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UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION
Vienna International Centre, P.O. Box 300, 1400 Vienna, Austria
Tel: (+43-1) 26026-0 · www.unido.org · unido@unido.org

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STRENGTHENING NATIONAL TECHNOLOGICAL CAPABILITIES IN THE FIELD OF DEVELOPMENT AND TRANSFER OF TECHNOLOGY*

0061.1

Report of an advisory mission to Jamaica

(5-12 December 1979)

Prepared by William H. Tanaka, Acting Head,
Development and Transfer of Technology Section

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Objective

1. At the request of the Scientific Research Council of Jamaica (SRC), to investigate the situation of science and technology infrastructure in general and R and D activities in particular, and to draw up for SRC an action programme of assistance aimed at strengthening the local technological capabilities in the country as a basis of promoting and accelerating industrial development in Jamaica; and also to identify and recommend ways and means of promoting twinning and co-operative arrangements between SRC and other institutions and organizations in developing and developed countries as appropriate.

Schedule

2. The mission carried out a working programme for the period of 5-12 December 1979, as prepared by the SRC, composed of meetings and interviews with senior officials of SRC, as well as with the UNDP Resident Representative's office. The schedule of meetings as well as the persons met are given in Annex I.

Background

3. The Scientific Research Council (SRC) was established by enactment of the Jamaica Legislature No. 30 of 1960 as amended by No. 39 of 1963, to discharge on behalf of the Government the various functions set out in the Law. In Section 5 of the Law, the Council's functions are amplified inter alia, as follows:

"(1) It shall be the duty of the Council to undertake, foster and co-ordinate scientific research ... and to encourage the application of the results of such research to the exploitation and development of the resources of this island.

(2) In particular, ...

(a) to collect, collate and review information concerning scientific research schemes or programmes relevant to the development of the resources of this island ...;

(b) to co-ordinate scientific research schemes and programmes undertaken ... in this island;

(c) to foster and, ... to undertake and carry out scientific research and investigations relating to -

(i) the development and utilization of the resources of this island;

(ii) the improvement of existing technical processes and methods;

(iii) the development of new technical processes and methods for application to the expansion or creation of industries and to the utilization of waste products;

(d) to encourage persons engaged in any industry to undertake scientific research in connection with such industry on a co-operative basis;

(e) to establish and maintain a scientific information centre for the collection and dissemination of scientific and technical information;

(f) to give any Minister such advice as such Minister may require in connection with any matter on which, by virtue of the provisions of this Law, the Council is competent to give advice."

4. In October 1978 UNIDO, in co-operation with the World Association of Industrial and Technological Research Organizations (WAITRO) organized a Seminar/Workshop which focused on discussing the advantages as well as the ways and means of promoting twinning

and co-operative arrangements between and among R and D institutions in the developing and developed countries. Dr. A.K. Ventura, Director of SRC, who is also the Vice-President and Executive Committee Member of WAITRO, participated in the Seminar/Workshop. Initial discussions were carried out at that time with Mr. W.H. Tanaka, Acting Head of the Development and Transfer of Technology Section of UNIDO concerning advice and possible assistance to be rendered to SRC, in order that SRC could more effectively discharge its tasks and contribute to the industrial development of the country.

5. Further discussions were carried out in May 1979 in New York and August 1979 in Vienna during the UNCSTD. An exchange of correspondence between UNIDO and UNDP-Kingston finally resulted in an official indication of interest by the Government of Jamaica as per cable of Mr. Jouri, UNDP Resident Representative, requesting a mission to visit Jamaica to carry out the tasks as agreed upon.

6. The mission also had the benefit of meeting and exchanging views with Mr. Jouri in November 1979 during his visit to Vienna.

Description of Activities

7. In view of the limited available time, the activities of the mission were organized in the following manner:

(a) to undertake a general overview meeting with the SRC Director, Dr. Ventura, and with the Resident Representative, Mr. Jouri and the Deputy Resident Representative of UNDP Mr. Radovic;

(b) to carry out a general meeting followed by discussions with the senior staff members of various Divisions of SRC;

(c) to formulate potential assistance project proposals identified through the discussions;

(d) to carry out a review of the project proposals with the SRC senior officials as well as with the Chairman/ Director with the aim of identifying the priority ratings of each proposal;

(e) to discuss/report the findings with the UNDP Resident Representative.

8. It should be expresaly mentioned that the activities of the mission, as described in this report, are only an initial step of follow-up actions to be actively undertaken by UNIDO after the return of the mission to headquarters, and it is hoped that appropriate financial means can be found to support the implementation of as many of the projects as possible.

9. The outcome of discussions with each of the Divisions of SRC are described below, focusing only on those project proposals that could be followed up by UNIDO, within the assigned area of competence.

Project Development and Co-ordination Division (Dr. K.C. Lee)

10. The terms of reference of the Division is the initiation and determination of the feasibility of national industrial projects, including the promotion of the commercialization of R and D results for practical industrial production activities. Three main projects were discussed:

(i) Solar Salt and Caustic Soda Manufacturing;

(ii) Utilization of Urban Waste/Garbage for Production of Fertilizer; and

(iii) Biogas Demonstration Unit.

Furthermore, the application of the Technological Services Delivery System (TSDS) was discussed, firstly at the national level for the benefit of the medium and small industries in the rural/non-urban areas of Jamaica, and secondly at the regional level for the benefit of the small island countries of the Caribbean sub-region.

Solar Salt Production - Caustic Soda Manufacture

11. This project has been formulated for building up a caustic soda manufacturing capacity, an important manufacturing component of the alumina manufacturing industries which is ranked as a top priority industry of Jamaica. At present, at least some US$30 million of foreign exchange is spent annually on the import of caustic soda from abroad. SRC has carried out a pre-feasibility study on manufacturing caustic soda taking into consideration the high cost of electric power on the one hand and the abundant deposit of limestone as well as the potential of producing solar salt on the other. The study concluded that there would be a great merit in building up a factory, incorporating the Solvay-Soda-Ash process, although the general trend is to adopt the process of electrolysis of brine. The Solvay method would be the appropriate choice of technology for Jamaica, and it would also eliminate the problem of chlorine disposal.

A twofold feasibility study would be required on:

(a) Solar salt manufacture;

(b) Caustic soda plant based on the Solvay and Lime-soda processes.

The terms of reference of (b), and a report on feasible sites as well as a pre-feasibility study of (a) are given in Annexes II, III and IV.

Biogas

12. SRC has already designed and built a demonstration unit which has been used for cooking and water heating, and the residue used as fertilizer. Further work is continuing for utilizing biogas for lighting, irrigation pumps, generating electricity, etc. and on larger scales. There is a desire on the part of SRC for exchanging information on experiences of other countries with biogas applications. Meanwhile, UNIDO could also seek possibilities of utilizing the SRC knowledge and experience for the benefit of other developing countries.

Fertilizer Production from Urban Waste/Garbage

13. An initial study was carried out by SRC to utilize the urban waste from the Kingston area for the production of fertilizer for the rural agro-needs. The project concept could have a double significance by disposing of the urban waste and simultaneously contributing to the supply of badly-needed fertilizer for increasing the agricultural production of the country. Statistics of import of fertilizers were submitted for reference and are given in Annex V. UNIDO could support the SRC efforts by providing international experts to survey the possibilities of further following up the concept and eventually undertake a feasibility/prefeasibility study.

Technological Services Delivery System (TSDS)

14. The medium and small industries in the urban as well as the rural areas of the island definitely require advice, guidance and support in improving their technological performance. A certain number of advisory services are already being provided, but on an ad hoc basis, and still leave much to be be desired. In the metropolitan area of Kingston, a considerable range of technological services and expertise exist, however, they are not available for the medium and small industries on a day-

to-day basis and in a systematic manner, particularly for those small-scale industries in the rural areas.

15. With the experience and knowledge accumulated through its project in the Philippines, UNIDO could support the SRC to build up a TSDS to sustain the development of the medium and small industries towards improved technological performance thus making a better contribution to the national industrial development plans of Jamaica.

16. A preparatory action plan could be initiated by UNIDO to assist SRC in:

(a) carrying out a survey on the technological services available in the island;

(b) undertaking a survey on the needs and requirements of the small and medium industries in the island, in selected priority branches/sectors of industries;

(c) developing a nation-wide network of technological advisory centres/units by identifying the potential regional centres/units, organizing them into a network-system, and providing guidance needed, training of staff, drawing up the terms of reference, methods of operation etc.;

(d) organizing the TSDS into a functional mechanism based upon appropriate arrangements for securing the co-operation of the technical resource agencies for its substantive support, with the SRC as the focal point of the system.

It would be advisable for UNIDO to recruit an international expert for a period of three man-months to carry out a preliminary study of the TSDS potential and a possible form of TSDS including the identification of priority areas, possible outline of network etc. An official letter of request for

assistance was sent to the UNDP Resident Representative (see Annex VI).

