1. PREAMBLE

1.1 A National Energy Policy and an Energy Plan are being pursued by the Ministry of Mining and Energy consequent on the energy crisis and the necessity to reduce Jamaica's almost total dependence on imported oil for its commercial energy needs, without retarding economic growth.

1.2 With the drastic rise in oil prices commencing in 1973, Jamaica paid in 1980 approximately 32.3% of her annual import bill for oil compared with 9% in 1972. This upward trend is expected to continue. In addition, Jamaica's relative energy utilization is among the highest in the developing world. This is due in part to the fact that much of its industrial base is energy intensive and oil dependent. With little proven conventional energy resources, the development of a well co-ordinated energy policy and plan, incorporating a suitable strategy, are therefore essential, if Jamaica is to survive and achieve a smooth transition from almost total reliance on oil, to other sources of energy, without adversely affecting the economic and social goals of the country.

2. ENERGY POLICY

2.1 The goal within the next 5-10 years, is to maintain or reduce oil imports at 1981 - 82 levels, while maintaining economic growth. The policy objectives through which this is to be achieved, focuses on:

(a) reduction of the dependence on imported oil;
(b) energy conservation;
(c) acceleration of exploration for indigenous hydrocarbon energy resources;
(d) the development of new and renewable energy resources; and
(e) diversification of the present energy supply mix of the energy system.

2.2 Government is aware that there are various energy options available and in order that a realistic assessment of those options may be made in relation to the lead-time necessary for implementation and the cost/benefits which would be involved, the services of specialist energy Consultants were
engaged through USAID to evaluate the country's options.

The result of the consultants report has provided the government with a range of possible scenarios. These have been helpful in selecting the most promising energy strategy.

2.3. The choice between energy options is complicated by the fact that there is no single criterion which can be used to make the choice. Although the primary concern was the role of each option in displacing imported oil, there are a number of factors such as capital costs, employment effects and environmental impacts, all of which are important but incommensurate.

2.4. The general approach adopted in deciding on the option was to start with a projection of future energy - and particularly oil - demand, assuming no alternative energy sources were implemented. Each alternative energy source or option was then characterized by its cost, potential contribution to the national energy system and other criteria.

Generally, a new technology was not introduced into the system until it was considered to be economical, vis-à-vis the world price of oil.

2.5. The total energy demand (excluding the requirements of the bauxite/alumina industry) is expected to increase by approximately 56% over current levels by 1990, i.e. from a current 7.7 million barrels of oil equivalent in 1980 to 12 million barrels of oil equivalent in 1990.

It is further estimated that a combined conservation programme and an appropriate alternative energy strategy as being pursued by the Ministry of Mining and Energy could reduce the dependency on oil as a fraction of total energy needs from just under the current 97% to 64% by 1990.

It is recognised that the projections might be optimistic within that time frame, given the institutional and socio-economic constraints. The planning strategy has therefore been extended beyond 1990. This reduction in the volume of imported oil if achieved, would represent just over 4.32 million barrels per year.

At 1981 prices, this would be worth US$151 million.

At a projected price of US$59/barrel in 1990 (based on a projected increase
of 5% annum) this would be worth US$255 million. It should be noted that the bauxite/alumina industry currently uses about 8.1 million barrels of oil per annum or about 50% of the current total national consumption of about 17 million barrels of oil equivalent per annum but the cost of this is financed off-shore by the companies concerned.

3.0. THE NATIONAL ENERGY PLAN:

3.1. The Energy Plan addresses the policy objectives through a number of programmes and projects concerned with -

(a) Measures aimed at increasing energy conservation and energy economy.

(b) Institutional support for effective implementation of the energy plan and economic transformation; and

(c) The identification and development of local energy resources including the non-conventional sources of energy.

