market assessment was followed by an assessment of the viable options available to distribute gas from an LNG terminal to the various customer locations. These efforts and the outcomes of this work are summarized in this report. This report also examines the policy and regulatory frameworks that will be required to foster investment in the infrastructure that will make natural gas available to business and industry in Mindanao.

3.0 Competitive Fuel Prices

3.1. Fuels Potentially Convertible to Natural Gas

The main fuels currently in use on Mindanao that are candidates for conversion to natural gas are light fuel oil (diesel), residual fuel oil (bunker fuel) and coal. The load surveys also indicated more limited use of kerosene and liquid propane gas (LPG). Relying largely on price forecasts by the International Energy Agency's (IEA) 2011 World Energy Outlook (WEO), a competitive fuels price forecast has been developed for Philippine energy prices from 2012 to 2035. The purpose of this price forecast is to provide a plausible range of expected LNG prices, landed in Philippines and some comparable prices in the Philippines of competing fuel oils.

The price outlook produced by the IEA in its WEO is structured around three pricing scenarios:

- The Current Policies Scenario (CPS) which is based on perpetuation, without significant change, of the government policies and measures that are in place in 2011.
- The New Policies Scenario (NPS), which is based on adoption of the broad policy commitments and plans that have been announced by countries around the world to tackle energy security, climate change and local pollution, and other pressing energy related challenges.
- And, the 450 Scenario (450S) which is based on an energy pathway consistent with a 50% likelihood of meeting the goal of limiting the increase in average global temperature to two degrees Celsius (2°C), compared with pre-industrial levels.

CGSI has based all of the competitive fuels analysis on the Current Policies Scenario. This is judged appropriate for two reasons. First it reflects what is, as opposed to what may be and second, it produces the forecast with the lowest price spread between natural gas, which is the cleanest burning of all the fossil fuels, and the petroleum based fuels which produce more greenhouse gases when burned. For this reason, the Current Policies Scenario makes for a good "base case" for this project as the competitive position of natural gas will tend to improve if any policy action is taken in relation to greenhouse gas emissions.

The WEO presents its price forecasts in $(US) 2010 and $(US) nominal, but only provides discreet forecasts in five year intervals. The WEO forecasts have been converted from five-year intervals to annual forecasts by linear interpolation for the intervening years. Because the IEA provides forecasts in real and nominal terms, the WEO's interpolated nominal price forecast for 2012 is taken as the base price for $2012 prices, which then became the basis for all forecasts.

WEO provides price forecasts for natural gas imports into the US (which would be roughly equivalent to US Henry Hub prices) and into Japan (based on an unspecified formula tied to crude oil prices). The WEO's US gas price forecast is directly used in forecasting LNG prices into Philippines, and the WEO's Japan price forecast is indirectly used as a comparative check on Philippine LNG prices. In addition, the IEA forecasts an average import price for steam coal into IEA countries. While Philippines may benefit from slightly lower landed coal prices due to proximity to some major coal exporting nation, the IEA forecast is used here as such differences are not expected to be material.

While crude oil prices are quite transparent, petroleum product prices are less transparent. Based on information obtained from confidential Canadian sources a proxy for Philippine petroleum products have been calculated as a percentage of crude oil price plus a constant for transportation to the Philippine market. These values are 122% of crude oil prices for light fuel oil or diesel and 94% of crude oil prices for residual fuel oil or bunker fuel.

3.2. LNG Price Forecast

Based on the data assumptions outlined above, the forecasted prices are presented in Figure 1, below. The LNG prices in Figure 1 consist of two scenarios, shown in $/mmbtu $US 2012). The two scenarios are based on two LNG pricing formulas. The LNG Pricing formulas are in the form of Y=a*X + b, as follows:

QatarGas Formula = .154*JCC[1] plus $.60/mmbtu. This is a typical contract for sale of LNG to Japan, and the formula is obtained from a confidential, but reliable source. If the "a" factor in the formula were at the energy conversion rate between oil and gas (ie, .1724), the price of landed LNG in Japan would increase at exactly the same rate on oil price. The "b" factor has been reduced by $.26/mmbtu, reflecting the basis differences between Japan and Philippines relative to Qatar.[2] Qatar is now the world's largest LNG exporter.

GAIL Formula = 1.17*Henry Hub Price plus $5.90. This is a new form of contract currently under development based on LNG exports from the USA to India, and is obtained from media reports.[3] The "a" factor offers a premium price to the US gas suppliers, and the "b" factor covers the full cost of liquefaction, transportation and regasification. Historically, the lower 48 US states have been gas importers, including LNG, not exporters, but this is now changing with the shale gas glut on the market and low gas prices.

[1] JCC stands for Japanese Customs-cleared Crude, which is the average price of customs-cleared crude oil imports into Japan (formerly the average of the top 20 crude oils by volume) as reported in customs statistics; also known by its nickname the "Japanese Crude Cocktail."

[2] Based on private communication with energy economist Jim Jensen, international LNG expert, Weston Massachusetts, U.S.A.

[3] See http://www.reuters.com/article/2012/01/16/india-lng-gail-idUSL3E8CG2X420120116

Figure 1: Japan LNG Price Forecasts - $2012/mmbtu

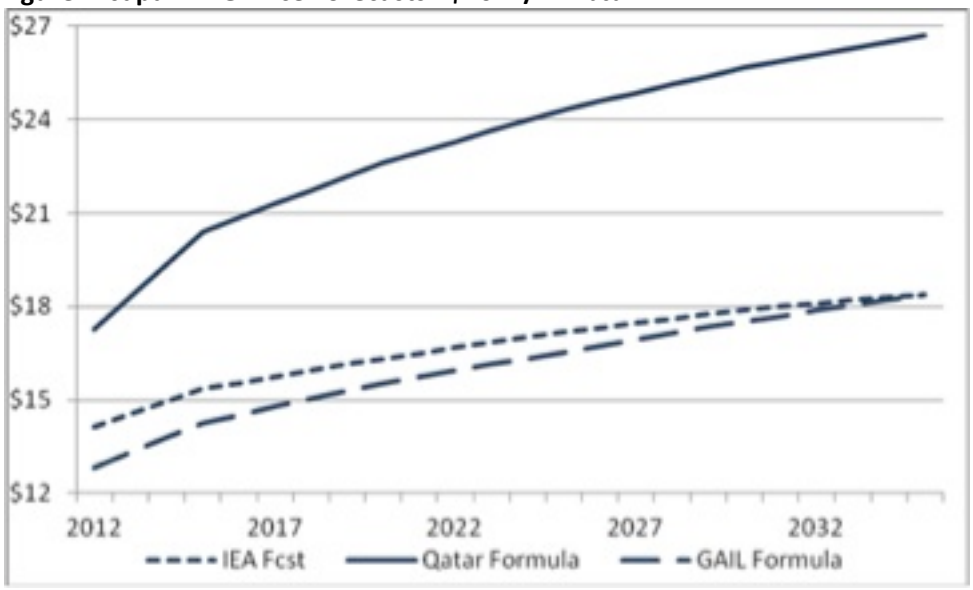
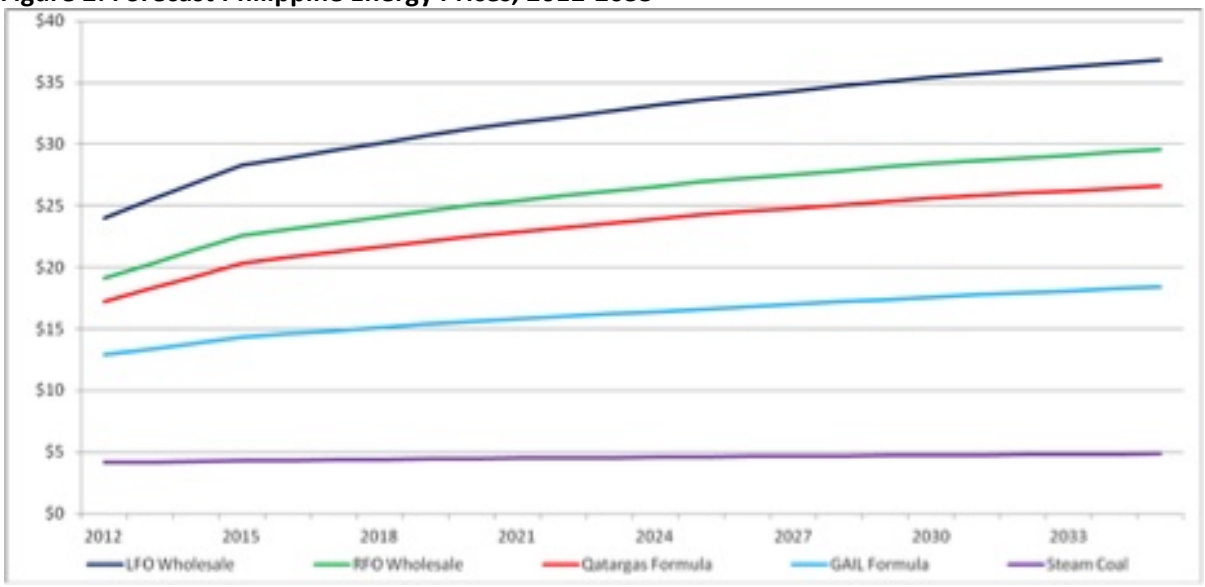


Figure 1 shows a comparison of LNG prices in Japan, the world's largest LNG importer, and an LNG price setter for the Asian market. It shows Japanese LNG prices under the above two scenarios, as well as the 2011 WEO forecast of Japanese LNG prices. Figure 2 shows forecasts prices for LNG landed in Philippines, and contrasts these LNG price forecasts with the forecasted prices for fuel oils and coal, which would be the principal competing fuels with natural gas in industrial markets. The LNG prices in Figure 2 do not include the 7 per cent import duty that currently applies to the import of LNG to the Philippines. This import duty exists, but in practice is never collected as there are currently no imports of LNG to the Philippines. CGSI has assumed that if the government wants to promote the use of clean-burning natural gas as a catalyst to economic development and to help lower the operating costs of local industry, then the elimination of this import duty will be one component of the government's support for the development of this industry.

Figure 2: Forecast Philippine Energy Prices, 2012-2035



3.3. Pricing Calculations

Some general conclusions that can be drawn from the forecasts depicted in Figure 2:

- Fuel oil prices, both light and residual, will be significantly higher than natural gas prices under each scenario. Depending upon which of the scenarios is selected, natural gas will enjoy a price advantage ranging between 10 and 32% over residual fuel oil and between 28 and 46% light fuel oil (commodity cost landed in the Philippines). These price spreads are largely because the IEA's 2011 WEO expects natural gas prices to continue to be significantly discounted relative to oil prices.
- Coal will continue to be the cheapest fuel source, according to the IEA forecasts. This, of course, is before any carbon pricing, which would be expected to disproportionately fall on coal prices. While it is reasonable to expect increasing pressure towards and increasing likelihood of carbon prices being adopted over this forecasting horizon, it is very difficult to estimate when this may happen in countries like Philippines.
- LNG prices can be expected to grow in real terms, but likely not as rapidly as oil prices, especially over the next decade, at least. This should make LNG an attractive fuel option for the Mindanao, which will benefit the regional economy.