SRC as Centre Par Excellence on Technology Transfer and Development for the Caribbean Sub-Region

17. Discussions were also carried out concerning the possibility of strengthening and supporting the SRC to eventually act as a Centre Par Excellence on technology transfer and development for the small island countries of the Caribbean sub-region. The activities of the Centre could be those of the SRC itself on matters related to R and D in general, including SRC's role/function as a technical and industrial information centre, and the provision of technical services as envisaged within the TSDS activities for the medium and small industries.

18. For this purpose, it would be advisable to organize a sub-regional expert group meeting with the participation of senior representatives for all the island countries, and perhaps a few donor countries who might be interested in supporting the concept. Depending upon further elaboration and discussions, such a meeting might be held, for instance, in Jamaica or the Dominican Republic, during 1980, depending upon availability of necessary financial resources. The SRC has, tentatively, expressed its interest in such an action.

Food Science and Nutrition Division (Mrs. Sadie Campbell)

19. The terms of reference of this Division are to design and implement programmes to promote better nutrition through the judicious use of present and potential food resources. By their nature, the main areas of activity of the Division falls under the mandate of FAO, however a number of potential project ideas were identified.

Upgrading of the Domestic Rabbit Industry

20. Of particular interest was the possibility of training in the

processing of rabbit plez/skins including, eventually, the creation of a small-scale rabbit skin processing industry.

Strengthening the Edible Oil/Animal Feed Industry

21. SRC has been carrying out studies on the utilization of domestically-growing sunflower seeds. The possibility of developing a safflower seed plantation/oil extraction was also discussed, and it was agreed that contacts with the Japanese authorities should be established for further consideration of the idea. Meanwhile, there was a need to obtaining some laboratory equipment , however due to shortage of funds, the plans had to be kept in abeyance. It was agreed that SRC would UNIDO send the technical data of the required equipment for consideration of supply either by UNIDO, UNDP or a bilateral donor country.

Appropriate Technologies for Small-Scale Food Production Technologies

22. SRC was interested in expanding and broadening its knowledge on available technologies for small-scale food processing. It was agreed that the surveys carried out by UNIDO as well as the compilations prepared by UNIDO should be forwarded to SRC for their reference and information.

Agro-Industry Division (Dr. Clinton Chambers)

23. The objective of this Division is to initiate and implement programmes and projects designed to maximize the utilization of agricultural lands and products, as well as to provide technical consulting services. Again, by their nature, a large part of the activities fall under the mandate of FAO.

24. Since its establishment in 1960, SRC has undertaken more than 25 projects of R + D utilizing raw materials and resources available in the country and many of them have resulted in commercial application and production. From the projects ongoing at present, the following are those that may be of interest to UNIDO for assisting in the follow-up:

(a) Essential Oils, Spices and Flavours

25. A considerable amount of work has been undertaken in the search for new essential oils and developing of a commercially viable process of extraction, recently focusing on such oils from pimento berry, pimento leaf, ginger, citrus and local pine. Particular interest is placed on the synthetization of citrus oils to be scaled up to a pilot plant operation. As this process, if successful, could contribute not only to import substitution but also increased export earnings, UNIDO might be able to seek possibilities of funding such pilot operations.

26. Support of such pilot operations could also be considered for other laboratory-level experiments which have favourable prospects for export, such as pimento oil, pine oil etc. A careful survey should be carried out in selecting those projects which should be considered for financial support.

(b) Medicinal Herbs

27. A number of plants have been investigated as suitable for possible extraction of medicinal properties. In view of UNIDO's experience in this area, a short-term project may be formulated to provide the services of an

international expert for a total of about 4-5 weeks. While advising on possible developments, the expert could also formulate projects which may be initiated towards twinning or co-operative arrangements between SRC and other institutions, preferably from developing countries.

Technical Information Division (Ms. Merline Smith)

28. This Division functions as the major organ for collecting, collating, storing and disseminating scientific and technical information, not only to meet the needs of the Council's staff but also those of the nation's scientific and technological community. The services provided include referral and switching systems, general and selected dissemination of information, reference and photocopying, as well as overseas-generated information. The Division also provided the secretariat for the National Science and Technology Information Network (STIN).

29. After exchanging views on possible ways of strengthening co-operation between SRC and UNIDO in this field, and the need to link the services of UNIDO's INTIB (Industrial and Technological Information Bank), the following project proposal emerged:

Study Tour on Strengthening of Information Services

30. It was felt useful if UNIDO could assist by organizing a study tour for senior officials to visit a selected number of information institutions in developing countries to assess and draw guidelines for operations in Jamaica. In order to ensure maximum effect of such arrangements, UNIDO might arrange such a study tour on a group basis, involving a group of countries having similar interest and needs. The study tour might involve a debriefing visit to Vienna where the experience could be put together as a basis for needed follow-up assistance to be provided by UNIDO and/or other appropriate organizations. The duration of the study tour would be about three weeks including travel time.

Renewable Energy Development Division (Dr. Dennis A. Minott)

31. The Division was set up in February 1979, primarily to seek renewable indigenous sources of energy which would assist in lowering the imported fuel costs of the country. From the outset, it was decided by the SRC Director that solar energy utilization would be excluded from the work programme of the Division.

Very interesting and stimulating discussions were carried out along the lines of the following four areas:

a) Mini-hydro generation (MHG);
b) Wood fuels, particularly dead coconut palm wood utilization;
c) Evaporative Roof-Cooling;
d) Biogas Pilot Operation

32. Furthermore, the possible contribution of SRC to the UNIDO on-going project on preparation of a MHG Manual/Handbook including the various inputs needed such as standardization of equipments, system application, civil engineering work was discussed. It was felt that the practical experience accumulated by SRC could be a valuable contribution in further promoting UNIDO's work in this area for the benefit of the developing countries. SRC will submit a proposal on the possible areas of contribution.

Mini-hydro Electric Generation

33. One MHG station has been completed by SRC with the active support and co-operation of three other entities in the form of provision of manpower for construction. The MHG station designed and constructed by SRC is in its last stage of test running, utilizing to a large extent available not-in-use equipment, and involving a minimum investment cost of US$4,000 for the 10 kW station (excluding cost of manpower.)

34. SRC has further completed surveys and feasibility studies on energy potential at eight locations, and implementation funds are being sought at present. Simultaneously, geological surveys, stream gauging and preliminary data assessment of five waterfalls have been undertak...

35. SRC, through practical experience accumulated during the construction of the first MHG plant, has already developed a useful level of knowledge and experience. UNIDO/UNDP could support and accelerate such developments through the provision of an advisor to assess and apply available machines and equipment, presently not in use, for MHG purposes, and simultaneously to look into the possibility of local production of machines, components and parts. The project of some six man-months' service of an international expert might also include a part of the cost of equipment up to US$50,000. The estimated cost of MHG plant Nos. 2-8 are summarized in Annex VII.

Wood fuels

36. SRC has carried out a basic study on the prevailing situation of wood fuels, particularly charcoal, analyzing inter alia: a certain disease which kills the coconut palm trees and leaves behind dead tree trunks standing in flat land plantations; the increasing demand for charcoal resulting from the increase of petroleum prices; the low productivity of small-scale coal pits; the utilization of wood otherwise in demand for export and domestic means to produce charcoal etc. The logical conclusion of the study is (a) to make use of the dead trunks of the coconut palm trees, (b) to develop an improved charcoal kiln (coal pit) for better productivity, (c) to develop an improved charcoal stove etc.

37. UNIDO could assist these efforts by providing the services of an international expert, for which the exact terms of reference, length of service, and other inputs needed are to be further discussed and agreed upon.

Evaporative Roof-cooling

38. SRC has, with the financial support of the National Advisory Council on Energy Conservation, developed a system of intermittent water spraying for roof cooling. Following the completion of designs for a demonstration spray cooler unit at its premises, SRC is presently designing a pilot

commercial unit for a 9,000 sq.ft. Welfare Centre. While the system requires spraying of water to take advantage of evaporation to lower the temperatures of the sprayed roofing, it has demonstrated the possibility of effectively reducing the need for air-conditioning and thus the energy consumption for operating the air-conditioners by 60-70 per cent.

39. Provided the outcome of the pilot commercial unit operation turns out to be as successful as anticipated, it could be of great interest to many developing countries which are located in the tropical zone, and suffering from high energy costs for air-conditioning.

UNIDO could support the further development work of SRC in this respect, and assist in dissemination of the experience of SRC for the benefit of other countries.

Mineral Resources Division (Mr. Neville McFarlane)

40. The terms of reference of this Division is the development and exploitation of the country's mineral resources, as well as to provide services to other public and private agencies and individuals in the form of technical assistance, consultancy and mineral analyses.

Potential projects were identified and discussed.