3.2. In view of the time lag required in the identification, research and development in alternative energy projects the strategies being pursued are categorized as -

(a) Near-Term (1 - 5 years)

(b) Mid-Term (5 - 10 years)

(c) Long-Term (over 10 years)

3.3. Based on the consultants recommendations, it has been decided that the most effective methods of reducing oil imports to the year 2020 are -

(a) Near Term (present to 1985)

Conservation in industrial and transportation sectors beginning 1981 - 82; (a major thrust)

implementation of the slow speed diesel option in the JPSCO system (by 1984); and
Alternative Energy Projects such as:

- the use of coal by JPSCo and other specific industries, e.g. the Cement Company. This will replace units to be retired in the JPSCo. system and will significantly reduce the importation of fuel oil;
- solar water heaters for domestic, commercial and residential uses;
- the development of small and medium scale hydropower;
- the use of fuel alcohol in the transport sector from Biomass sources, e.g. sugar cane, cassava, tropical grasses and fast growing trees. The greater emphasis has been on the reduction of oil imports used for electricity generation, but the production of liquid fuel is equally important. The impact of this will largely be felt in the mid to long term, but research and development work will proceed in the near term.

(b) Mid-Term (1985-1990)

- energy conservation in transportation and industry;
- the utilization of coal for electricity in specific industries;
- Ocean Thermal Energy Conservation (OTEC) for electricity generation;
- large scale hydro-power (the Blue Mountain Multipurpose Project);
- urban wastes (garbage and sewage) for power generation, depending on the viability of the garbage collection system;
- liquid fuels from vegetable oils;
- biogas for schools, small farms, villages and small urban projects.
further development and application of appropriate technology for utilizing biomass for energy production;
- the utilization of coal for electricity in the JPSCo system;
- expansion of biogas and its applications in the rural areas for cooking gas, electricity and refrigeration;
- continuation of solar water heating programmes;
- development and utilization of solar thermal energy for power generation.

(iii) Long-Term: (1990 - 2000)

(a) OTEC;
(b) Solar ponds for electricity generation;
(c) High temperature (concentrating) solar collectors;
(d) Large wood based electricity generation;
(e) Urban Waste use for electricity generation;

There are noted overlapping of the programmes within the time spans, i.e. near, mid and long term objectives, but what is clearly seen is the continuity of programme development depending on the lead-times and state of the art technology required for implementation.

4.0 THE GOVERNMENT'S PROGRAMMES:

The measures recommended are largely consistent with the programmes and projects being pursued by the government:

4.1 Near-Term

1. Conservation:

The conservation programme focuses on:

(a) phased reduction in the utilization of petroleum products;
(b) retrofitting and energy auditing for the purposes of identifying energy wastes and increasing energy efficiency in the public and private sectors;

(c) fiscal measures with the objectives of -

(i) rationalizing the pricing and marketing of petroleum products to encourage conservation; and

(ii) encouraging investment in energy efficient equipment.

(d) public education designed to -

(i) educate and inform the public on energy issues relevant to government plans and projects;

(ii) motivate greater energy savings consciousness; and

(iii) encourage the use of new and renewable sources of energy.

4.2 Phased Reduction of Petroleum Products:

A programme concerned with the phased reduction in the availability of petroleum products began in 1979. This started with a target of 10% reduction on controlled petroleum products (i.e. gasoline, automotive diesel oil, kerosene and LPG (cooking gas) during the fiscal year 1979/80 over the 1978/79 period. The actual achievement during the period was a reduction of 7.2%. In 1980/81 a further 10% on the 1979/80 actual consumption was implemented. The actual achievement was 9.3%. The net reduction over the two (2) year period was 15.5% or an annual average of 7.9%. The total saving is approximately US$78 million in part due to the effectiveness of conservation measures and in other part the result of decreased demand consequent on reduced output in the economy.

No further reduction is planned for the fiscal year 1981/82 due to the drastic reduction in consumption in the two previous years (which
is in excess of any percentage reduction target by any other country).

With the expected growth in the economy, and the related anticipated growth in the consumption of petroleum products, a modest net increase of 5% in utilization of those products has been projected for the current year. This increase is essentially related to growth in demand for fuel oil by JPSCo., increase in the use of asphalt for road paving and construction and a small increase in demand for diesel oil for industrial processes.

4.3 Energy Audit/Retrofitting:

The Energy Audit Scheme is designed to identify energy wastes and recommend practical methods of increasing energy efficiency, particularly in industry. Associated with this programme is a proposed Energy Retrofitting Programme which provides credit facilities and expertise for the replacement of inefficient parts and equipment for industry. Energy conservation standards for the construction industry are currently being developed for implementation later this year. Of the forty-three public sector institutions audited in 1980, the energy savings to be realized from retrofitting averages approximately 14% of their current energy usage.