4.0 Demand Assessment

4.1. Methodology

The demand assessment was conducted over a five-month period beginning in November 2011. CGSI with the assistance of the Department of Energy (DoE) met various stakeholders in Manila, Davao City, Iligan City, Cagayan de Oro (including the PHIVIDEC Industrial Estate) and General Santos. These stakeholders included government departments and agencies and various business groups in each of the Mindanao communities. These meetings were used to develop a target list of business and industry that were likely to benefit from the availability of natural gas as an energy source. This information supplemented the preliminary research conducted by the consulting team, which included both internet research and personal communication. From this initial screening, a list of potential industries was developed and ranked into high, medium and low potential targets.

Through both direct and indirect assistance from the above-noted business groups CGSI engaged with local parties to conduct load surveys with business and industry that comprised the target list of potential end users of natural gas. Surveyors used the load survey form (a copy of which is attached as Appendix I) developed for the project to collect information each of the industries' current energy consumption requirements. In some cases, the industries were provided the survey form directly from DoE or CGSI for self-completion. In either case, CGSI's Philippines Energy Expert attempted to complete a verification interview with each of the companies. Significant effort was expended on the verification process in order to ensure the data would be of the highest possible quality.

The load survey form identifies existing energy use by fuel type and provides an opportunity for the company to identify their interest in switching to natural gas based on various levels of cost savings, being 0%, 10%, or 20%. The opportunity was also provided to indicate where various processes are not candidates for fuel switching.

4.2. Load Survey Results by Area

Results from each of the five areas have been summarized below. For each of these areas, a projection has been made of the annual consumption forecast for those customers who are expected to convert to natural gas within the first three years of natural gas being available. These figures are shown in the "Annual" column. Process loads for customers were included in the Annual column if their desired savings could be achieved by substituting natural gas for their existing fuels based on the competitive fuel assessment detailed in Section 3. Process loads where the desired fuel savings could not be achieved have been included in the "Future" column.

Power generation loads were generally excluded from the immediately convertible loads as most industry in Mindanao currently maintain some form of backup power generation. This is no doubt due in part to the sometimes unreliable nature of the power system in Mindanao. From the load survey, it is clear that many of these customers run this backup generation frequently. These loads have been excluded under the assumption that if natural gas fired generation is introduced to the mix of generation serving the island, then reliability will be increased and the need to run these generators will be decreased. Loads were only considered immediately convertible if a detailed understanding of the customer's requirements could be obtained and power generation installed is integral to the customer's

operations and not simply for back up. All other power generation loads were included in the Future category.

Similarly, cooling loads were excluded from the immediately convertible loads. This is because the ability to convert to gas fired chillers or cooling is dependent on more than just willingness on the part of the customer to convert. Gas fired chillers are generally larger and heavier than their electric equivalents. Therefore, the customer's physical plant must be able to accommodate the larger size and weight. In addition, the economic advantages of gas fired chillers are not sufficient to warrant the replacement of existing cooling systems unless those systems are nearing their end of life. Collecting this sort of detailed information was beyond the scope of what could practically be collected by the load survey. There were some significant cooling loads identified by the load survey and it is reasonable to assume that some of these customers might be interested in converting these loads during the first three years of the availability of gas, however in order to maintain a conservative approach to forecasting potential loads, cooling load has only been included under Future Load.

4.2.1. Cagayan de Oro

The City of Cagayan de Oro is the regional centre of northern Mindanao, situated along the shores of Macajalar Bay. The city's population is in excess of half a million people and the city is a hub for business and industry. Within Cagayan de Oro, 32 companies were identified as potential users of natural gas. Of these, six were ranked as high potential and 14 were ranked as medium potential. These 20 formed the pool of companies targeted to complete the gas demand survey. Surveys were completed with four of the high potential targets and six of the medium potential targets.

Table 2 – Cagayan de Oro Market Survey Results

Company Identifier	Peak (GJ/hr)	Annual (GJs)	Future (GJs)	Indicated Savings To Convert
CO01	54	30,068	252,000	20%
CO03	131	21,081	1,255,789	30%
CO04	167	42,497	-	Not Specified
CO05	224	536,899	535,477	10%
CO07	8	-	2,229	20%
CO09	-	-	-	Not Applicable
CO10	-	-	-	Not Applicable
CO11	-	-	-	Not Applicable
CO17	-	-	-	Not Applicable
CO20	-	-	-	Not Applicable
	584	630,545	2,045,495	

4.2.2. PHIVIDEC

The PHIVIDEC Industrial Estate is located northeast of Cagayan de Oro City along the shores of Macajalar Bay and stretching inland for several kilometers. The estate itself is more than 3,000 hectares in size,

making it one of the largest industrial estates in the Philippines. For the purposes of this study, the industry located in the neighbouring communities of Villanueva and Jaasan have been included in the survey results for PHIVIDEC. In this area, 26 companies were identified as potential gas users. Of these, 14 were rated as having either high or medium potential and were approached to complete the survey. Eight of these companies completed the survey and three of those represent a significant portion of the natural gas potential in northern Mindanao.

Table 3 – PHIVIDEC Market Survey Results

Company Identifier	Peak (GJ/hr)	Annual (GJs)	Future (GJs)	Indicated Savings To Convert
PH02	113	617,998	323,603	0-20%
PH05	29	-	97,200	20%
PH08	-	-	-	Not Applicable
PH09	-	-	-	Not Applicable
PH11	191	1,039,722	382,751	0%
PH12	4	22,328	-	20%
PH13	26	4,328	591	10-20%
PH14	50	154,800	21,600	20%
	413	1,839,176	825,745	

4.2.3. Iligan

Iligan City is located approximately 40 km from Cagayan de Oro on the eastern shores of Iligan Bay. The city has heavy industrial zones to the north and south of the city. There were nine industries identified as potential users of natural gas in the immediate Iligan area. Of these, two were identified as high potential targets and the rest were judged either medium or low. Surveys were successfully completed with five of the nine companies identified.

Table 4 – Iligan City Market Survey Results

Company Identifier	Peak (GJ/hr)	Annual (GJs)	Future (GJs)	Indicated Savings To Convert
IC04	23	153,900	-	20%
IC05	11	69,938	2,509	Not Specified
IC06	-	-	5,370,000	10%
IC07	56	202,500	1,700,000	20%
IC09	3	14,175	85	20%
		404,513	7,073,094*	

* Approximately 7 million GJs identified as Future potential relates to coal consumers who indicated a minimum of 10 % savings to convert. As these savings will not occur under current policies, these volumes have not been factored into design options in the subsequent stages of the report.

4.2.4. Davao City

Davao City is a vibrant regional hub. At nearly 1.5 million people, it is the largest city in Mindanao. In Davao City and the immediately surrounding region, 32 companies were initially identified as potential users of natural gas. Of those, four were ranked as high potential and nine were ranked as medium potential. The large number of low potential targets is partially due to the relatively high number of hotels and shopping malls, that are potential markets but primarily for their cooling loads. All of the 13 targets identified as either high or medium potential were interviewed and completed load surveys, however it was later understood that one of the companies surveyed only maintains an office in Davao City and does not have any operations in the region. The largest load centres in Davao are located at the city's outskirts or beyond resulting in a very dispersed distribution of load making the available options for serving this load challenging.

Table 5 – Davao City Market Survey Results

Company Identifier	Peak (GJ/hr)	Annual (GJs)	Future (GJs)	Indicated Savings To Convert
DA01	19	45,231	-	20%
DA02	6	31,668	2,228	20%
DA03	-	-	4,380,000	10%
DA04	2	12	-	20%
DA05	23	-	-	Will Not Convert
DA06	15	1,570	28,231	20%
DA07	2	1,934	-	20%
DA08	40	-	112,264	20%
DA09	7	-	3,441	Will Not Convert
DA10	56	146,060	216,000	10%
DA11	4	-	2,096	Will Not Convert
DA12	3	-	20,381	Will Not Convert
	177	226,475	4,764,623*	

*4,380,000 GJs related to current coal consumption has been excluded from this total and from design assumptions

4.2.5. General Santos

General Santos City and the surrounding region is home to significant fresh seafood processing and canning industries. Inland at Polomolok there is also agricultural processing industries including fresh fruit and meat processing. The nearby community of Alabel is home to a small electric power generating station. In General Santos, 52 companies were initially identified as potential users of natural gas. Of those, 9 were ranked as high potential and 24 were ranked as medium. It was decided that these 33 companies would constitute the survey targets in this region. Survey completion was 100 per cent of the high potential industries and 46 per cent of the industries identified as medium potential.

Table 6 – General Santos Market Survey Results

Company Identifier	Peak (GJ/hr)	Annual (GJs)	Future (GJs)	Indicated Savings To Convert
GS01	135	216,000	528,048	Not Specified
GS02	13	-	87,617	20%
GS03	16	-	58,181	20%
GS04	14	-	144,581	20%
GS05	4	452	151	20%
GS06	3	630	155	Not Specified
GS07	14	-	8,003	20%
GS08	46	9,301	176	10%
GS09	5	-	144,000	Not Specified
GS10	3	723	12,404	Not Specified
GS12	36	176	295,611	30%
GS13	18	72,900	1,207	20%
GS14	1	-	360	20%
GS15	9	-	43,020	20%
GS16	14	-	260,593	20%
GS17	12	706	43,947	20%
GS18	14	12,768	53,698	10%
GS19	29	-	12,182	10%
GS20	6	1,161	6,606	10%
GS21	322	2,750,000	-	10%
	714	3,064,817	1,700,540	

4.3. Other Potential Sources of Demand for Natural Gas

4.3.1. Cooling Load

In addition to the information on cooling load collected on the load survey, the study team also accessed data from an ongoing study on commercial and industrial chillers being conducted by the Philippine Department of Environment and Natural Resources (DENR). In the industrial sector, cooling load consists primarily of refrigeration applications in the food processing industries, while in the commercial sector cooling load consists primarily of air conditioning. The DENR survey covers primarily shopping centres and hotel complexes that were not covered in the load survey for this study. The DENR data shows approximately 100,000 GJs annual equivalent cooling load from commercial customers in Cagayan de Oro, and approximately 300,000 GJs annual equivalent in Davao City. To date, the DENR has not collected data in General Santos or Iligan. The load survey showed significant industrial cooling load in General Santos, primarily in the seafood processing industry, but also in other sectors of the food processing industry. The potential cooling load identified in General Santos by the load survey alone exceeds 400,000 GJs annual equivalent.

4.3.2. Transportation Load

The transportation market is another viable source of demand for natural gas. However, transportation has been a difficult market for natural gas to crack even in North America where natural gas is relatively inexpensive and plentiful. The traditional market for alternative transportation fuels such as natural gas has been fleet vehicles that return to a central location each night for refuelling. Buses, garbage trucks, delivery trucks and taxis have been some of the earliest adopters of natural gas for vehicles. Natural gas for vehicles has traditionally been in the form of compressed natural gas, though the technology allowing the use of LNG directly in vehicles has also been commercialized.

As natural gas is fairly straightforward conversion from LPG, those segments of the transportation market that have already converted to LPG are a particularly attractive segment. On Mindanao, this segment is primarily taxi cabs. In the Davao region, where there are nearly 4,000 taxi cabs, more than 55 per cent of those taxis have been converted to LPG. In Cagayan de Oro, there are about half the number of taxis as in Davao and a smaller share, less than 10 per cent, have been converted to LPG. Intercity busses represent another potential for conversion. There are approximately 1,500 intercity busses operating in Mindanao. While transportation represents an additional potential market, there would be significant additional work required to develop the related infrastructure and technical expertise required to make this market viable.