Acid Resistant Floor Tiles from Indigenous Clay

41. A considerable amount of R + D has been undertaken to produce floor tiles by utilizing local clays and other available raw materials in order to replace their importation and eventually to export them to Caribbean countries and elsewhere. What are considered to be suitable products have been developed at laboratory scale, and the work has now reached the stage of carrying out pilot plant operations, in order to evaluate certain mass production parameters. The equipment required for the pilot operation could also be utilized for other clay-based structural component production, since the production technology for both cases overlap considerably. Following a preliminary market survey,

there seems to be sufficient demand for the products, and it will be expected that provided that the pilot operation shows feasible results, the process technology can be put into commercial scale operation through appropriate investment promotion.

Limestone Utilization Development

42. Due to its overwhelming significance in the economy of Jamaica, the bauxite and aluminia industries have been traditionally given the top priority in the mineral industry sector. The 1978-1982 Five-Year Development Plan has identified several other minerals for development with a view to broadening the mineral basis of the economy. The goals and objectives set forth in the plan specifically call for, inter alia, (i) the development of a diversified local mineral industry based on local mineral resources and providing local employment; (ii) the advancement of national self-sufficiency by developing mineral resources to meet local needs and exporting the surplus; and (iii) maximum local processing of the mineral resources.

43. One of such minerals is limestone which is abundantly available in the country. It is accordingly proposed to initiate an overall and comprehensive project of limestone utilization development, composed of a number of components in an integrated manner. Several such components were discussed extensively. Although not exhaustive, the components of potential project proposals are as follows:

a) Caustic soda production (see elsewhere in this report);
b) Natural whiting from local calcium carbonate deposits.
   - to identify local deposits suitable for processing into natural whiting with respect to quality and quantity of reserve;
   - to identify the grades of natural whiting with export potential;
   - to develop the technology of processing local deposits into exportable grades of whiting.

c) Other surveys, research and development to maximize the use of the extensive resources.

d) Create within and attached to the University of the West Indies Geology Department, a unit which will undertake specific projects of R + D, and simultaneously provide on-the-spot basic training in the theory and practice of the geology and technology of industrial rocks and minerals in general and limestone utilization in particular. The project may eventually develop into the creation of a post-graduate diploma course in industrial minerals open for qualified personnel from Jamaica as well as throughout the West Indies. Limestone is one of the most commonly found mineral resources in the sub-region.

Short-term Expert on Kilns for Ceramics

44. It was identified that a short-term expert of about three man-months to provide guidance and advice to the local technicians in kilns for ceramics would be urgently needed. Such an advisory mission could fall under the SIS Programme (Special Industrial Services) of UNIDO/UNDP, and it was agreed that an official request should be submitted to UNIDO according to the established procedures.

GENERAL MATTERS

The legislative measures establishing the SRC have also enumerated the anticipated effects emerging out of the designated functions described in paragraph 3 of this report. It specifically refers, inter alia, to:

- the co-ordination and monitoring of the nation's scientific and technological endeavours;
- ways in which Jamaica's science and technology infrastructure can be strengthened to aid production;

- improving the island's negotiating ability for the procurement of technologies and to ensure their suitability;
- the upgrading of the nation's existing industries thus rendering them more efficient and competitive;
- the generation of employment for the nation's labour force, and in doing so, the amelioration of the heavy burden of unemployment.

In order to discharge these assigned tasks and duties, it is essential that SRC undertakes specific programme activities, inter alia, in:

- linking the science and technology capacity and capability to the local development objectives;
- strengthening the local science and technology infrastructure;
- drawing up a national science and technology policy to provide the overall framework of activities that fall in line with the national economic and industrial development strategy, and with the appropriate financial and manpower resources allocated;
- taking necessary action in accordance with the national development strategy, policies and programmes.

These activities will have to be carried out parallel to the various sectoral level activities as reviewed and described in the preceding paragraphs. It will therefore be most important to establish a priority list of the activities bearing in mind the relevant time perspective.* Before the elaboration of such a priority list, the description of some projects of a general, overall nature are provided herewith.

Technological Services Delivery System (TSDS)

A description of proposed activities is given in paragraphs 14-18 of this report. The objective of this project is to provide a systematic and continuous delivery of technological and other services to the medium

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* The Five-Year Development Plan 1978-1982, as prepared by the National Planning Agency of the Ministry of Finance and Planning, provides a general guideline to the development of science and technology as well as an overall indication of priority areas, measures, and productive sectors to be pursued during the five-year period. (Chapter B - ix etc.)

and small industries in order to improve and strengthen their technological performance .

Metal Production Development Units (MPDUs)

The metalworking industry is considered as the centre piece of any sophisticated industrialization process. Contrary to the structural set-up in developed countries, the developing countries quite often lack the appropriate industrial infrastructure to serve this industrial sector both in the form of production inputs of metalworking parts as well as of services.

UNIDO has developed two basic modules, (i) for casting and (ii) for metal forming, by adapting the large-scale, modern technologies applied in developed countries to suit the conditions in the developing countries through scaling down, and labour-intensifying them while still retaining product quality and economic production. A most essential part of the modules is the creation of a manufacturing and engineering capability for provision of appropriate technology through adaptation of tools and redesign of products.

UNIDO is at present planning the implementation of a pilot project in a country in Africa with the possible approval of the EEC for financial support from the Lomé Convention - II based upon the priority requests of that country. Negotiations are under way with another ACP country for a similar project. It would be quite possible to initiate a project in Jamaica along the same lines, provided that the Government authority accords the project a high priority in its assistance fund allocations.

ANNEX I

Work Programme of the mission and persons met

5 December 1979 - Arrival in Kingston
Discussions with Dr. Arnoldo Ventura - Technical Director, Scientific Research Council (SRC)

6 December 1979 - Courtesy call and discussion at UNDP
(i) Mr. Jouri, Resident Representative, UNDP
(ii) Mr. Radovic, Deputy Resident Representative
- General Discussions at SRC
Dr. A.K. Ventura and senior officials
- Individual Discussions at SRC
(i) Dr. K.C. Lee, Head, Project Development and Co-ordination Division

7 December 1979 - Individual discussions at SRC
(ii) Ms. Versada S. Campbell, Head, Food Science and Nutrition Division
(iii) Dr. Clinton Chambers, Head, Agro-Industry Division
(iv) Dr. K.C. Lee
(v) Ms. Merline Smith, Officer-in-Charge Technical Information Division
(vi) Dr. Dennis Minott, Head, Renewable Energy Development Division.

8 December 1979 - Preparation of draft mission report (part 1)

9 December 1979 - Discussions with Dr. A.K. Ventura on general scope and orientation of co-operation and assistance.

10 December 1979 - Individual discussion at SRC
(vii) Mr. Neville McFarlane, Head, Mineral Resources Division
(viii) Dr. A. K. Ventura and Dr. K. C. Lee
Preparation of draft mission report (part 2)

11 December 1979 - General discussions at SRC
Dr. A.K. Ventura and senior officials

12 December 1979 - Departure from Kingston

TERMS OF REFERENCE

The report of this study should be in the English Language and quantities in the Metric System of units.

PURPOSE

It is the intention of the Government of Jamaica to establish a "grass-roots" Caustic Soda Plant based on the Solvay and Lime-Soda processes, using local limestone and local salt produced by evaporation of sea water if feasible, or imported salt.

The production of caustic is envisaged to be 300,000 metric tons per annum in the form of 50% solution; additionally approximately 5,000 M.T/annum excess sodium bicarbonate for the detergent and other industries approximately 20,000 M.T./annum sodium carbonate of the dense grade suitable for glass manufacture, and approximat 20,000 M.T./annum excess slaked lime for the building and other industries will be produced.

The purpose of this terms of reference is to describe the services required of the Consultant to investigate the feasibility of this limestone-based chemical industry complex by conducting suitable marketing, engineering, financial and economic studies. The results of these studies are required for the purpose of informing and assisting the Government of Jamaica with sufficiently accurate capital cost estimates and appropriate technical, planning, financial and economic analyses to make an investment decision in respect of the establishment of the limestone-based chemical industry complex.

OBJECTIVE

The Consultants are required to carry out a two-part feasibility study and report on the optimum development of a limestone-based chemical industry complex. Phase I consists of market study, raw materials and site investigations, process engineering and financial analyses. All studies are to be carried out at the optimum complex

size as determined in the market study. Phase II is the execution of detailed engineering, procurement and project management consultancy, erection, operations start-up and manpower training. Phase I will commence immediately upon contract award but initiation of Phase II of the project must be authorised in advance by Owner.

YOUR QUALIFICATIONS FOR MAKING THIS STUDY

State whether in the last 20 years you have been engaged in

(1) conducting a feasibility study similar in nature to this study

(2) designing and /or constructing Solvay/Lime-Soda Plants for producing caustic soda anywhere in the world.

If your answer to the above is affirmative please give particulars of work done.