4.4 Government Fuel Policy:

The current policy of Government is that the total cost of importing petroleum products is passed on to the Jamaican consumer.

The Government through the Ministry of Mining and Energy is currently conducting a sectoral survey to determine energy use in the various sectors of the economy. The results of the survey will be used to establish an input/output model as well as for the purpose of determining a rational economic fuels and pricing policy.

At this stage the Ministry of Mining and Energy is examining various incentive programmes for the encouragement of conservation and the development and utilization of alternative energy resources.
Through a proposed programme, Government plans to establish a revolving loan fund which will be available to the private sector for retrofitting and development of alternative energy applications.

Other measures include recommendations for amendment in the Building Code to accommodate energy conservation.

4.5. Public Education Programme:

A major programme for the development of public awareness of the energy crisis and its implications for Jamaica was initiated in April, 1979, and the support of the public and private sectors as well as international agencies was sought. The programme focuses on methods of conserving energy and the use of alternative energy resources. A special new focus is on energy conservation educational thrust at all levels, with special reference to the curricula of craftsmen, engineers and architects. A number of special recommendations by the National Advisory Council on Energy Conservation are being implemented on a phased basis. In addition, given the need to reach rural communities through existing extension programmes, material for the extension workers are being developed for use with other ministries and agencies which might be able to assist.

A survey of the impact of the Public Education Programme undertaken in June 1980, and published in September, 1980, concluded that Public Education as an educational programme for the general population in the efficient use of energy is highly effective and should be continued.

4.6. National Energy Accounting System (NEAS)

The Accounting System is being established to identify and quantify energy inputs-outputs in the different sectors of the economy for purposes of decision-making and estimation of future energy needs. The ultimate objectives will be the establishment of a national energy model designed to assist Government in instituting relatively accurate and appropriate controls on the energy resources of the country.

5.0. II. Alternative Energy

The alternative energy projects focus on the identification, research and development of potential
alternative energy sources. The final goal is the promotion of the utilization of new and renewable sources of energy, with a view to reducing the country's dependency of imported oil. Programmes and projects which include alternative technologies are as follows:

5.1 Bio-Energy:

This includes the research, development and utilization of material of biological origin (excluding peat and fossil fuels) for the production of energy and organic fertilizers. Programmes include:

(a) Biomass Survey:
An island survey is being conducted to quantify the biological resources available and their potential application for energy production. The sources include:

(i) Forest/wood and crop residues;
(ii) crops grown, specially for energy;
(iii) animal wastes/manures;
(iv) other organic waste e.g. urban and sewage.

The project started in March, 1981, and is to be completed in August, 1981.

(b) Biogas:

(1) With the assistance of OLADE the Ministry of Mining and Energy is constructing nine household Biogas digesters in nine parishes for the production of methane gas to be used for cooking. The
estimated volume of gas to be produced is approximately 114 kg. methane/day.

(ii) The Scientific Research Council in co-operation with Ministry of Mining is constructing a 67M³ digester at the Mona Rehabilitation Centre to provide cooking gas and lighting for the Centre. The estimated volume is 109 kg. of methane/day.

(iii) The Ministry of Mining is constructing two 67M³ digesters at Elim Agricultural School for cooking gas with an estimated volume of 218 kg. methane/day. This should be completed by July, 1981.

It is planned to promote this programme through construction of digesters at all Agricultural Schools. The plants will be equipped to provide electricity for lighting and refrigeration.

(c) Wood/Charcoal/Re-afforestation:

In co-operation with the Ministry of Agriculture (Forest Department) a project is being pursued with the following objectives:

- construction and commercial operation of twenty-four (24) charcoal kilns with a production capacity of 1056 tonnes/yr. of charcoal, additional kilns will be completed by mid 1981.
- research, development and identification of suitable species for charcoal production and direct combustion for energy and producing an efficient charcoal stove.

(d) **Electricity Generation from Saw-mill Wastes:**

This project involves the utilization of wood residues from the Twickenham Park Saw-mill being operated by FIDCO. The estimated cost is J$3.3M with an installed capacity of 1.2 MW and unit cost of 8.8 c/kWh. Investigations by FIDCO and the Ministry of Mining are in progress. This will be implemented during 1981. The project will provide the power requirements for the saw-mill with surplus being fed into the national grid.