4.3.3. Other Demand on Mindanao or Elsewhere in the Philippines

While the scope of this assessment was confined to the five areas detailed above, these five areas are not the only potential demand centers on Mindanao. Other potential customers and industry clusters were identified in Butuan, Bukidnon and Zambongua and certainly as the availability of natural gas comes closer to being a reality, there will be time to explore these potential markets. The study team did make a preliminary examination of all three of these markets and the one that offers the greatest potential is Zambongua by virtue of a single power generator that is currently fired with bunker fuel, but is easily convertible to natural gas. Similarly, an LNG terminal located in Northern Mindanao could easily serve satellite locations on other islands of the Philippine archipelago.

4.3.4. Commercial Market Segment

The majority of the potential demand for natural gas in the commercial segment comes from the cooling load discussed above. However both cooking and water heating represent additional potential commercial loads that could be economically served, particularly where these loads occur in significant concentrations such as hotel complexes and shopping malls or restaurant districts.

4.3.5. Bottled Compressed Natural Gas (CNG)

The potential also exists for the development of market for compressed natural gas sold and distributed in bottles or tanks for both the residential and small commercial market. As noted in the transportation section above, LPG to natural gas conversions are very simple and cost effective. Market forces will determine if there is market for the distribution of bottle CNG either in competition with bottled LPG or complimentary to this existing market.

4.4. Aggregated Demand

While these other sources of demand for natural gas discussed above are potentially significant, they have not been accounted for directly in the assessment of the aggregated demand, nor have they been factored in directly to the designs contemplated to serve the load in Mindanao. However, it is equally unreasonable to assume that all identified load is likely to convert to natural gas, particularly in the short term. For design purposes, the entire Annual load is assumed to convert and half of the Future load is assumed to convert. In addition, a further "Unspecified Future" load equal to half of the Future load has been added for design purposes.

Table 7 – Mindanao Aggregated Annual Demand (in GJs and in Tonnes of LNG)

Location	Annual	Future	Unspecified Future
Northern Mindanao			
Jasaan to Cagayan de Oro	2,439,653	1,262,020	1,262,020
Iligan	440,513	851,547	851,547
Northern Mindanao Total	**2,880,166**	**2,113,567**	**2,113,567**
Northern Mindanao in Tonnes of LNG	**51,958**	**38,129**	**38,129**
Southern Mindanao			
General Santos, Polomolok & Alabel	3,064,817	850,270	850,270
Davao	226,475	192,312	192,312
Southern Mindanao Total	**3,291,292**	**1,142,582**	**1,142,582**
Southern Mindanao in Tonnes of LNG	**59,272**	**20,612**	**20,612**
TOTAL	**6,171,458**	**3,256,149**	**3,256,149**
TOTAL in Tonnes of LNG	**111,230**	**58,741**	**58,741**

5.0 Distribution Options

5.1. Introduction

In determining the optimum distribution strategy and infrastructure requirements to serve the identified customers on the Island of Mindanao, CGSI considered and evaluated the trucking of LNG and CNG, the installation of isolated underground pipeline networks and the transportation of natural gas in LNG form via marine barges. Capital and operating costs for these modes of distribution were considered.

In general terms distributing natural gas via pipeline is the most economic method of distribution. While capital costs are sometimes higher, pipelines enjoy low operating cost and are an efficient way to deliver gas over short distances, and, depending upon the volume, over long distances as well.

5.2. Infrastructure for Distributing Natural Gas

Natural Gas Distribution Infrastructure Options - Major Components		
Item #	Component	Description
1	Pipelines	The main pipeline from the LNG receiving terminal is recommended as a steel pipeline operating at 19 Bar (285 psi). The lateral service lines to customers can either be comprised of polyethylene or steel depending on the delivery pressure to the customers. Generally speaking three options exist for the material used in pipeline systems. Medium Density Polyethylene which is used for pipelines where an operating pressure of less than 80 psi is required,High Density Polyethylene pipe which is used where operating pressure between 80 psi and 125 psi are required, andSteel Pipe, which is used where operating pressures above 125 psi are required.
2	District Pressure Reducing Stations	Pressure reducing stations that are installed within a pipeline network to reduce supply pressures from a feeder pipeline for distribution of the natural gas into a lower pressure pipeline system that feeds more than one customer.
3	Customer Regulating and Metering Facility	Is an assembly installed at the customer's premise that reduces pressure for final distribution within the customer's facility and measures gas delivered to the customer for billing purposes.
LNG Truck		
4		An LNG tanker truck transports natural gas in liquid format from the bulk terminal to a storage and regasification facility serving one or more customers. The natural gas is transported at approximately minus

		162 degrees celsius. A tanker with size typically varying from 15 m^3 to 56 m^3 is towed by a truck either fuelled by diesel or natural gas.
LNG Storage and Vaporization		
5	LNG Satellite Storage	A LNG satellite storage facility will have one or more cryogenic (nickel stainless) storage tanks. These tanks are typically a cylinder, with stainless interior shell and a steel outer shell with insulation or vacuum in between. Depending on size they may be configured either vertically or horizontally.
Vaporizer		
6	Satellite Vaporizer	There are many vaporizer types but for the applications in this project either air or hot water is likely to be the medium used to vaporize the LNG. Gas fired vaporizers were chosen for this application. Gas fired vaporizers have lower capital cost but higher operating cost than using air. They have fewer problems though since when the LNG passes thru the finned tubes for heat exchange a feedback control system can control the water temperature. For air, the finned tube heat exchanger can ice up. Vaporizers are sized to meet the peak hour demand and also have backup capacity.

5.3. Recommended Distribution Options and Costs – Northern Mindanao

Due to the number of industrial customers, the proximity of these customers to each other, and the proximity of these customers to the receiving terminal, the potential customers in the PHIVIDEC area are ideally suited to be served from a natural gas pipeline distribution system.

A pipeline system of approximately 27.4 kilometers in length is proposed to serve a cluster of customers. The customers to be serviced from this pipeline are outlined in Tables 2 and 3 of the Demand Assessment Section of the report. A single line diagram indicting pipe sizes and pressures is contained in Appendix II and the conceptual routing of the pipeline is illustrated in the Google Earth Image contained in Appendix III.

The conceptual pipeline system proposed by CGSI is capable of supplying a peak load of 30,000 m3/hr with an inlet pressure from the LNG vaporization facility of 19 bar (approximately 285 psi). The pipe sizes and capital costs are shown in the table below. The conceptual pipeline system is designed to serve the current potential peak hourly load of approximately 23,650 m3/hr and leave a residual capacity of approximately 6,350 m3/hr for future load growth.

Table 8 – PHIVIDEC Distribution Infrastructure, Capital and Operating Costs

Item	Description	Qty (M)	Unit Cost (USD)	Total Cost (USD)
1	4 Inch Steel Pipe	400	78	31,200
2	6 Inch Steel Pipe	3,450	112	386,400
3	8 Inch Steel Pipe	15,270	140	2,137,800
4	10 Inch Steel Pipe	6,820	183	1,248,060
5	12 Inch Steel Pipe	1,500	218	327,000
Sub-Total Pipelines		**27,440**		**4,130,460**
6	Lateral Service Lines and Customer Metering & Pressure Reducing Stations	6	200,000	1,200,000
Sub-Total Services				**1,200,000**
Sub-total Material and Labour				**5,330,460**
7	Marketing (3 %)			**159,914**
8	Engineering (5 %)			**266,523**
9	Construction Mgmt (8 %)			**426,437**
10	Contingency (10 %)			**533,046**
11	Capital Allowance for Start-up of Operations			**500,000**
	PHIVIDEC Total Capital Costs			**7,216,380**
PHIVIDEC Annual Operating Cost Estimate				**280,000**

The Market Demand Assessment identified four (4) customers in Iligan that could be served by natural gas. These customers are ± 110 kilometers from the LNG Import Terminal / natural gas supply source. CGSI considered three options for supply the natural gas:

1. A pipeline from the LNG Import Terminal to end use customers,
2. CNG transported via truck and trailer combined with a total of four (4) kilometers of distribution pipeline, and
3. LNG transported via truck and trailer combined with a total of four (4) kilometers of distribution pipeline.

The first option, of using a pipeline to supply the natural gas, was ruled out early due to the high capital cost of running the pipeline the length required to service the relatively small requirements of the Iligan

customers. The cut-off point on feasibility of CNG versus LNG supplied by truck and trailer is known to be 100-150 km's where below this distance the feasibility favours supply by CNG and above this distance the feasibility favours supply by LNG. Given Iligan is exactly on the cut-of distance of the two options the economics of both options are considered to be equal. CNG would have lower capital costs but higher operating costs than LNG, but over a reasonable project lifespan the costs of both are comparable at this distance. A major contributor to the higher operating costs of CNG is trailer capacity. CNG trailers have a maximum capacity of approximately 15 m^3 of LNG equivalent versus the 56 m^3 capacity of the LNG trailer. Based on the above CGSI used the LNG supply option to determine costs for supplying natural gas to the customers in Iligan as the LNG supply option has the added flexibility to act as a satellite supply terminal for other customers further out from Iligan and these added customers could be served either via LNG or CNG. The demand in Iligan can be served from one LNG Truck and Trailer. CGSI has added the cost of a second trailer to the estimate for security of supply issues in case the case of required maintenance and repairs to the primary LNG trailer.

The conceptual design to serve the four customers in Iligan consists of two satellite LNG terminals and two sections of polyethylene distribution pipeline totalling 4 kilometers in length. For receiving the 56 cube (cubic meter) delivery recommended in this report, two 120 cube storage tanks would seem to be optimum for the satellite located on the south side of the city. One 120 cube tank (or smaller) would satisfy the other location on the north side of the city. The components of the system and associated capital costs are shown in the table below.

Table 9 – Iligan Distribution Infrastructure, Capital and Operating Costs

Item	Description	Qty	Unit Cost (USD)	Total Cost (USD)
1	LNG Truck and Trailer	2	450,000	900,000
2	Spare LNG Trailer	1	250,000	250,000
3	LNG Satellite Terminal	2	1,010,000	2,020,000
4	6 Inch Polyethylene Pipe	4000 m	52	208,000
Sub-total Material and Labour				**3,378,000**
5	Marketing			**25,000**
6	Pipeline Engineering			**25,000**
7	Pipeline Construction Mgmt			**35,000**
	Iligan Total Capital Costs			**3,463,000**
Iligan Annual Operating Cost Estimate				**477,000**

As will be detailed in the distribution costs section, the distribution options outlined for both PHIVIDEC and Iligan show very favourable economics and likely form a logical first phase for natural gas distribution for Mindanao. Future phases will take longer to develop as they require the development of

local marine distribution from the LNG terminal in northern Mindanao to regional hubs for further distribution.

5.4. Recommended Distribution Options and Costs – Southern Mindanao

CGSI considered three options for supply the natural gas to Davao and General Santos:

1. A pipeline from the LNG Import Terminal at PHIVIDEC and running overland to end use customers in Davao and General Santos,
2. LNG transported via truck and trailer combined with a total of approximately twenty (20) kilometers of distribution pipeline, and
3. LNG transported via barge to a regional satellite terminal location in General Santos area and then distributed to customers in the Davao and General Santos area via pipelines and LNG trucks.