If your answer to the above is negative please state whether you have access to the technology of the Solvay-Soda-Ash-Casutic Soda Process. Please give this source.

SCOPE OF WORK

In order to fulfill the above purpose and objectives the following work should be carried out by the consultants:

PHASE I - FEASIBILITY STUDY

1. MARKET STUDY

Carry out a market study to determine the following for the products produced by the limestone based chemical industry complex.

(i) Jamaican market demand, customers and prices and demand forecast for the next ten years. The effects of economic growth rates in the countries which consume Jamaica's alumina, the main local user of caustic soda, are to be examined.

(ii) CARICOM countries current demand, supply sources and prices, and demand forecast for the next ten years.

(iii) World industry structure and future development trends as affected by the important economic activities including petroleum pricing trends, and trends in clorinated hydro-carbons demand and pricing.

(iv) World supply/demand balance and trends. The effects of economic growth rates in the consuming countries for the products are to be examined.

(v) Local and international pricing patterns and future development trends.

(vi) Recommended pricing strategy to be adopted for this project.

(vii) Qualities and quantities to be produced by the complex.

2. LOCATION AND EXTENT OF OPERATIONS

(i) Raw Materials

(a) Limestone

Specify additional geological studies and samples necessary to evaluate the merits of alternative limestone mining areas. Carry out necessary laboratory tests on samples. Develop 20 years reserves (5 years measured and 15 years indicated) and identify future reserves of limestone for the proposed industrial complex.

(b) Salt

The feasibility of making solar salt will be undertaken in a separate study.

This present study will be based on using imported salt and will identify sources of supply from over:

(c) Energy

Evaluate the economics of using either coal or oil as the primary energy source, and submit this evaluation along with its conclusions.

(ii) Plant Site

Evaluate potential alternative process plant sites, having regard to -

- Raw materials and markets accessibilities
- Utilities availabilities
- Infrastructure requirements
- Environmental impact
- Land availability and cost.

3. TECHNOLOGY

(i) Alternative Technology

An evaluation of the feasibility of employing the conventional electrolytic process versus the chosen Solvay/Lime-Soda process for the production of caustic soda in Jamaica should be carried out, and the conclusion along with the reasons stated.

(ii) Block Flow Diagram

This will include a diagram and related narrative setting out major components of the limestone based chemical complex processing facilities. On this diagram will be included a single line flow path, the major units and their capacities, the throughput levels, the raw materials input rates and the individual product output rate.

Overall process control system will also be shown.

Reasons for the selection of the process technology chosen including any technological modifications to the basic Solvay/Lime-Soda processes are to be stated.

(iii) Project Specifications

Project specifications detailing recommended codes and standards to be used for establishing design criteria are to be given. The consultants in their

design work shall take cognizance of local codes and standards. Recommendations as to the equipment sparing policy and plant design to ensure safety and ease of maintenance and operation are to be included. Specifications will contain basic process and mechanical information necessary for purchases and/or detailed desig

(iv) Material And Utility Balance

The materials and utility balances for the industrial complex will be provided in terms of mass or weight and where applicable also in terms of volume; utility balance will include water, steam, electricity, fuel, inert gas and air.

(v) Major Facilities

A list of major facilities will be provided and will include items for the on-site process facilities, off-site storage and quarrying, materials handling and transport facilities, required building, fire protection, all mobile land equipment, roads, effluent treatment and disposal. Expected delivery periods for major items are to be included.

(vi) Plot Plan

Provide an overall plot plan for the project which identifies areas such as processing units, storage and handling facilities, services to the site including inter-plant roads, buildings, product shipping and receiving facilities. This plot plan should be specifically related to the recommended site to be indicated in 2 (ii) above and should not be a general layout adaptable to any other site.

(vii) Objective Schedule

Prepare an objective schedule for implementation.

including a bar chart showing the stages of design, engineering, procurement, construction, operator training and start-up.

(viii) Project Organisation

For both construction and operations, manpower requirements by skill are to be shown. The proposed organisational and management structure is to be included.

4. FINANCIAL EVALUATION

All expenditures shall be expressed in US dollars for foreign currency requirements and in Jamaican dollars for local currency requirements.

(i) Capital cost

An estimate of capital investment, including offsites and ancillaries, are to be provided and related to the major facilities list, giving preliminary estimates of site works, materials and labour costs and showing amounts included for contingency, escalation, engineering procurement, start-up costs and working capital.

(ii) Operating Costs

An estimate is to be provided of all operating costs including the various fixed and variable costs, overhead and capital charges.

(iii) Cash Flows

Provide a cash flow over the construction period plus a period of 15 years from start-up together with the discounted cash flow and the internal rate of return on both total capital and on equity. The cumulative assets and liabilities, net present value and pay-back period for the project are to be shown. Supporting

documents should include a total source and use of funds schedule, analysed over time during the pre-start-up period.

(iv) Sensitivity

Provide a sensitivity analysis of the project economics on changes in capital costs, operating costs, market prices and costs of raw materials. The sensitivity analysis on market prices should reflect the price ranges determined by the market study into pricing patterns and future development trends for the products of the industrial complex.

(v) "Turn-Down" Economics

Provide an analysis to indicate minimum through-put at which the project would break even.

(vi) Financing

Provide a financing plan showing sources of funds and reflecting certain financing assumptions given by the Owners.

5. ECONOMIC VIABILITY

Provide an analysis of the economic viability of the project including the net foreign exchange earnings of the project, and the direct and indirect local employment generated by the project.

6. SUMMARY CONCLUSIONS AND RECOMMENDATIONS

Provide a summary of the conclusions and recommendations of this study.

CONSULTANCY

State whether you are prepared to serve as Consultant to the Jamaican Government in the implementation of this project if so requested. The service involved in this Consultancy will include:

(1) Drafting invitations for international bids

(2) Assisting the Government of Jamaica in the evaluation of the qualifications of prospective bidders

(3) Assisting the Government of Jamaica in monitoring the quality and progress of the purchased equipment under construction

(4) Assisting the Government of Jamaica in monitoring the quality, progress and cost of plant construction/erection

(5) Assisting the Government of Jamaica in monitoring the test runs on equipment as well as on the Plant as a whole.

For these consultancy services please quote on a lump sum fixed cost basis the amount that you are asking.

These Consultancy services would be required in conjunction with the other aspects of Phase II of the work.

DSJ/KCL/lh:

23rd April, 1979.

ANNEX III

FEASIBLE SITES
For
SOLAR SALT MANUFACTURE
In
JAMAICA

This report presents the results of an investigation to see if on the island of Jamaica there are sites where solar salt can be made commercially. Major credit in this investigation must be given to Messrs. T.H. Barbours and D.G. Henry of Water Resources Division, Ministry of Mining and Natural Resources, whose untiring and expertise assistance in identifying the soil conditions of the areas under consideration had made possible the conclusion as presented herein. Gratitude is also due to the Meteorological Office, Hathven Road, Kingston, for furnishing without reservation all climatological data required for the study.

SCIENTIFIC RESEARCH COUNCIL

January 1973

ANNEX III

FEASIBLE SITES FOR SOLAR SALT MANUFACTURE IN JAMAICA

Requirements of a Solar Salt Site

A feasible solar salt site must fulfil the following four conditions:-

1. It must possess a climatology favourable to solar salt production; this means it must have a long season in which evaporation is considerably higher than rainfall. Actually Jamaica is not climatologically ideal for solar salt manufacture, because it does not have a real dry season during which there is not a single drop of rainfall. But such climatologically ideal places which fulfil at the same time other requirements of solar salt manufacture are rare any way. As far as Jamaica is concerned the fact that it has a comparably high temperature throughout the year coupled with continuous breeze in parts of the island would result in reasonably high evaporation in many places, and if amongst these places rainfall is found to be low, such places would be considered climatologically favourable for solar salt production.

2. It must be by the sea and reasonably flat (to save on the cost of levelling).

3. The soil on the site must be such that it is impervious to water and strong enough to sustain modern harvesting machines. This is a very important requirement, especially the imperviousness part. Recently, a French solar-salt engineering firm was engaged to make a feasibility study of the Yallahs Ponds for salt making and its conclusion was negative because the soil leaked.

4. The water table must be low so that draining would be possible. In a solar salt operation there are two occasions when drainage are necessary.

   (1) the mother liquor or bittern in the salt crop must be drained away, and

   (2) the surface water is decanted after raining before it has a chance to mix with the bulk of the brine.

Locating suitable sites

From the 30-year mean rainfall curves prepared by the Jamaican Meteorology Office (Fig. 1) it is seen that most of the southern coast and a part of the northern coast fall within the least rainfall region of about 40 inches per annum. The northern coast part is well within the tourism development area and was therefore deemed both uneconomical and inappropriate to place into it a solar salt operation.