5.2 **Coal:**

Following a Prefeasibility Report on the evaluation of the possibility of JPSCo., and certain specific industries, e.g. the Cement Company utilizing coal as a substitute for fuel oil, the Ministry of Mining and Energy is to conduct a Feasibility Study this year with a view of establishing coal fired electricity generating systems. Depending on the cost/benefit analyses the first plant should be operational by 1986.

5.3 **Geothermal Energy:**

With the assistance of OLADE the Ministry of Mining and Energy (Geological Survey Department) is conducting a survey to assess the potential of known underground hot
water sources for the production of electricity.
Completion date for this project is scheduled for mid 1981.

5.4 Hydro:

(a) Mini-Hydro - to tap the hydro-electric potential on small rivers and water mains, namely, Rio Cobre, Negro River, East Morant River and Ginger River, Ram Horn Tunnel and the Hermitage Dam. Estimated output is 2.0 MW installed capacity (by 1985).
An all island survey to identify total Mini hydro potential is to be completed by 1981.

(b) Mid and Western Rivers: to supply hydro-electricity from medium size rivers namely:
Great River: 7.7 MW (installed capacity in 1985)
Rio Bueno 0.9 MW -do-
YS River 2.50 MW -do-
Approval has been given for the Great River and Rio Bueno developments while an alternative usage study is to be conducted for the YS River. The purpose of the Study is to determine whether tourism/recreation would be more appropriate than energy development.

(c) Large Hydro - (Blue Mountain Multipurpose Scheme) - large Hydro development which is to be conducted in three (3) phases is categorized as a mid to long term development. However, a feasibility study is now in progress (near term). In the initial
phase the priority is for augmenting the domestic water supply of the Kingston Metropolitan Region with an estimated 10 million gallons per day. Hydro development will be added in subsequent phases as it becomes feasible to produce 55 MW of energy by 1990 - 2000. International assistance is being obtained from the Canadian and Swedish Governments for Mini-hydro. The Swedish Government is also assisting with the Mid and Western Rivers as well as the Blue Mountain Scheme (large-Hydro).

5.5 Oil and Gas Exploration:

The exploration programme has been proceeding on-shore in Northern and Western Jamaica and off-shore in the Pedro Bank. Geophysical data have been acquired and interpreted in relation to both activities. Drilling on-shore should commence by the 4th quarter of 1981, and off-shore by March, 1982. Funding for the on-shore programme is through IADB and the Petroleum Corporation of Jamaica. Off-shore drilling will be carried out through contracting firms.

5.6 Peat/Electricity: (Non-renewable bio-energy)

The resource investigations to determine the quality and quantity of peat for electrical generation from the Negril and Black River Morasses estimated at 80MW for 30 years is completed. An engineering feasibility in relation to exploitation is now to be undertaken. A report on the environmental implications of mining the peat is due in July, 1981, and this will assist in determining the strategy to be adopted in the exploitation of the resource.
5.7 Recovery of Waste Lube Oil:

A feasibility study has been completed on the recycling of waste lube oil. It has been estimated that 25% - 30% of the 2 million gallons of lube oil now imported can be recovered. The capital cost is estimated at J$2.0 million with savings of J$3.0 million. The project has been prepared by the Petroleum Corporation of Jamaica for implementation by an international Agency.

5.8 Solar Energy:

Assessment and development of solar energy potential are being conducted and some projects are already in the implementation stages:

The solar energy projects include:

(i) crop-drying, design of solar collectors and photovoltaics in the research and development stages;
(ii) water heating - implementation programme in the public and private sectors and residential buildings;
(iii) solar stills - construction and installation in schools.

A number of other solar projects e.g. solar pumps for irrigation, solar ponds and solar thermal for power generation are at different stages of investigations prior to feasibility studies and eventual implementation if found feasible.

5.9 Urban Waste:

Preliminary studies previously conducted indicated the possibility of a feasible project for the recycling of urban waste (garbage and sewage) for energy production.
The prevailing problem to be overcome is the lack of an efficient garbage collection system. A proposal for a feasibility study to begin in 1981/82 has been forwarded to an international agency for consideration. Potential power is 15 - 30 MW, with implementation in 1986 - 87. The Capital Cost is to be identified from the Study.