CGSI recommends the main supply of LNG for the Davao and General Santos areas be supplied via LNG trucks loaded at the main terminal in PHIVIDEC and routed to satellite terminals located in Davao and General Santos.

The first option, of using a pipeline from the main import terminal to supply the natural gas, was ruled out early due to the high capital cost of running the pipeline the length required to service the Davao and General Santos customers. The third option of using a system of barges to transport the LNG was ruled out after some study due to the complexities that exist with this mode of transport. Although technology has evolved since the early days of using barges to transport LNG, there remain challenges with this type of transport and for that reason it is not widely used today. Marine options to serve the southern half of the island are likely to emerge overtime as a better way to serve this market, particularly if other local markets such as Cebu are to be developed. However, at this time, the second option of using LNG trucks loaded at PHIVIDEC and travelling overland to the Davao and General Santos area provides the most cost effective and proven method of transport and therefore is the option CGSI recommends.

The table below summarizes the capital costs associated with the recommended option.

Table 10 – Davao and General Santos Transportation and Distribution Infrastructure, Capital and Operating Costs

Item	Description	Qty	Unit Cost (USD)	Total Cost (USD)
1	LNG Truck and Trailer	7	450,000	3,150,000
2	LNG Satellite Terminal	5	1,010,000	5,050,000
3	6 Inch Polyethylene Pipe	20,000 m	52	1,040,000
4	Lateral Service Lines to Customers	10	200,000	2,000,000
Sub-total Material and Labour				**11,240,000**

5	Marketing (3%)			**91,200**
6	Pipeline Engineering (5%)			**152,000**
7	Construction Mgmt (8 %)			**243,200**
8	Capital Allowance for Start-up of Operations			**250,000**
	Davao / Gen San Total Capital Costs			**11,824,400**
Southern Mindanao Annual Operating Cost Estimate				**6,200,000**

5.5. CAPEX and OPEX Assumptions and Limitations

The CAPEX and OPEX estimates prepared for this study are directional in nature and based upon conceptual designs as opposed to detailed designs. They have been compiled in order to provide an estimate of the costs for the distribution of natural gas and to assist in calculating the estimated feasibility of natural gas as an alternative energy sources. It has been necessary to make assumptions regarding material and labour pricing as well as site influences.

Opex for the pipeline systems has been assumed at approximately 2.5% of capital costs. Opex estimates for the LNG were estimated based on the Mindanao pump price for diesel fuel and the fuel usage rates, driver wage rate ($10/hr), insurance including liability for flammable goods transfer, routine tractor/trailer maintenance, tractor engine replacement and miscellaneous. Tractor fuel was the biggest component making up approximately 60% of the operating cost.

As for the LNG satellite terminal operating costs it was estimated between 2-3% of LNG volume was required to fuel the vaporizers and priced it at $15/GJ, operator/maintenance wages at $10/hr, 2% of initial capital costs for various and sundry annual maintenance and administration requirements, and liability insurance costs. Liability insurance for 365d/year for flammable liquids storage and transfer was the biggest portion of the operating cost and its approximate impact.

Unit costs are based on current project contract cost data available to CGSI with adjustments for the location of this project. Client costs, approvals, land leases, right of way permits, licenses etc. are excluded. CGSI assumes that at time of installation a tendering process would be used to obtain best value.

5.6. Preliminary Distribution Rate Estimates

In order to summarize the manner in which projected demand will integrate with projections for capital, operating and commodity costs to culminate in a delivered cost of gas to the end consumer, CGSI has conducted some preliminary rate analysis for the recommended Phase 1 regions of Cagayan de Oro (including the PHIVIDEC Industrial Estate), and Iligan. In both cases the analysis reflects the cost of gas, together with the cost of the distribution infrastructure. The costs associated with the LNG terminal are not reflected in the projected rates although the World Bank has calculated that the throughput cost associated with the Mindanao LNG terminal should be in the range of USD 1 per mmbtu.

For Cagayan de Oro, the delivered cost of gas is projected to commence at USD 13.80 per mmbtu in Year 1, increasing to USD 18.30 in Year 20. Over the 20 year analysis period, the price is projected to average USD 13.27 in 2013 dollars. Of this total, approximately $12.95 is attributable to the commodity, while the remaining $.32 is allocated to the cost of the distribution infrastructure. The realization of potential future demand, as reflected in Tables 2 and 3 would have the effect of reducing the present value of that component of the cost of gas that is attributable to the distribution infrastructure.

For Illigan, the delivered cost of gas is projected to commence at USD 15.37 per mmbtu in Year 1, increasing to USD 20.90 in Year 20. Over the 20 year analysis period, the price is projected to average USD 14.67 in 2013 dollars. As was the case with Cagayan de Oro, approximately $12.95 of this total is attributable to the commodity, while the remaining $1.72 is allocated to the cost of the distribution infrastructure. Given the significant potential future demand in Illigan, as reflected in Table 4, there is an opportunity for that portion of the rate allocated to the distribution infrastructure in future years to be only a fraction of the current $1.72 projection.

This same preliminary rate analysis has been prepared for Southern Mindanao. For General Santos and Davao, the delivered cost of gas is projected to commence at USD 16.43 per mmbtu in Year 1, increasing to USD 21.97 in Year 20. The 20 year average price is projected to be USD 15.75 in 2013 dollars. As in the previous cases, approximately $12.95 of this total is attributable to the commodity cost, with $2.80 is allocated to the cost of the distribution infrastructure.

5.7. Price Comparisons to Competitor Fuels

In section 3.2, the chart in Figure 2 showed forecasted prices of LNG, diesel, bunker oil, and coal. These same price forecasts are represented in table format below. These comparative costs provide a valuable picture of the relative cost of these various energy sources; however they are somewhat limited in their utility in that they do not take into account distribution costs.

Table 11 – Price Comparisons to Competitor Fuels

	Philippine Landed Costs of LNG, Fuel Oil and Steam Coal, Current Prices Scenario, in USD per mmbtu				
	Qatargas LNG	GAIL LNG	Light FO	Residual FO	Steam Coal
2012	17.19	12.89	24.03	19.11	4.15
2013	18.25	13.37	25.45	20.27	4.19
2014	19.30	13.85	26.87	21.44	4.23
2015	20.35	14.34	28.30	22.60	4.28
2016	20.79	14.59	28.90	23.09	4.31
2017	21.23	14.85	29.49	23.58	4.35
2018	21.67	15.10	30.09	24.07	4.39
2019	22.11	15.35	30.68	24.55	4.42
2020	22.55	15.61	31.28	25.04	4.46
2021	22.89	15.81	31.75	25.42	4.49

2022	23.23	16.01	32.21	25.80	4.52
2023	23.58	16.20	32.68	26.18	4.55
2024	23.92	16.40	33.14	26.56	4.58
2025	24.26	16.60	33.60	26.94	4.61
2026	24.53	16.80	33.97	27.24	4.64
2027	24.80	17.00	34.33	27.54	4.67
2028	25.07	17.20	34.70	27.83	4.69
2029	25.33	17.39	35.06	28.13	4.72
2030	25.60	17.59	35.42	28.43	4.74
2031	25.81	17.76	35.70	28.66	4.76
2032	26.01	17.93	35.98	28.88	4.78
2033	26.22	18.10	36.26	29.11	4.80
2034	26.42	18.27	36.54	29.34	4.82
2035	26.63	18.44	36.81	29.57	4.84

In order to provide a more meaningful comparison of the cost of energy delivered to the customer, CGSI contacted some of the Mindanao industries included in the demand assessment survey and obtained, on a confidential basis, actual fuel costs paid by these customers in mid-2012. These delivered fuel costs and the corresponding delivered costs of LNG are provided in the table below. These costs are exclusive of the 12 percent VAT, as the VAT is ultimately credited back to these industries at the time they sell their end product. The prices for diesel, bunker and LPG include Philippine Excise Taxes at their appropriate rate. The LNG prices in the table below are for regasified LNG in Iligan, the highest priced location for Phase 1 LNG based on this analysis. To arrive at these prices, the 2012 prices from the table above have been used with an additional $1 per mmbtu assumed for the LNG terminal fee and $1.72 per mmbtu added for distribution costs. The LNG prices do not include Philippine Excise Taxes, as there are currently no excise taxes levied on natural gas in The Philippines. An excise tax on natural gas may be revisited once natural gas becomes available. Similarly, LNG prices do not include the seven per cent import duty currently imposed on imported LNG. CGSI recommends that in order to promote the development of LNG as an energy source the Philippine government should eliminate the existing import duty.

Table 12 – Notional LNG Prices Compared to 2012 Actual Fuel Costs

Mindanao 2012 Distributed Cost of Fuel in USD per mmbtu					
	QatarGas LNG	GAIL LNG	Light Fuel Oil	Residual Fuel Oil	LPG
USD / mmbtu	19.91	15.61	29.88	23.94	40.62
% Savings of QatarGas LNG	-	NA	33.36%	16.83%	50.98%
% Savings of GAIL LNG	21.59%	-	47.76%	34.79%	61.57%

In this context, the delivered cost of LNG can provide fuel cost savings of 16-35% over bunker fuel or residual fuel oil and 33-48% savings over diesel or light fuel oil.

5.8. Financial Analysis Methodology

To determine the economic viability of supplying gas to each of the four regions under consideration, CGSI undertook an integrated financial analysis comprising the following steps:

1. Existing fuel use was determined for the major customers in each of the four regions under consideration. Alternative fuels included coal, kerosene, propane, diesel, and bunker oil.
2. Existing fuel use was categorized to determine the volumes that can be readily converted to gas, and the volumes that are more likely to be converted in the long term.
3. Twenty year projections were determined for the commodity cost of each alternative fuel. Transportation costs were added to arrive at a landed cost for the customer.
4. Using relative values for heat content, the landed cost of alternative fuel was converted into an equivalent volume of natural gas.
5. Natural gas commodity prices were projected for a twenty year period. GAIL Gas price projections, as outlined in the LNG Price Forecast above, were utilized as a base case, together with the Current Policy Scenario.
6. Capital and operating costs were determined for four different options for the transportation of gas to each of the four regions. These included:
    a. Transport of LNG by LNG powered truck
    b. Transport of LNG by diesel powered truck
    c. Transport of LNG by barge
    d. Transport of gas by pipeline
7. NPV analyses were undertaken in which the annual difference between the landed cost of alternative fuels and the commodity cost of natural gas was netted against the capital and operating costs associated with each of the four transportation options for each of the four regions. Based on the relative net present values, the optimal gas transportation method was determined for each of the four communities.
8. In order for the gasification of the regions to be economically viable, the sum of the net present values of the optimal alternatives for the viable regions must exceed the cost of the LNG terminal combined with the cost of liquefaction and transportation of the LNG, by an amount that allows for sufficient savings to entice customer conversion.
9. Sensitivity analyses were undertaken to confirm the validity of the results of the NPV analyses under various assumptions, including:
    a. Individually excluding each alternative fuel from the analysis
    b. Individually excluding each region from the analysis

c. utilizing Qatar Gas pricing projections
d. utilizing the New Policy Scenario for gas prices
e. Varying the discount rate for the NPV analysis

10. Preliminary calculations were performed to determine the average rates that customers would be required to pay per Section 5.5 above. For purposes of the rate calculations, the after-tax weighted average cost of capital was assumed to be 10%, and the annual percentage of rate base recovered was assumed to be 2.5% (regardless of the capital structure).