The soil composition and property in regions along the southern coastal 40-inches rainfall curve was examined from the report "Soil and Land Use Surveys" carried out by the Regional Research Centre, St. Augustine, Trinidad, and obtainable at the Water Resources Division, Ministry of Mining and Natural Resources, and it was found that two regions had soils that could possibly be expected to meet the requirements of solar salt manufacture. The regions were (1) Old Harbour Bay Region, south of the town of Old Harbour and east of Port Royal and (2) the Parottee - Pedro Region, south of the towns Fullerswood and Park, west of the towns Williamsfield and Watchwell and north of Morrisson's Point (Shaded areas on Fig. 2)

The soil of the Old Harbour Region in question was found to consist predominantly of ledge clay loam while that of the Parottee- Pedro Region was a mixture - in the swamp area peat underlain by clays and the higher area old alluvial soils mainly clay (Black River Morasses Reclamation Project - by Grontmij of the Netherlands).

Records at the Ministry of Mining and Natural Resources further showed that the water table at the Old Harbour Bay Region is approximately at sea level and examination of the area on the 1.5000 topographic series revealed that the majority of the area under consideration was in excess of 5 ft. above sea level. (See Fig. 3)

Records also showed that the depth from ground surface to water table was approximately three feet in the Parottee-Pedro Region (Hall Logs W.R.D.)

Inspection of sites

Trips were then made to these two regions to confirm the nature of the soil, to look over the topography, to see the present use of the site, and to determine approximate area of site available.

(1) Old Harbour Bay Region

It was found that the region was very flat; most of the land was either not in use or for pasture. There was, however, a strip of sugar cane field in the middle of the region. It was estimated total area available was about 2,000 acres including the sugar cane strip.

(2) Parottee - Pedro Region

The region was not all flat and a part was in swamps. Most of the land was not utilized, a small portion was used as pastures. Land of such nature was estimated to be about 8,000 - 9,000 acres.

Examination of areal photographs flown by HASA in 1971 revealed that approximately 5,000 acres was of alluvial soil and 4,000 acres of swamp land.

Estimates of salt production per acre

Rainfall and evaporation data for the Old Harbour Region are not available in the Meteorology Office. But for the Parottee- Pedro Region such data are available and then a rough estimate of unit salt production can be made.

For the Parottee-Pedro, 30-year average rainfall data on monthly basis are available from the Meteorological Offices for Port Charles and Pedro Plains. Port Charles is very low in rainfall and is right in the region under consideration while Pedro Plains is higher in rainfall and is on the northeastern outskirt of the region. To be on the conservative side the mean value of these two stations are used to represent the rainfall of the region for the following estimate of salt production. For evaporation data there is an one-year measurement by the near-by Crawford Meteorological Station. For lack of better data this is used to represent evaporation of the region.

30-year Average rainfall inches	J	F	M	A	M	J	J	A	S	O	N	D	TOTAL
Port Charles	1.3	1.0	1.3	2.6	4.0	2.4	2.1	3.3	3.4	5.5	3.5	1.6	32.0
Pedro Plains	1.2	1.2	1.4	2.9	4.3	3.0	2.2	3.5	3.9	6.4	4.0	1.8	36.1
Mean of Port Charles and Pedro Plains rainfall	1.4	1.1	1.4	2.8	4.2	2.7	2.2	3.4	3.7	6.0	3.8	1.7	34.4...(1)
Evaporation	7.8	5.9	6.2	6.3	6.8	7.5	6.5	6.8	6.0	5.3	4.5	5.0	74.6...(2)
Prime Evaporation (2) x 0.60	4.7	3.5	3.7	3.8	4.1	4.5	3.9	4.1	3.6	3.2	2.7	3.0	... ...(3)
Net Evaporation (3) - (1)	3.3	2.4	2.3	-1.0	0.1	1.8	1.7	0.7	-0.1	-2.8	-1.1	1.3	

In the above table it is to be noted that the evaporation of brine is taken to be 60% of evaporation (which is on pure water). From the table it is seen that during the months of May, September, October and November the net evaporation is negative. So the operation of solar salt manufacture shall begin every year in December and complete the harvest by the end of August of the following year. During these nine months net evaporation is 14.4 inches.

To produce one ton salt from sea water (containing 3% salt), evaporation of water required is $\frac{96}{3}$ = 32.3 tons.

Water evaporated per acre during 9 months of operation is
$\frac{14.4}{12} \times 43,560 \times \frac{62.4}{2,240}$ = 1,460 tons.

∴ Production of salt per acre

$\frac{1,460}{32.3}$ = 45 tons.

For the Old Harbour Bay Region there is no climatological data available. Based on data recorded in stations nearest to the area available the unit salt production is roughly estimated to be 35 tons per acre.

Assuming salt will be imported at $8 per ton (Mexico's offer, present cost is much higher) the yield of salt per acre in monetary value in the Portmore - Pedro Region will be $360 and that of the Old Harbour Bay Region $280, comparable to the yield of good agriculture crops.

CONCLUSION AND RECOMMENDATION

1. With data so far available indications are that there are two regions in Jamaica where climatology and soil conditions are such that solar salt can possibly be made. Yield of salt is estimated to be comparable to that of a good agricultural crop in value; but note must be taken that such land is waste land where no crop is or expected to be grown in the foreseeable future.

2. Salt is indispensable not only for human consumption but also for caustic manufacture; its production is important to the economy of Jamaica. It is worth the effort and money to pursue the matter further.

Therefore, it is the recommendation of the writer that meteorological stations be set up right in the center of these two regions to monitor their climatology and that a number of drills be made in the regions to determine their soil properties and position of water table in order that a decision regarding their feasibility can be reached without a shadow of doubt.

[redacted]

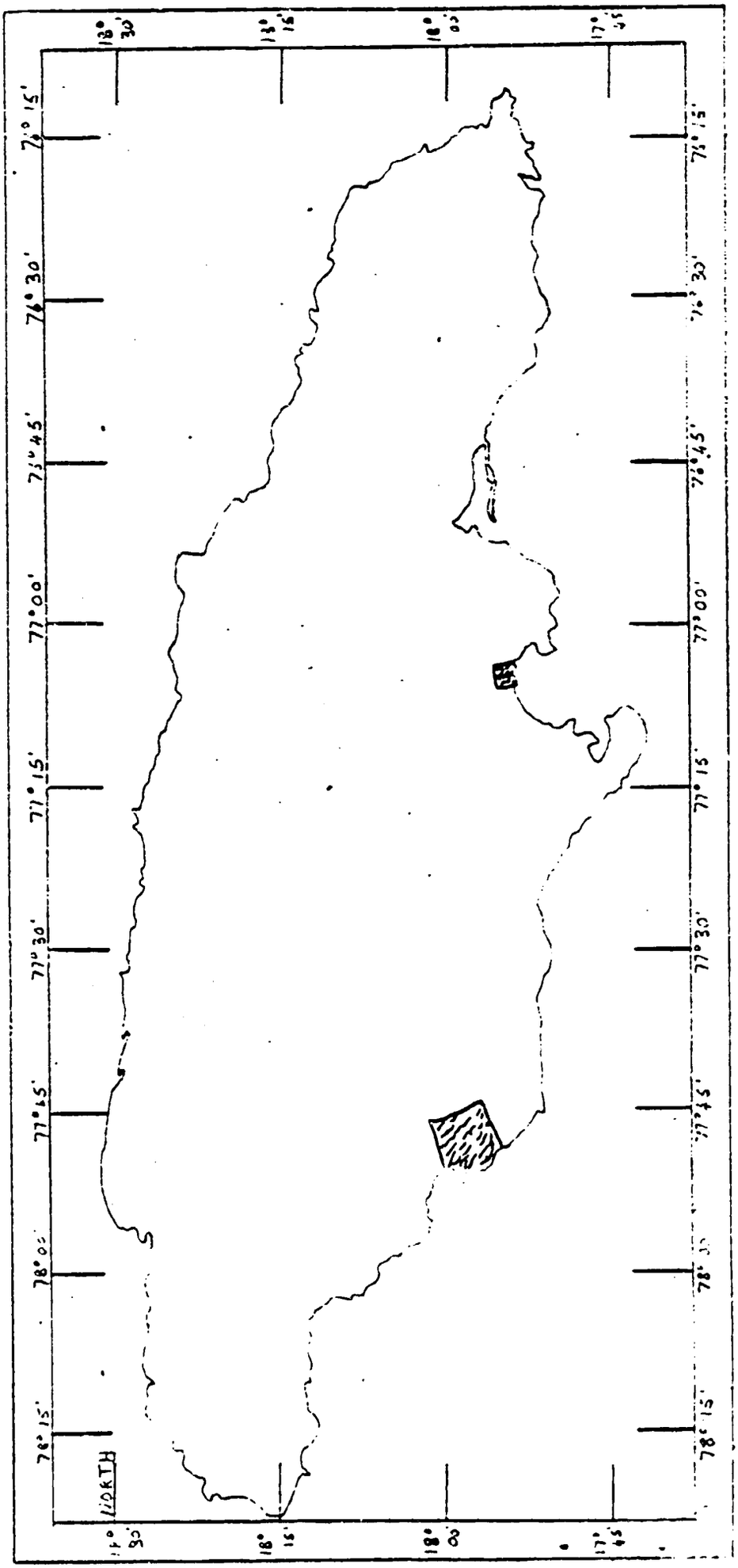


Fig. 2 Feasible Sites for Solar Salt Production (Shaded area)