5.10 Wind Energy

With the assistance of the European Development Fund (EDF) an all island survey of wind regimes has been proposed for the identification of suitable sites for utilizing wind energy for water pumping and electricity generation.

5.11 OTEC

Ocean Thermal Energy Conversion of temperature difference of the ocean waters. Preliminary studies have indicated three favourable sites on the north coast with temperature gradients of 20°C. The technology is still in the early stage, but Jamaica has been cited as an area for case studies, i.e. an experimental plant for construction, with a capacity of 10 MW.

Proposed activities beginning in 1981 are:

Phase I - Component Development and Testing
Cost US$4.5 million
Time 2 years.

Phase II - Site Investigations and Preliminary Design
Cost US$500,000
Time (2 years) concurrent with Phase I.

Phase III - Plant layout and Refined Component Development
Cost US$5 million
Time 1 year.
Phase IV - Construction

Cost US$ 70 million
Time 2 years

Provided the experimental station is feasible, additional plants could be added in the 1990's. The Petroleum Corporation of Jamaica is conducting investigations.

5.12 Mid-Term (ii)

The Ministry's objectives in the medium term are:
- further implementations of economically and technically feasible new and renewable energy projects;
- continued oil exploration programme;
- utilization of coal for electrical generation;
- exploitation in peat for electricity;
- utilization of urban and sewage waste for fuel;
- development of large hydro- Blue Mountain Multipurpose Project;
- expansion of biogas and biogas applications;
- Ocean Thermal Energy Conversion
- development of solar thermal energy in keeping with technological advancement
- Energy farm developments; and
- the rationalization of appropriate technologies within the total energy mix of the economy.

(iii) Long-Term:

The long-term objective is primarily the continuation and expansion of the programmes of the near and mid terms as substitutes for oil imports, including the major energy projects, new and emerging renewable energy technologies, energy planning, co-ordination and institutional development.
6.0 ELECTRICITY DEMAND - JPSCOE.

Since electricity supply is a major component of the alternative energy strategies, it is useful to indicate a summary of the demands in different periods and the possible sources of supply. Table I, is based on the JPSCOE average growth rate projections of 4.4% to the year 2000.

### Table I Present and Projected Capacities in MW

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<tbody>
<tr>
<td>Present Capacity (with retirements over-time)</td>
<td>454</td>
<td>418</td>
<td>365</td>
<td>205</td>
</tr>
<tr>
<td>Projected Demand</td>
<td>223</td>
<td>276</td>
<td>342</td>
<td>524</td>
</tr>
<tr>
<td>Installed Capacity Required</td>
<td>323</td>
<td>400</td>
<td>496</td>
<td>760</td>
</tr>
<tr>
<td>New Plant Requirements</td>
<td>0</td>
<td>0</td>
<td>131</td>
<td>555</td>
</tr>
</tbody>
</table>

**NOTES:**

i) Retirement of units is based on an economic life for diesel engines of 15 years, gas turbines 25 years, steam turbines 30 years and hydroelectric plants 50 years.

ii) Installed capacity requirements is calculated on the basis of a 45% reserve above the peak demand. Using this formula the present installed capacities of 454 MW in 1980 and 418 (based on retirements) in 1985 are greater than the requirements.