11. Other key assumptions utilized within the financial analyses included:

    a. Inflation rate of 2.0%
    b. Exchange rate of $.02367 USD per Philippine Peso
    c. Discount rate for the NPV analysis of 15%

6.0 Policy and Regulatory Analysis

6.1. Overview

There are three complementary objectives for the Government of the Philippines to balance in developing the policy and regulatory framework for the establishment of a distribution network for natural gas on the island of Mindanao. These objectives include:

- Protecting the public interest;
- Supporting economic development; and
- Attracting private sector investment and participation.

During the initial development phase of this new energy source and establishing the associated infrastructure for the distribution of the natural gas, the ability to attract private sector investment to undertake this development becomes a primary objective. As the availability of this new energy source begins to flourish, it will be necessary to ensure the continued attraction of private sector investment and participation in order to promote economic development. In this context, it is reasonable to anticipate an evolution of the regulatory framework over time, beginning with what might be described as Project Driven Regulatory Model in the early years, which could be as much as a decade, to a more Formal Regulatory Model once the market has matured and become fully developed and portions of the market have become competitive.

Many aspects of the Project Driven Regulatory Model can be built into the initial contracts that are used to develop the required infrastructure. Aspects of the Formal Regulatory Model can then be developed over time in a manner appropriate to the evolving marketplace. It is neither necessary nor practical to think that the Philippines should develop a Formal Regulatory Model for the distribution of natural gas for either Mindanao or the entire country in advance of moving forward with such a relatively small distribution network as is envisioned for Mindanao. By adopting a Project Driven Regulatory Model, the government of the Philippines can ensure the public interest is protected while supporting economic development in Mindanao and attracting the required private sector investment.

6.2. Recommended Regulatory Framework

Executive Order No. 66, series of 2002, designated the Department of Energy (DOE) as the lead agency in developing the Philippine natural gas industry. Subsequently, DOE Circular No. 2002-08-005, otherwise known as the Interim Rules and Regulations Governing the Transmission, Distribution and Supply of Natural Gas, was issued. The circular serves as a guide to the oversight anticipated for the downstream natural gas industry in the Philippines and identifies DOE as the body with regulatory oversight for the distribution of natural gas. During this development phase of distribution infrastructure in Mindanao, CGSI anticipates that many of the regulatory provisions will be contractually based, and in all likelihood will result from a competitive bidding process. In this context, the Project Driven Regulatory Model, which would be administered by the DOE, functions as a complaint based or reactionary model whereby, following contract award, the terms of the contract are fulfilled by the successful party(s) who establish the anticipated business relationships with customers and charge the rates anticipated by the formulas set out in the contracts. If one of the parties to this arrangement, or for that matter a member of the public, feels that the terms of the contract are not being adhered to, then the DOE would become involved as the result of complaint from an interested party. As the

distribution infrastructure in the region matures, a more direct oversight regulatory model may become desirable, in which case the Philippine Government may consider adding to the regulatory oversight duties of the Energy Regulatory Commission that currently oversees portions of the electricity sector, or the establishment of a separate Regulatory Commission to oversee the natural gas industry. Whether regulatory oversight resides with a new commission, the ERC or DOE, additional resources will be required by these agencies in order to fulfill these expanded mandates.

6.3. Project Driven Regulatory Model

6.3.1. Introduction

A Project Driven Regulatory Model is recommend initially for Mindanao in order to enable the successful introduction of LNG while protecting the interests of the Gas Aggregator, end-use customers and the general public. While the project envisioned for Mindanao is small, and the number of customers proposed to be served is small, when compared to the scale of gas distribution projects and systems in many developed countries around the world, the need still exists for regulatory oversight in critical areas. CGSI recommends that the minimum amount of regulatory oversight be placed on the project at the outset and that the regulatory oversight matures as the use of natural gas matures on the island of Mindanao.

In general terms the Project Driven Regulatory Model should encompass the following items which are in keeping with the regulatory framework already in place for the Malampaya project:

1. Review and approval of the draft contractual terms developed for the selection of the Gas Aggregator.
2. Periodic review, against the established formula, of the retail price for natural gas charged to end-use customers
3. The establishment of appropriate industry specific safety regulations needed to supplement existing established safety regulations.
4. Periodic auditing of the industry to ensure compliance to industry regulations.

6.4. Infrastructure To Be Regulated

In order for natural gas to become a viable fuel choice for Mindanao, three distinct sets of infrastructure will need to be developed:

- The LNG terminal;
- The anchor power plant; and
- The distribution network.

The scope of this report relates primarily to the distribution infrastructure; however, to the extent that the distribution infrastructure is dependent on the LNG terminal, relevant points with regard to the LNG terminal have also been included.

The Northern Mindanao LNG terminal will be a separate business, and in all likelihood, operated by a separate company. The services offered by the LNG terminal are likely to include:

- The berthing of LNG carriers at the LNG terminal;

- Receipt of LNG through unloading at the terminal;
- Temporary storage of LNG;
- Vapourization or re-gasification of LNG and associated compression of the re-gasified LNG; and,
- The dispatching of re-gasified LNG into the downstream gas pipeline network.

Most, if not all, of these activities are likely to be covered by a uniform per unit charge that will be consistently charged to all consumers in Northern Mindanao. The level of that charge will ideally be the result of a bidding process from proponents wishing to be the operator of the Northern Mindanao LNG terminal. That charge will also ideally decline over time as volume throughput at the terminal increases above certain thresholds. The formula for the throughput charges must be well understood and will become a pass through cost paid by customers of the distribution system.

Similarly, the distributor of natural gas should be expected to treat the cost of the LNG itself as a cost that is passed-through without mark-up to consumers. The distributor will earn the return on its investment through the tariffs charged to customers for the distribution of the natural gas.

Due to the relatively small size of the market, it is recommended that a single entity be contracted and charged with the role of procuring adequate gas supplies and providing all related distribution services. This approach will allow for a more timely development of the required infrastructure. It will be more effective for the Philippine Government to evaluate and negotiate a contract with a single entity which, through this structure, will then have the scope necessary develop this market in an efficient manner. By providing a full scope of control over the distribution in the early stage of the infrastructure development, the government will remove any potential barriers that bidders would otherwise face associated with aggressively developing the market. This should serve to maximize throughput and therefore lower per unit costs for all customers. Within this context, it is not necessary that a single entity perform all of these functions. Rather, the successful bidder could be:

- A single entity with the necessary scope to fulfill all functions;
- A single entity that puts in place the required sub-contractors in order to fulfill all functions; or
- A consortium of companies which together can fulfill all the required functions.

Based on the infrastructure laid out in the Distribution Options section, there are likely to be three components to the distribution of LNG and re-gasified LNG. Each of these will need to be subject to price and other regulations. These three components are:

- The pipeline distribution system;
- The trucking of LNG to satellite regasification facilities and subsequent pipeline delivery to customers; and,
- Barging or shipping of LNG to satellite LNG terminals and the subsequent trucking of LNG to local re-gas facilities and/or pipeline distribution of re-gasified LNG.

A potential fourth component is the distribution of natural gas in the form of Compressed Natural Gas (CNG). Given the relatively small size of this market, it is recommended that initially a single franchise for the distribution of LNG and re-gasified LNG be granted for the island of Mindanao. There are

complementary components of the distribution network, namely the truck distribution of LNG or CNG, that could likely be operated as a competitive marketplace; however, in the interest of the orderly development of the market as a whole, there are benefits to allowing a single franchisee to identify and secure customers, convert them to natural gas delivered by CNG or LNG tanker and then work to develop the market such that pipeline distribution systems become economically attractive. An initial term of 10 to 15 years will allow the franchisee to develop this market. To the extent that customers continue to be served by truck distribution, a purely competitive model for this portion of the market can be evaluated at the conclusion of the initial term. Provisions for automatic extension of the franchise in areas where pipeline networks are installed could also be built into the initial contract.

6.4.1. Gas Procurement

The procurement of LNG for Mindanao will likely be performed by a single entity, known as the Gas Aggregator who will also be charged with developing the natural gas distribution system on the island. Significant flexibility should be afforded this gas procurement function such that the aggregator can secure supplies on terms consistent with the needs of its customers. Some sort of mix between long-term and short term pricing may be advantageous; however, the aggregator will likely secure supplies from multiple sources in order to take advantage of current pricing dynamics at any particular point in time.

6.4.2. Pipeline Distribution System

It is anticipated that the initial pipeline distribution system will be in the region immediately surrounding the LNG terminal. While a final location for the LNG terminal has not been selected, it is assumed that it will either be within the PHIVIDEC Industrial Estate or further north of PHIVIDEC along the coast. In either case, it is anticipated that the pipeline distribution system will extend both north and south from the location of the terminal, with the southern leg stretching to the northern edge of the City of Cagayan de Oro. The primary mandate of the pipeline owner/operator will be to manage and maintain the high pressure gas pipeline according to prescribed safety standards. The DOE, in its role providing regulatory oversight, will need to cause the owner/operator of the gas pipeline to comply with certain Acts and Regulations beyond those related to the procurement and distribution of natural gas. For example, additional Acts and/or regulations will be needed in the areas of:

- The adoption of international standards for the engineering and construction of these facilities
- Operations and Maintenance practices
- Gas Pipeline Excavation Regulations
- Workplace Health and Safety Regulations
- Dangerous Goods Handling and Transportation of Petroleum Products
- Gas Fired Appliance Regulations.

6.4.3. Marine and Truck Delivery Systems

In addition to the pipeline distribution system, it is anticipated that trucks, making use of existing road networks, and possibly marine options, will be used to distribute LNG from the main terminal to either

individual customers or groups of customers. In the case of groups of customers, these customers would be linked together by localized pipeline distribution systems. In each case where either marine or truck options are used to deliver LNG, a regasification facility will be required to convert the LNG from its liquid to its gaseous state. Due to the cost of these facilities, there will need to be a critical mass of demand for natural gas before such installations will become economically feasible. The initial indications from the market assessment study undertaken here indicates that such critical mass exists in Iligan, approximately 110 road kilometres from PHIVIDEC, and possibly in General Santos. Given that the marine facilities required to serve General Santos are more complex and will require greater investment, it is expected that they will not form a part of the initial build out of the distribution infrastructure on Mindanao, but rather will be developed during future phases.

Where the required critical mass of demand does not exist to justify an investment in regasification facilities, customers can still be supplied with natural gas in the form of Compressed Natural Gas (CNG). CNG can also be delivered by tanker truck and fed either directly to a customer or into a local piped distribution system. CNG is well suited to smaller industrial customers, as well as institutional customers (such as hospitals), large commercial customers (such as hotels) or areas where smaller commercial customers are located in close proximity to one another.

Both the marine and truck distribution systems could conceivably be fully competitive services, but during the initial phase of developing the market in Mindanao, it is recommended that these also fall under the project regulatory model overseen by the DOE. In this way, the selected aggregator will have greater control and influence over the development of the market and will be able to bid more aggressively the overall volume that will flow through the LNG terminal. In addition to approval from DOE under the project regulatory model, the aggregator will also require a trucking franchise from the Land Transportation Franchise and Regulatory Board.