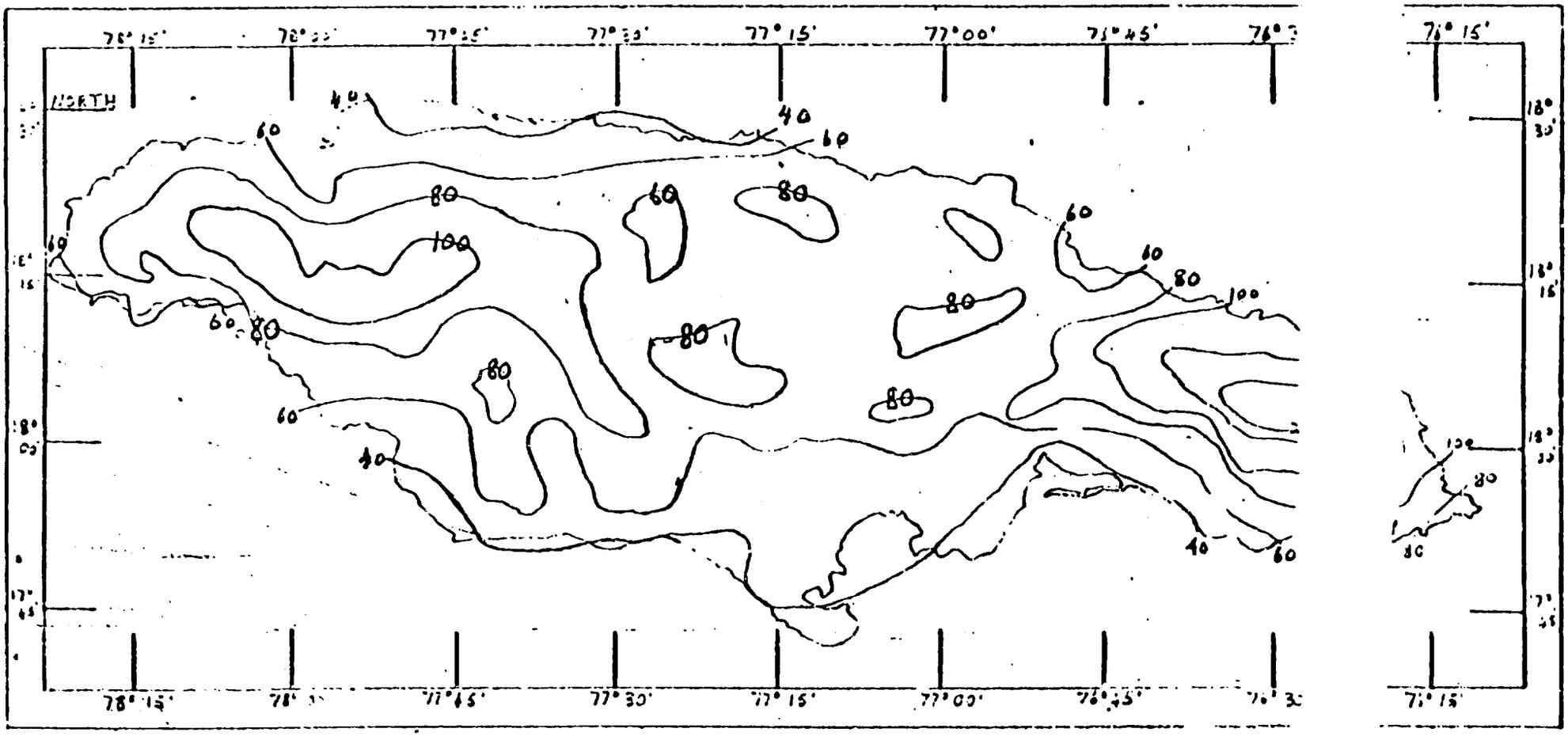


Fig. 1 Mean 30 Year Rainfall (1931- 1960)

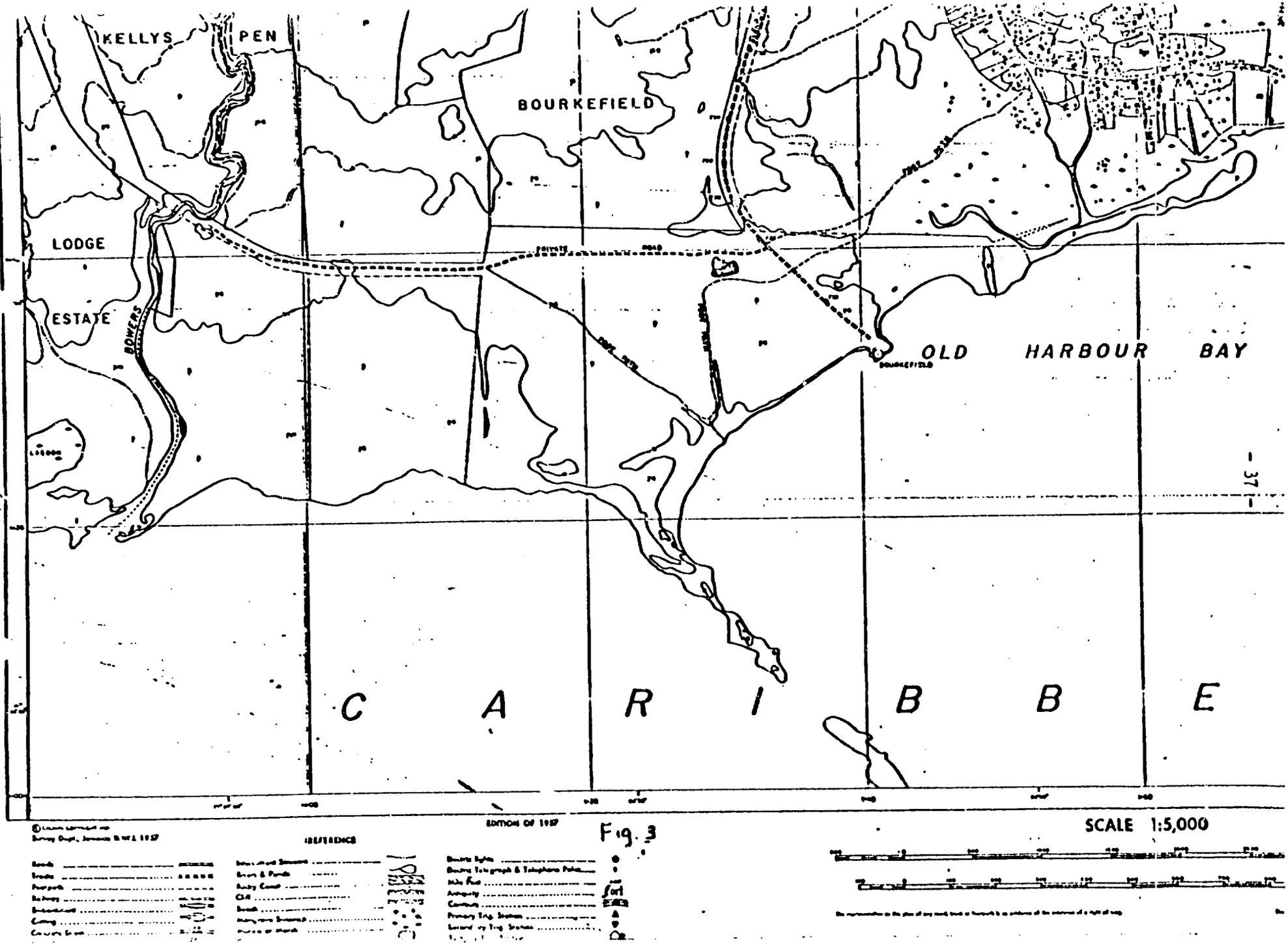

KELLYS PEN
BOURKEFIELD
LODGE
ESTATE
BOWERS
OLD HARBOUR BAY
C A R I B B E
- 37 -
EDITION OF 1957
SCALE 1:5,000

Fig. 3

ANNEX IV

CAUSTIC SODA PROJECT FOR JAMAICA

VIA SOLVAY SODA ASH

AND LIME SODA PROCESS

A PRE-FEASIBILITY STUDY

MARCH 1974

SCIENTIFIC RESEARCH COUNCIL

P.O. BOX 350

KINGSTON 6

JAMAICA. W.I.