### Table II Possible Sources of Supply in MW

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<tr>
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<tbody>
<tr>
<td>Coal Plant JPSCOE</td>
<td>-</td>
<td>70</td>
<td>330</td>
<td>6.2</td>
</tr>
<tr>
<td>Peat</td>
<td>-</td>
<td>80</td>
<td>80</td>
<td>4.8</td>
</tr>
<tr>
<td>Slow Speed Diesel</td>
<td>40</td>
<td>40</td>
<td>40</td>
<td>7.8</td>
</tr>
<tr>
<td>Solar Pond</td>
<td>-</td>
<td>-</td>
<td>25</td>
<td>N/A</td>
</tr>
<tr>
<td>OTEC</td>
<td>-</td>
<td>10</td>
<td>80</td>
<td>14-17</td>
</tr>
<tr>
<td>Photovoltaic</td>
<td>0.5</td>
<td>2.5</td>
<td>20</td>
<td>11-22</td>
</tr>
<tr>
<td>EnergyFarm</td>
<td>-</td>
<td>3.0</td>
<td>30</td>
<td>15</td>
</tr>
<tr>
<td>Urban Wastes</td>
<td>-</td>
<td>15</td>
<td>30</td>
<td>5.8</td>
</tr>
<tr>
<td>Hydro - Small</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>5-9</td>
</tr>
<tr>
<td>Medium</td>
<td>8.6</td>
<td>8.6</td>
<td>8.6</td>
<td>7.2</td>
</tr>
<tr>
<td>Large</td>
<td>-</td>
<td>22.5</td>
<td>55.0</td>
<td>13.5</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td>51.1</td>
<td>253.6</td>
<td>700.6</td>
<td></td>
</tr>
</tbody>
</table>
It is to be noted that although no new plant installation is required in 1985, the planning data indicate the economic benefits of replacing inefficient units with new units, thus the use of slow-speed diesel is considered a conservation measure rather than one of expansion. The development of hydroelectric power (a renewable resource) also reduces the dependency on imported oil. Further investigations of the country's small-scale hydro potential will also improve the inputs from this as the sources are identified over time.

Table II shows that with an innovative alternative energy programme, it is possible to produce electricity from petroleum and other sources not presently utilized, while allowing the Government flexibility to adopt the optimum energy mix over time.

The cost to the consumer is in most instances less than the current cost of Jc25.59 (approximately US$14.38).

7.0 RURAL ENERGY DEVELOPMENT

Special attention will be paid to rural energy development as an entity because of its importance in the development strategy for the country. Consequently, emphasis will be placed on energy for household purposes, agricultural processing, commercial and village industries as well as transportation. In this connection, various end use devices, such as lamps, pumps, engines and generators associated with several conversion energy technologies such as biogas systems, photovoltaics, windmills and small hydro technologies will be implemented as they are appropriate to the particular production goals and income constraints of small farmers and others.

8.0. PROGRAMME DEVELOPMENT AND MANAGEMENT

The Energy Division of the Ministry of Mining and Energy is directly responsible for planning, co-ordinating,

.../19 and
and ensuring implementation of all energy programmes and projects in the country. The Division works very closely with a variety of private and public sector agencies, particularly the Petroleum Corporation of Jamaica which is responsible for the development of petroleum resources.

Consistent with the development of the near to long term options, Government is currently planning to strengthen the institutional framework through training of the related personnel to provide the expertise required to efficiently manage and implement the transition from dependence on oil to other sources of energy.

9.0 Conclusion

While it will be noted that there are uncertainties in the economic characteristics of a number of options, the general picture of alternative energy usage in Jamaica indicates the possibility of achieving a reduction of approximately 50% of an anticipated 19 million barrels of oil which would be imported by the year 2000.

It will also be observed that the various options have quite different implications in terms of foreign exchange costs and that some options which do not seem highly favourable in the near-term have other implications, e.g. the Blue Mountain Multipurpose project in supplying domestic water to the Kingston Metropolitan Region and water for irrigation, will also be used for generation of electricity in the mid-term. With regard to coal, the future world price is highly uncertain as it is in the case of oil. The maximum economic returns of the coal option to Jamaica is dependent on large scale usage including the bauxite/alumina sector. Utilization of Peat and Urban Waste on the other hand, is considered to be economic provided certain technical problems are overcome. Preparatory work for these projects should commence in the short term.
Several options exist for replacing oil in the generation of electricity, but there are few options for direct fuel use in households and for the transport sector. Consequently, considerable attention will be paid to the following:

- increased energy efficiency of the transportation sector, including freight transport, urban mass transport and private vehicles. An urban and rural transport study which will deal with issues such as efficient public transport, traffic flows, transport parking, etc., is currently being completed in order to implement an appropriate policy for this sector;

- alternative liquid fuels from biomass including crops such as tropical grasses and from fast growing wood varieties;

- household fuels such as charcoal from "energy tree plantations".

It is expected that through a co-ordination of financial incentives, application of legal provisions, information and advice and of course public awareness and co-operation through voluntary action, government's energy policy and programmes will achieve the goals and objectives outlined in this document.

Ministry of Mining and Energy,
20th May, 1981.