6.4.4. Supply to Bottled CNG Distributors

Another form of distribution to end use customers that can be expected to develop is bottled CNG distribution. Bottled CNG can be used in nearly any application where bottled LPG is currently used. Bottled CNG is commonly used for residential water heating and cooking as well as for similar uses in small commercial applications. Given that there is a fully functioning and fully competitive market for bottled LPG distribution, it is recommended that the bottled CNG market be treated as fully competitive from the outset. In this sense, bottled CNG distributors will become customers of the LNG aggregator. From a regulatory perspective, DOE will need to ensure that current regulations in place to govern the distribution of LPG will be sufficient when applied to the distribution of CNG.

6.5. Customers

There are several main groups or classifications of customers that are expected to consume natural gas once it becomes available on Mindanao. The largest volume of gas coming through the LNG terminal is expected to be consumed by the anchor power plant, which will possibly be co-located with the LNG terminal. Depending upon the location of the power plant, it may or may not be a customer of the pipeline distribution system, but in any case, it will be a customer of the LNG terminal and this power plant will play a critical role in making the economics of an LNG terminal on Mindanao feasible. The size of this anchor power plant has not been determined, but it is likely to be in the range of 300 to 450 MW,

and will likely be designed to operate to provide backup and peaking power to the Mindanao power grid.

Other customers on the island are likely to include industries that require process heat and/or steam in their manufacturing processes, and food processors that require a combination of process heat and cooling capacity in order to keep their products cooled prior to shipping to market. Many of these existing industries also maintain back up generation that could be converted to natural gas, although the need for such backup generation may be reduced in the event that natural gas is used to provide more diverse and reliable grid-connected power generation capacity. The pivotal expected industrial scale use of natural gas is for power generation. Several existing power generators expressed a desire to convert existing diesel and bunker oil-fired generation to natural gas. Others still expressed an interest in adding additional natural gas-fired generation to existing generation resources.

The final set of customers that can expected to be served by the natural gas distribution system are commercial and institutional customers that have either significant water-heating, cooking, or cooling loads. These customers may be served directly by the pipeline distribution system, or indirectly by either CNG tanker truck or CNG bottle distribution.

6.6. Regulation of Distribution Costs

It is recommended the pricing mechanism for the pipeline portion of the distribution system be on a "postage stamp" basis in terms of distance inasmuch as it is assumed the pipeline would only be extended to the critical mass of customers which coalesce within reasonable economic reach of the natural gas terminal. It is expected that each of the large volume customers, be they natural gas fired turbine generation facilities or industrial customers, individually cover the cost of any take-off pipeline requirements from the main high pressure line. Apart from distance, consideration can be incorporated into the tariffs charged by the gas pipeline owner/operator to recognize the different levels of load factor. A higher load factor customer should be afforded a lower unit tariff relative to a customer with a low load factor as this consideration recognizes pipeline capacity rather than distance.

There is likely an economic justification to establish that customers served either by truck-trailer or marine delivery should be subject to differential rates due to the additional capital and operating costs that will be required in order to provide service to these customers. However the decision to establish various rate zones versus the alternative of opting for postage stamp rates for the entire island is as much a social decision as it is an economic one. There are a variety of factors that must be balanced in making such a decision, as inherently that decision accepts a level of cross subsidy between individual customers. The reality is that the setting of rates for any public utility results in cross subsidy from one customer or set of customers to another. The question then becomes what is the acceptable level of cross-subsidy. In a case such as Mindanao, a level of cross-subsidy may be desirable in that higher rates paid by some customers can be used to improve the economic viability of adding additional customers in more marginal regions of the island. This may be beneficial to those same customers that pay the higher rates in that each additional unit that passes through the main LNG terminal will serve to lower the per unit cost of that piece of infrastructure.

The initial distribution system, as outlined in the distribution option portion of this Report should not require any subsidy in order to realize the construction and maintenance of the pipeline system. The

pipeline owner/operator may be required to make payments for certain franchise fees inasmuch as the pipeline will be expected to cross various properties, be they private, public or municipal. Rights-of-way will need to be obtained by the pipeline owner/operator and agreements signed in advance of construction. Such agreements will be subject to DOE review and approval. The pipeline owner/operator should be subject to reporting to the DOE on an annual basis for financial confirmation of its fair rate of return. The tariffs will be reviewed by the DOE on an annual basis and changed only when prescribed by the DOE. The tariffs can be designed to cover different customer categories, once the customer mix has been identified. The tariffs can also be designed with an incentive structure built into them such that higher volumes of gas being delivered (thereby maximizing throughput of the LNG terminal) would result in both lower unit rates for customers and higher profits for the distributor.

It is also important that consideration be given to the implementation of legislation set down for a Regulatory Board. It is in the public interest to ensure rates are just and reasonable for the customers while at the same time, providing a fair rate of return to the operator of the facilities. Such Regulatory Board should have the purview to determine if franchise exclusivity should be granted. It will also have the jurisdiction to set down the structure of the distribution licences. The Board can also exercise its judgement to determine the ideal rate structure for any given participant. For example, the implementation of "postage stamp" rates may be considered appropriate so as to not unduly disadvantage any particular customer or group of customers. Such an attitude would enhance the orderly economic growth of the broader region to the benefit of all concerned. As a system matures, the Board will have the wherewithal to assess the merits of incremental expansion of facilities.

6.7. Regulation of Gas Supply Costs

The cost to supply natural gas to the island of Mindanao should be a pass-through cost to Mindanao consumers both in terms of the LNG supply and the charges related to the LNG terminal. Whether the role of LNG supplier falls to the terminal operator, as is done in some jurisdictions, or a market aggregator, or, as has been recommended here, a single entity that serves as both market aggregator and distributor, the concept of a pass-through cost of gas can been equally applied. The pass-through mechanism can either be contractually agreed upon or set out by the regulator. In either case one of the most important principles is that the mechanism be transparent not only to the oversight agency, but especially so to customers. In the case of Mindanao, it is anticipated that a contractually based mechanism would be most appropriate, especially in the early years; however, in the event that such a mechanism cannot be agreed upon in establishing a contract, a regulatory alternative is always an option.

As it can be anticipated that at least in the early years, there will likely be a single supplier (possibly from many different sources of supply) the contract with that supplier will need to set out rules appropriate to a sole supplier arrangement. The DOE should retain either an oversight and review function, or at the very least an enforcement function in the event that some independent body or party is put in place to arbitrate disputes as to prices or service levels. In this scenario, DOE would be entitled to adjust prices, issue fines, or, in the extreme, suspend or revoke a license. The aggregator, as both supplier and distributor, has a vested interest in maintaining positive customer relationships, particularly in the early years of the developing market place. In this context, a contractually defined, complaint-based method of regulation is very appropriate in these circumstances. The aggregator will want to maintain open and trustworthy relationships and a contract can be established to reflect that. In the event that disputes

arise between the aggregator and customers, the DOE would be charged with receiving complaints, investigating their legitimacy and ruling on appropriate sanctions. Within this context, the aggregator has the option to be as creative as it wants to be in terms of setting rates and sharing information, so long as it keeps customers on-side.

6.8. Safety Regulation

It is recommended that a number of Acts, Regulations and Codes be applied. The product by nature can be hazardous if not managed properly and as such, requires strict adherence by industry parties to comprehensive Acts and Regulations. To the extent gas is transported through the use of a gas pipeline, the implementation of a Natural Gas Pipeline Standard laying out the minimum requirements for design, construction, operations and maintenance requirements becomes imperative. Additionally Regulations such as a "*Gas Pipeline Excavation Regulation*" become imperative to inform and require third parties to act responsibly in the vicinity of the buried pipelines. Furthermore, to the extent, gas is shipped via rolling stock, "*Dangerous Goods Handling and Transportation of Petroleum Products*" becomes important. To the extent gas is sold to gas fired generation facilities and any other industrial facilities, a set of "*Gas Fired Appliance Regulations*" is important.

The indicative contents of various Acts and Regulations most applicable to the subject matter of this report are set out below. It is recognized that the Republic of the Philippines has extensive Acts and Regulations in place and has an established Energy Regulatory Commission. It is suggested that consideration first be given to the establishing an orderly structure for the industry, as fore noted. After which, it can be determined which of the existing Acts and Regulations prescribed can be applied in the noted geographic area and in the circumstances. Amendments can then be drafted as necessary.

The type of regulatory framework discussed here exists in many developed natural gas market places around the world. CGSI recommends that the Philippines initially adopt, from an appropriate jurisdiction, a developed project regulatory framework along with the required natural gas industry specific safety standards and regulations. This framework can be modified overtime as needed and in step with the maturing natural gas marketplace in Mindanao. This approach is consistent with the approach taken by many emerging natural gas marketplaces.

6.8.1. Natural Gas Pipeline Systems Standard

This is the Standard that would cover the design, construction, operation and maintenance of natural gas pipeline systems. DOE Circular 2002-08-005 allows for the adoption of appropriate ISO standards or other international accepted standards approved by DOE. In addition to the standards contemplated in the Circular, the following sections outline additional areas that should be addressed.

6.8.2. Gas Pipeline Excavation Regulations

Gas Pipeline Excavation Regulations establish the requirement for third parties wanting to excavate to contact the owners of buried gas lines and provide notice of their intent to excavate with pertinent details. The regulations would also require the owner of the buried pipelines to provide advice to the person giving notice of the location of any gas pipeline in or near the location of the proposed excavation and to prescribe appropriate methods of excavation. This type of regulation also establishes

safety practices with respect to above ground markers identifying the location of buried pipelines and the initial notification steps to be taking if a pipeline is damaged during excavation.

6.8.3. Dangerous Goods Handling and Transportation of Petroleum Products

Existing acts and regulations will need to be reviewed to ensure their adequacy in relation to the properties of both LNG and re-gasified LNG. These acts can then either be modified or regulations specific to natural gas can be developed. The issues that need to be considered include:

a. Qualifications for Petroleum Technicians Licence
b. Various types of tank installations
c. Alternation of approved storage sites
d. Leak detection devices
e. Product transfer areas
f. Secondary containment
g. Conditions of operating permit
h. Prohibition of storage, except if in compliance
i. Prohibition of delivery, except if in compliance
j. Grounds for refusal of permit
k. Use of tank vehicle for storage
l. Tests of tanking and underground piping

6.8.4. Gas Fired Appliance Regulations

The purpose of Gas Fired Appliance Regulations is to set the minimum safety and quality standards for the products that would be eligible for sale in the Philippines and to establish safe installation standards and practices. These regulations generally focus on the following areas;

a. The process and requirements for gas fitting and gas equipment installers to become licensed.
b. Establishes the classes and scope of gas fitter and installer licences, e.g.,
    i) Industrial Gas Fitter's Licence
    ii) LPG Licence
    iii) Licence renewal
    iv) Loss of licence
c. Identifies and lays out the requirements for installers to apply for and obtain and installation permit for natural gas equipment installations.
d. Lays out the process and requirement for a third party inspection of all gas equipment installations. Specifies the natural gas equipment installation code that will be applicable for Mindanao.