CAUSTIC SODA PROJECT FOR JAMAICA

VIA SOLVAY SODA ASH

AND SODA-LIME PROCESS

A study is made to determine whether it is technically practicable and economically viable to establish a caustic soda plant in Jamaica by manufacturing soda ash with the Solvay Process and the subsequent manufacturing of caustic soda with the soda-lime process.

CONSUMPTION OF CAUSTIC SODA IN JAMAICA

Caustic soda is used in Jamaica mainly for the manufacture of alumina from bauxite. The consumption of caustic soda in 1973 was 250,000 LT. Its projected consumption by the alumina companies for the immediate future is as follows :

Year	Projected Consumption of NaOH LT.
1974	257,800
1975	250,000
1976	259,300
1977	304,100
1978	304,100
1979	304,100
1980	304,100

FOREIGN EXCHANGE DRAIN

Before the energy crisis the c.i.f. price of caustic soda was about J$50 per long ton. (Caustic soda was all imported in 50% NaOH solution, the price was on the basis of 100% NaOH). But since the steep rise of fuel costs its price is now quoted at US$70 per LT c.i.f. Jamaica. Based on this new price the drain of Jamaica's precious foreign exchange reserve would be in the order of twenty million dollars every year.

MAKING CAUSTIC SODA IN JAMAICA - BY THE LIME-SODA PROCESS

It has been generally recognized that the drain of foreign exchange by caustic soda would be unavoidable because it is tied up with the manufacture of alumina which is now the one item that earns the largest amount of foreign exchange for the country. The only way to plug up this drain would be to make caustic soda here in Jamaica.

The common method of making caustic soda is by electrolysis of brine. With this process about 3300 Kwh of electricity would be required to produce one ton of caustic. The high cost of electricity would be a problem in Jamaica. Also for every ton of caustic produced 0.875 ton of chlorine will be co-produced, the profitable disposal of chlorine will post a problem.

The other method of making caustic soda is the lime-soda process. It consists of first making soda ash by the well established Solvay Process and the subsequent causticizing of soda ash with lime.

The relative merits of the two methods of making caustic soda have to be studied for each locality and for each set of conditions. For places where a ready market for chlorine exists and electricity is reasonably priced the electrolysis method would be preferred. On the other hand for places like Jamaica, where electricity is comparatively expensive and no profitable way of disposing chlorine is in sight, the lime-soda process is definitely having an edge over the electrolysis method. Additionally, in the long range view a process that consumes less energy would be more preferable to an energy-intensive one.

In early fifties there was a modified Solvay process developed in both West Germany and Japan in which ammonia did not merely act as a carrier of carbon dioxide and was finally recovered as such but actually entered into one of the end products. Thus for every molecule of sodium carbonate produced two molecules of ammonia would be consumed with the co-production of two molecules of ammonium chloride. For the size of the projected plant 135,000 LT anhydrous ammonia would have to be imported and 420,000 LT ammonium chloride would be co-produced.

This process is simpler than the Solvay Process as generation and recovery of ammonia become unnecessary. Chief draw back of the process that prevents it from wide acceptance(Japan is the only country using this process) lies in the difficulty of finding a profitable means to dispose of its co-product ammonium chloride. Though of high nitrogen content ammonium chloride is not an extensively used fertilizer because it is too acidic in character. It is used in rice paddies where its acidity is being diluted in mixed fertilizers in which its acidity is somehow partially neutralized or for areas where the soil is extremely alkaline. Then the production of 420,000 tons a year would be far too much anyway for Jamaica to consume.

DESCRIPTION OF PROCESS

The process which is being proposed for the manufacture of caustic soda in Jamaica consists of (1) the making of soda ash by the Solvay Process and (2) the causticizing of soda ash with lime by the double-filtration process. For causticizing of soda ash the other common process is the counter current washing process. The double-filtration process is chosen over the counter current washing process for the subject project because everything else being equal a more concentrated sodium hydroxide solution will be obtained, resulting in a saving in evaporation cost. This factor is not important when energy is abundant and cheap but under the present circumstances it becomes important and the deciding factor.

(1) Solvay Process of making soda ash:

The chief raw materials for the process are common salt and limestone. Limestone is calcined with coke in vertical kilns to yield lime and carbon dioxide. Brine is prepared and purified. It is ammoniated by passing down scrubbers counter current to the ammonia rising through them. It is then carbonated in the Solvay towers. There the ammoniated brine meets the CO_2 from the lime kiln and the calciners, resulting in the precipitation of sodium bicarbonate. The net result of reactions involved is :

$$H_2O + NH_3 + CO_2 + NaCl \longrightarrow NH_4Cl + NaHCO_3\downarrow$$

The precipitated sodium bicarbonate is removed by filtration. The NH_4Cl solution is treated with lime to regenerate ammonia. The sodium bicarbonate is turned into carbonate by heating in calciners to a temperature of 175 - 225°C.

$$2NaHC_3 \longrightarrow 2H_2O + CO_2 + Na_2CO_3$$

(2) Double filtration process of causticizing soda ash:

The reaction involved in the making of caustic by the lime-soda process is formation of sodium hydroxide and precipitation of calcium carbonate by the action of lime on soda ash.

$$Na_2CC_3 + Ca(OH)_2 \longrightarrow NaOH + CaCO_3\downarrow$$

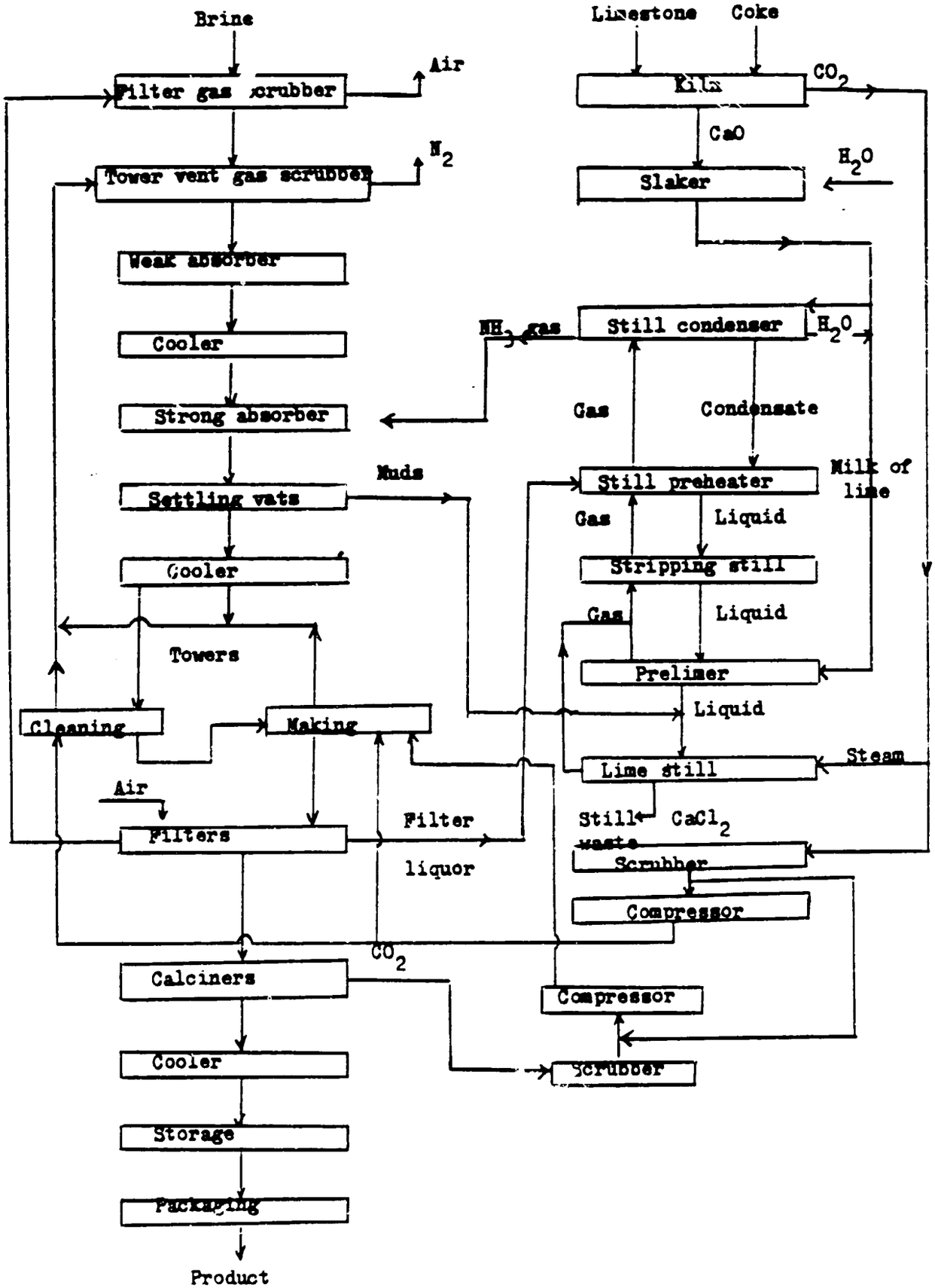
Here again lime stone from which lime is made is the only raw material besides soda ash.