6.8.5. Workplace Safety and Health

As was the case with Handling of Dangerous Goods regulations, existing acts and regulations related to Workplace Safety and Health will need to be reviewed to ensure their adequacy in relation to the properties of both LNG and re-gasified LNG. The existing provision can either be modified or regulations specific to natural gas can be developed. The issues that need to be considered include:

a. Dealing with flammable and explosive substances
b. Ventilation requirements
c. Requirements for safe work procedures to be developed and implemented.
d. Requirements for routine inspections of workplace
e. Notification of serious incidents at workplace is provided to the relevant authorities
f. Record retention requirements
g. The need for risk assessments to be conducted by the employer and requirement of employers to put in place effective risk mitigation plans.

6.9. Role of Government

The Government of the Philippines has a key, though supporting, role in establishing a viable supply of natural gas to the island of Mindanao, and perhaps the entire southern Philippines. This supporting role should be aimed primarily at developing a clear regulatory framework to facilitate the various transactions necessary to make the infrastructure viable in Mindanao. In addition to the framework in relation to the natural gas distribution system, as has been outlined here, the government will also need to provide a regulatory framework that will encourage the long-term lease of an LNG terminal and construction of a regasificaiton facility in order to supply both the distribution system and the anchor power plant. In terms of developing a power plant, the government will also need to establish a clear regulatory framework that will set down terms for a long term power purchase agreement between an independent power producer and the local electric distribution companies in Mindanao.

6.10. Regulatory First Steps

The initial short-term focus of regulation in the area of Natural Gas for Mindanao should be on implementing the minimum necessary quality, safety and consumer price setting and monitoring mechanisms in order to enable the successful introduction of natural gas to the region, while at the same time protecting consumer and public interests.

CGSI recommends that the Philippines initially adopt, from an appropriate jurisdiction, a developed project regulatory framework along with the required natural gas industry specific safety standards and regulations. This framework can be modified overtime as needed and in step with the maturing natural gas marketplace in Mindanao. This approach is consistent with the approach taken by many emerging natural gas marketplaces.

7.0 Conclusion

The market assessment of natural gas potential among industrial users in Mindanao has revealed a substantial potential market, a large portion of which is easily served within close proximity to the potential location of a LNG terminal Northeast of Cagayan de Oro. The forecast cost to import LNG, vaporize the product to natural gas and distribute it to customers is well within range that will make LNG and regasified LNG a viable alternative energy source to both fuel oil and LPG. The Mindanao market is relatively small in global terms, but it can also be served with relatively little investment. The government of the Philippines should proceed to share the information with regard to this market's potential with potential investors and members of the industry who are best suited to making a project like this a reality. The government's role is to set the framework that will make this possible in the short term while working to establish reasonable rules for the industry as it matures over time.

APPENDIX I
MINDANAO LOAD SURVEY FORM

MINDANAO NATURAL GAS ENERGY DEMAND STUDY

THE WORLD BANK

FACILITY INFORMATION:

Facility Name _____
Company Name _____
UTM Coordinates[1] _____
Address or Location _____

Major Product or Industry _____
Number of Employees _____
Operating Hours per Day _____
Floor Area (sq m)[3] _____

PARENT COMPANY INFORMATION:

Parent Company[2] _____
Head Office Address _____
Email Address _____
Telephone _____

FACILITY CONTACT DETAILS:

Contact Person _____
Position _____
Email Address _____

CURRENT FUEL USE:	LPG (ltr/yr)	Coal (MT/yr)	Diesel (ltr/yr)	Kerosene (ltr/yr)	Bunker Oil (ltr/yr)	Electricity (kWh/yr)	Other *pls specify* (_____)	Likely to convert to NatGas in 3-5 yrs if savings in the following			
								0%	10%	20%	NOT
Major Process Loads											
1. Boilers											
Total Connected Load (Btu/hr)											
Annual Consumption											
2. Ovens											
Total Connected Load (Btu/hr)											
Annual Consumption											
3. Furnaces											
Total Connected Load (Btu/hr)											
Annual Consumption											
4. Other: _____											
Total Connected Load (Btu/hr)											
Annual Consumption											
Cooling/Chilling Loads											
Number of Units											
Total Installed Capacity (TR)											
Annual Consumption											
Power Generation											
Total Installed Capacity (kW)											
Fuel Consumption Capacity (Btu/hr)											
Annual Fuel Consumption											

Prepared by: _____ Date: _____
Position: _____ Telephone: _____

Notes: [1] Universal Transverse Mercator GPS coordinates of the facility, if available.
[2] If the facility's company is a subsidiary. Also indicate "government" if government-owned.
[3] Plant floor area or commercial space.

For questions in filling this form, please send email to jrescay@gmail.com

All information declared in this survey will be handled with full confidentiality and for the sole use of the Department of Energy.

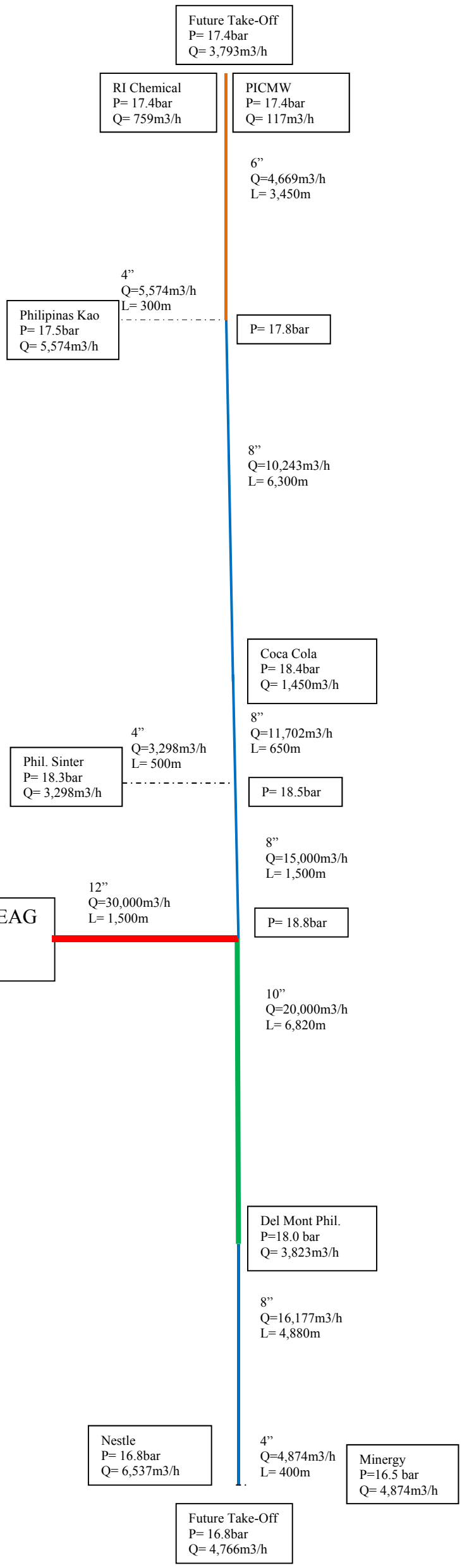
Canadian Gas Services International

APPENDIX II

SINGLE LINE DIAGRAMS FOR PIPELINE DISTRIBUTION SYSTEMS

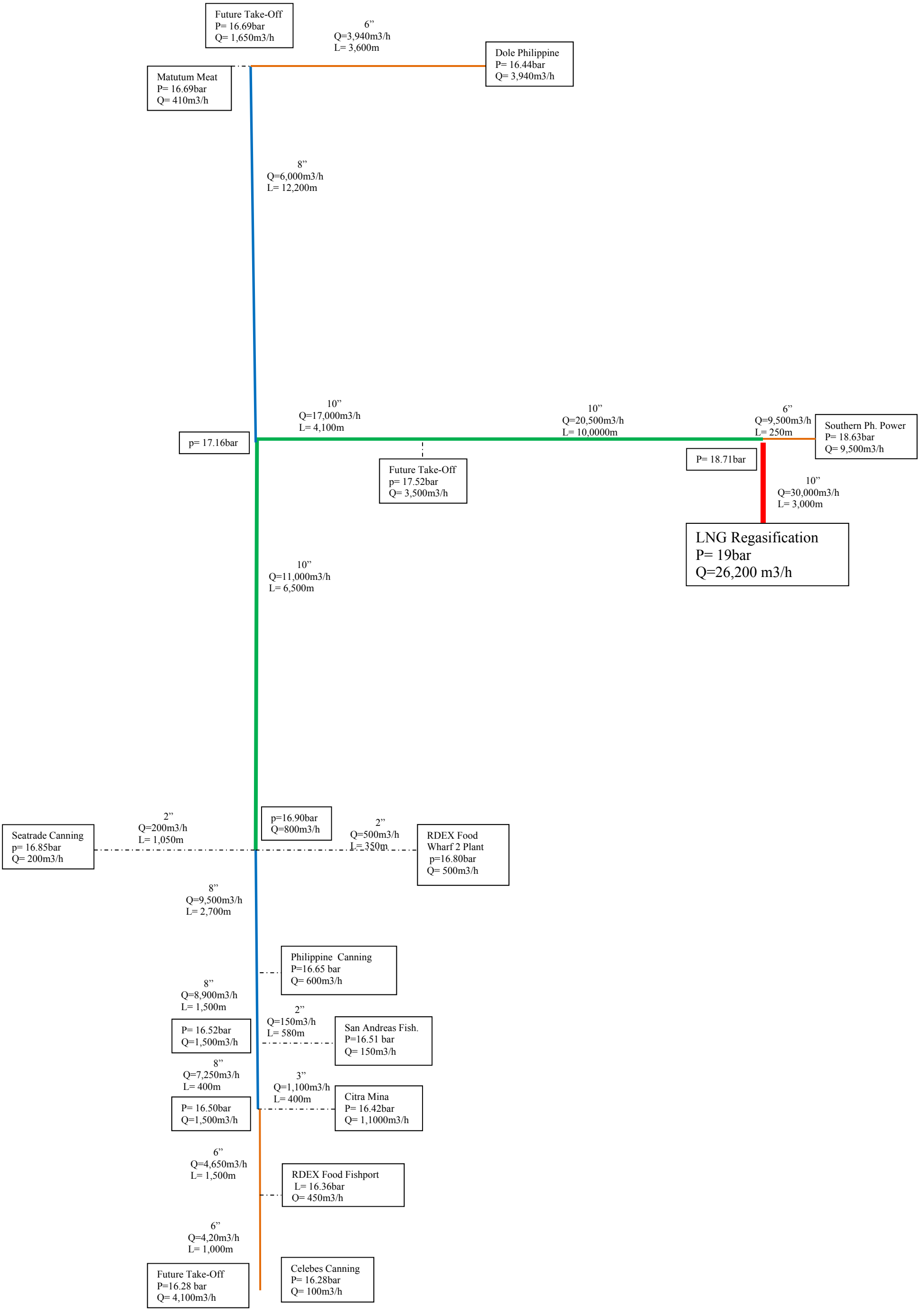
Single Line Diagram – Phividec Pipeline System

Supply Pressure – 19 bar

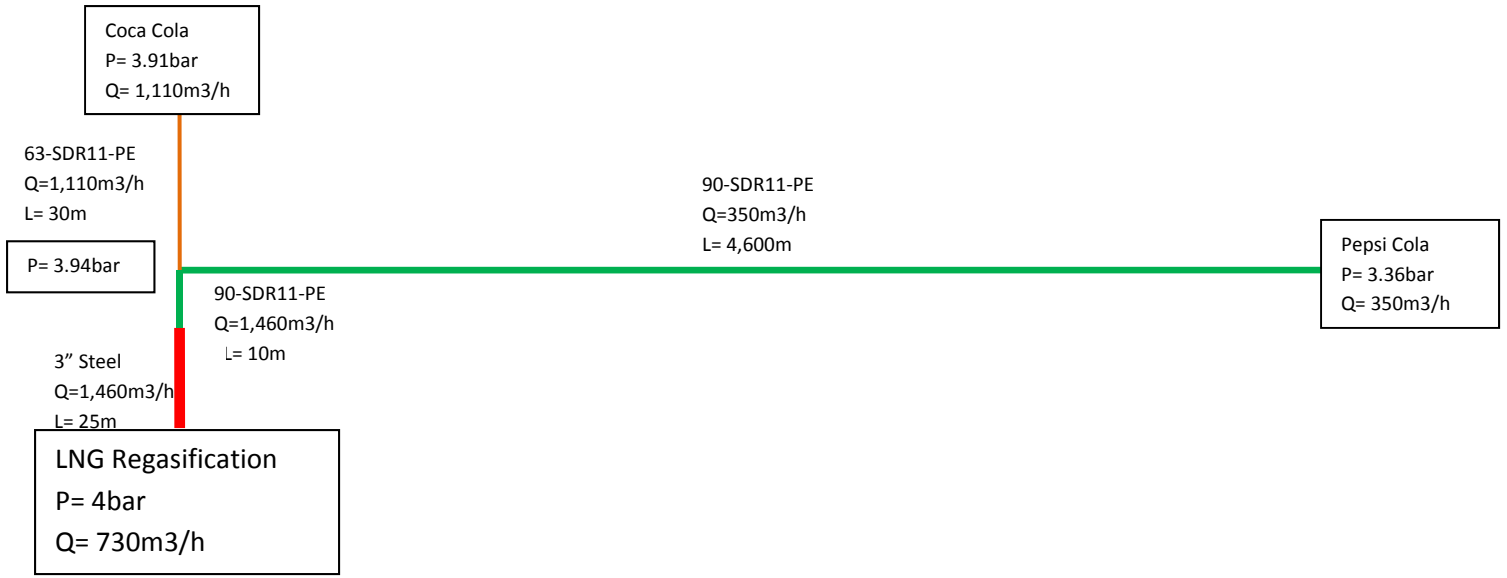


Single Line Diagram - General Santos Pipeline System

Supply Pressure – 19 bar

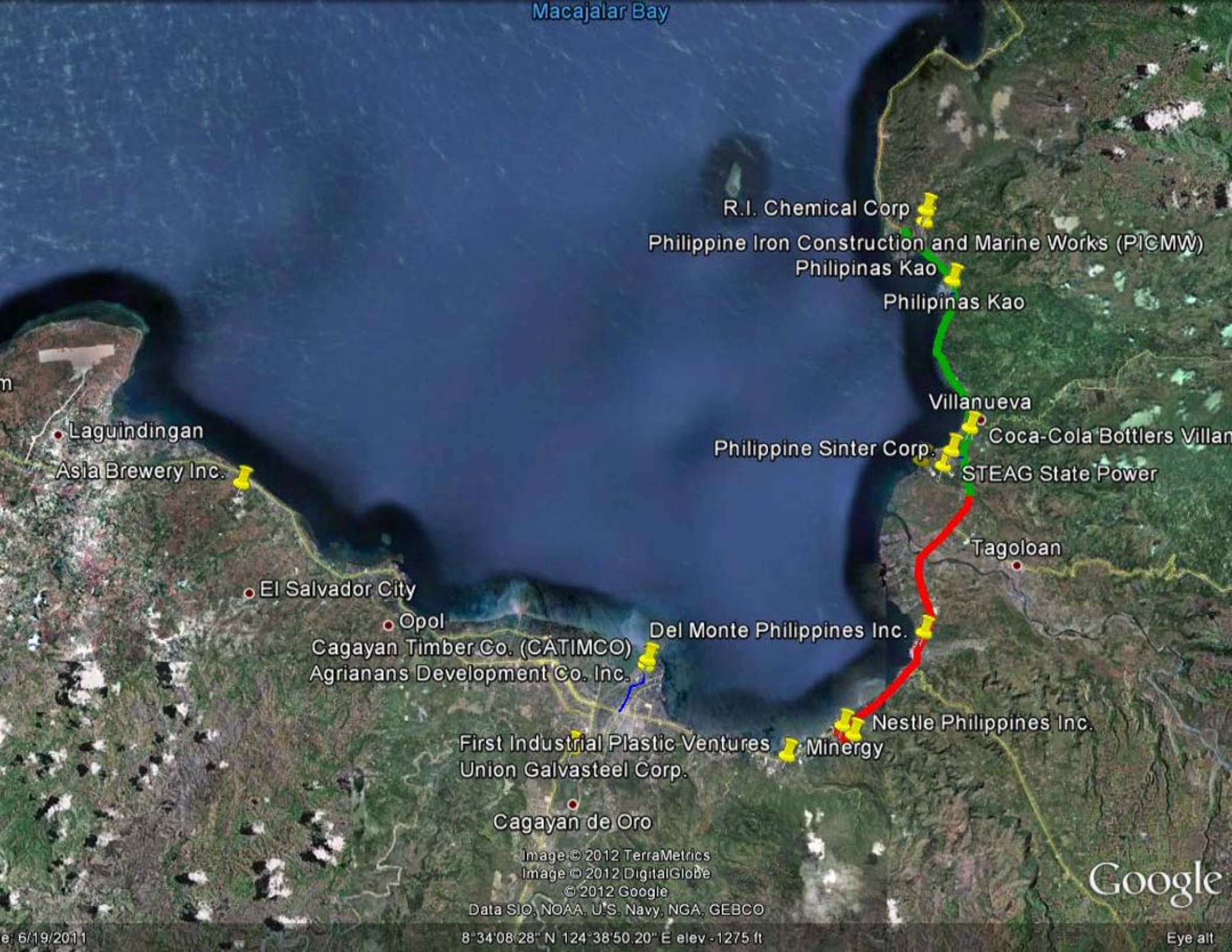


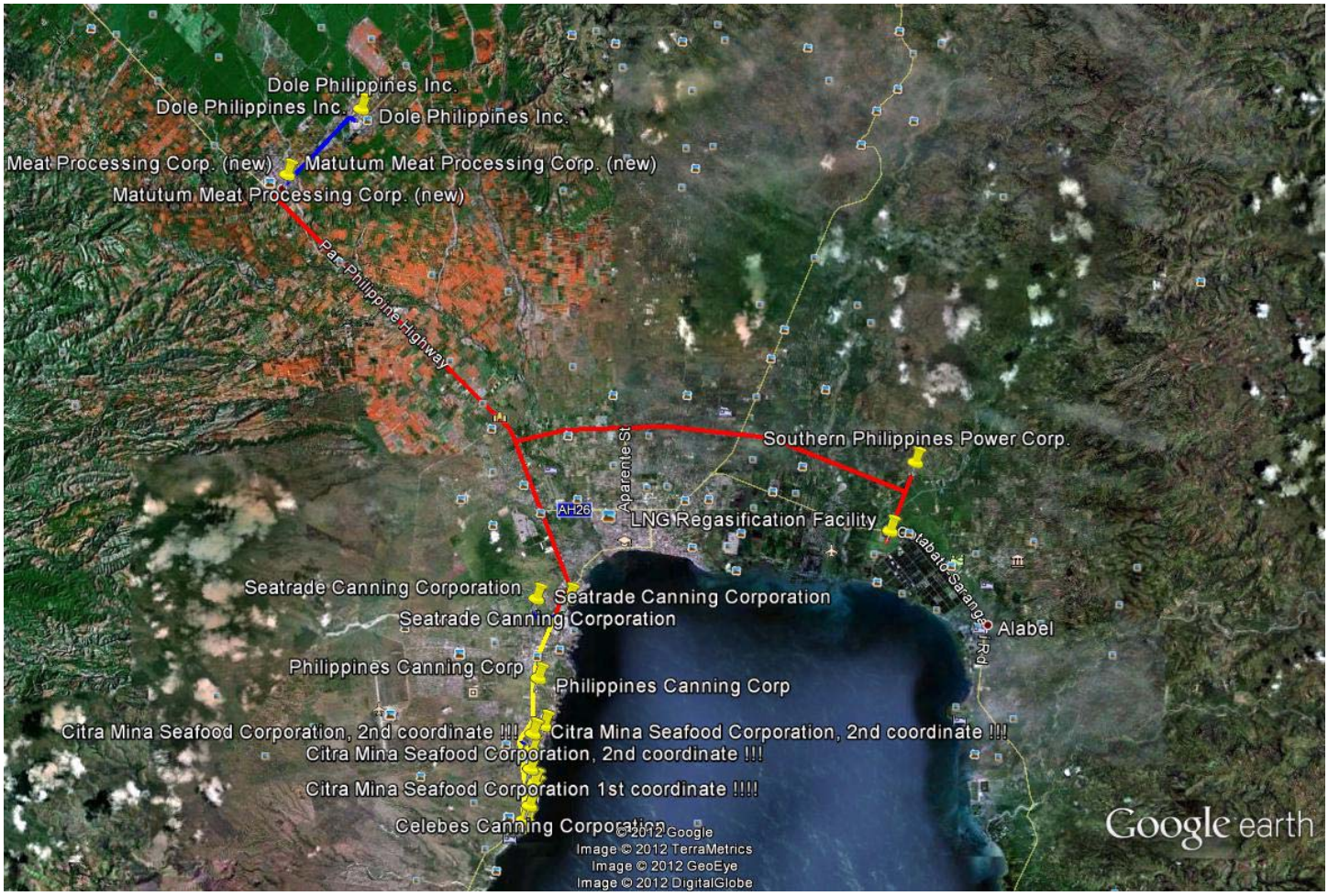
DAVAO – Coca Cola & Pepsi Cola Connection (4 bar System) – Doubled capacity



APPENDIX III

GOOGLE EARTH IMAGES OF CONCEPTUAL PIPELINE DISTRIBUTION SYSTEM ROUTING


Macajalar Bay
R.I. Chemical Corp
Philippine Iron Construction and Marine Works (PICMW)
Philipinas Kao
Philipinas Kao
Villanueva
Coca-Cola Bottlers Villan
Philippine Sinter Corp.
STEAG State Power
Laguindingan
Asia Brewery Inc.
Tagoloan
El Salvador City
Opol
Del Monte Philippines Inc.
Cagayan Timber Co. (CATIMCO)
Agrianans Development Co. Inc.
Nestle Philippines Inc.
First Industrial Plastic Ventures
Minergy
Union Galvasteel Corp.
Cagayan de Oro
Image © 2012 TerraMetrics
Image © 2012 DigitalGlobe
© 2012 Google
Data SIO, NOAA, U.S. Navy, NGA, GEBCO
Google
8°34'08.28" N 124°38'50.20" E elev -1275 ft
Eye alt



Google earth

miles 10
km 20