The subsequent procedure after causticization reaction is merely a means to separate the caustic solution from the precipitated calcium carbonate, and to recover as completely as possible the caustic that is retained or absorbed on the surface of the particles of calcium carbonate.

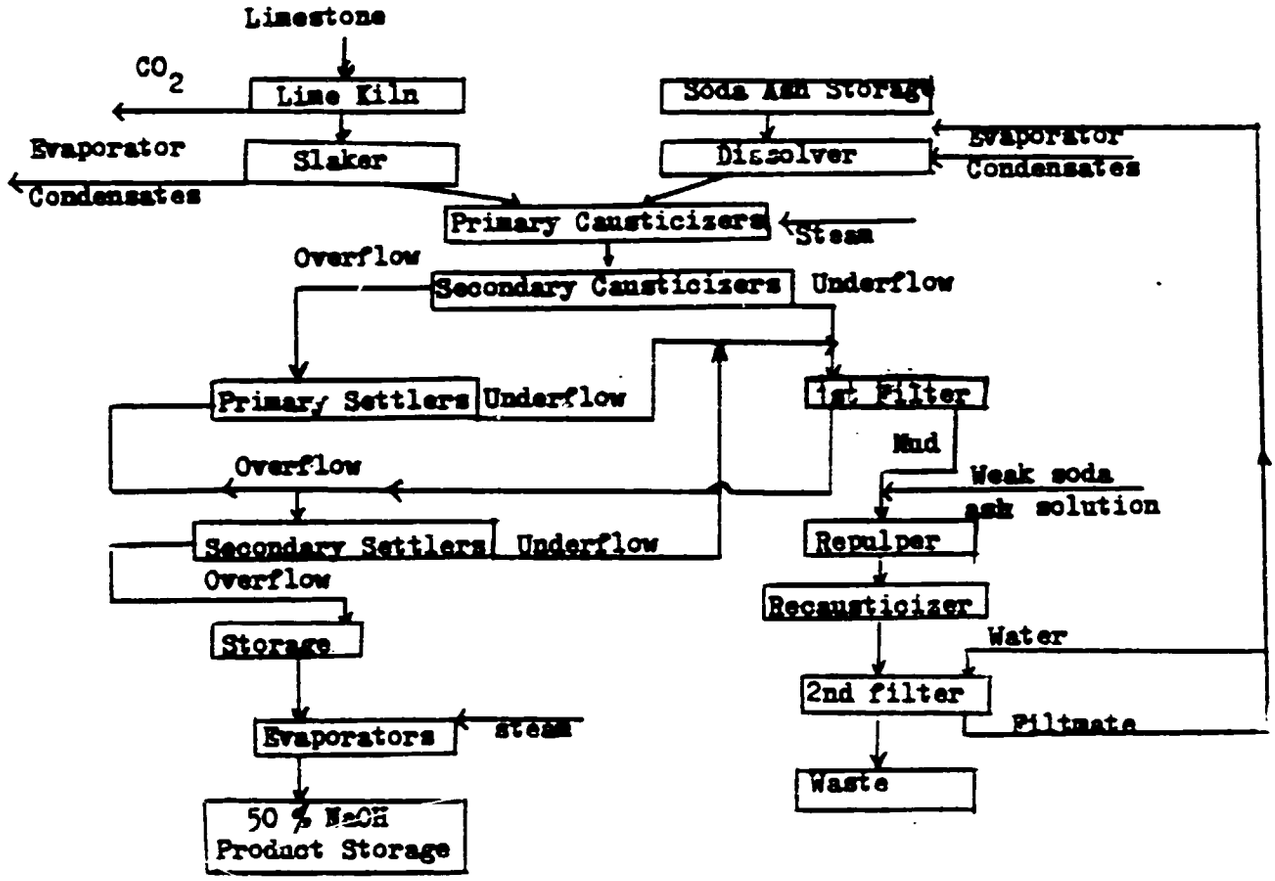
In double filtration process as the name indicates the caustic is separated from the precipitated calcium carbonate by filtration and recovering adhering caustic by washing, repulping of filter cake, and re-filtration. The caustic solution resulting from this process is of 11% NaOH. It is concentrated in multiple effect evaporators to 50% NaOH solution as the final product.

On separate sheet are flow diagrams of these two processes. They indicate in detail the steps involved.

Flow Diagram, Solvay Process of Making Soda Ash



Flow Diagram, Double Filtration Process
of Causticizing Soda Ash



INTEGRATED OPERATION

As pointed out in the preceeding paragraph the chief raw materials for the manufacture of caustic soda by the lime soda process are limestone and common salt. To cut down costs it is recommended that the projected plant operate its own limestone quarry as well as make its own salt by the solar evaporation method.

Limestone suitable for soda ash and caustic soda manufacture should be physically hard and strong and chemically low in silica and iron oxides. Limestone of such quality occurs extensively in Jamaica. A typical limestone analysis gives Loss on Ignition 44.12%, CaO 55.33% SiO_2, 0.01% R_2O_3, 0.15%. It is of excellent quality, most suitable for soda ash and caustic soda manufacture. For our purpose we should acquire a good quarry not only easy to mine but also of proximity to the projected caustic plant site to cut down transportation cost.

UNIDO expert Mr. H.A. El Sharawy made a feasibility study of solar salt manufacture in Jamaica and found it definitely favourable. He recommended West Harbour as a suitable locality for large scale production of solar salt. In this energy crisis the making of salt by means of evaporation of sea water with solar energy should be encouraged against all possible odds. In the judgment of the writer there is no question that solar salt industry can be developed in Jamaica, but whether West Harbour is the right site would require more detailed study.

CAPACITY OF PROJECTED PLANT

To fully meet the anticipated demands for caustic soda, of 300,000 LT a year the projected plant must have a daily capacity of 900 LT. For producing 900 tons caustic, 1240 tons of soda ash would be required. So the capacity of the plants will be designated as follows :

Soda Ash Plant	1,250	LT/D
	1,240	LT/D for NaOH manufacture
	10	LT/D for Sales as Na_2CO_3.
or	416,000	LT/Yr. of 333 operating days.
Causticizing plant	900	LT/D in 50% solution
or	300,000	LT/Yr. of 333 operating days.
Solar salt	470,000	LT/Yr.
	450,000	LT for soda ash plant
	20,000	LT for sale
Lime quarry	860,000	LT/Yr.
or	2,600	LT/D

POWER GENERATION

In the processes of making soda ash and its subsequent causticization, a large amount of process steam would be required. It would be advantageous to generate electric power with high pressure steam and then utilize the exhaust steam for processing purposes. A generator of 20,000 kilowatt is therefore incorporated into the project.

ESTIMATED CAPITAL INVESTMENT REQUIRED

Soda ash-Caustic Plant:			
Equipment		J$31,500,000	
Freight 15% of equipment		4,730,000	
Installation 20% of equipment		6,300,000	
Concrete Constructions, Lime Kilns, Chimney, Foundations		2,000,000	
Buildings		1,500,000	
Land, 50 acres		500,000	
Land Improvement		500,000	$47,030,000
Solar Salt Plant	470,000 LT/Yr.		3,000,000
Limestone Quarry	2,600 LT/D		2,300,000
Power Generation Unit	20,000 Kilowatt		6,000,000
Engineering			4,000,000
Contigency			2,670,000
	TOTAL		$65,000,000

SUGGESTED SOURCE OF CAPITAL

Of the capital requirements the local expenditures plus engineering fees come to about $20,000,000 while the balance is for foreign purchases. Therefore it is suggested that investors will put up the $20,000,000 as equity capital, and a loan of $45,000,000 be negotiated with a suitable bank, such as the World Bank or the Export-Import Bank of the United States.

Equity Capital	$20,000,000
Long-term Bank Loan	45,000,000
	$65,000,000

It is further suggested that the stock-holders of the company be composed of the Government of Jamaica and the consumers of caustic soda, namely, the alumina manufacturers in Jamaica .

The Jamaica Government will hold 50 per cent of the equity and the balance 50 percent is divided among the alumina manufacturers in proportion to their rated capacity of alumina production. The Government's share of the equity, it is further suggested, will be temporarily advanced by the alumina manufacturers, to be repaid without interest with dividends declared by the Company after it is in operation.

DIRECT COST OF PRODUCTION OF SODA ASH

Basis: Per LT Soda Ash Produced

It is calculated on the basis of US figures with due allowance made for Jamaican conditions. (Chemicals 35% added to take in freight and insurance, labour 50% more, and supervision doubled).

			$	$
Salt, LT	1.5	@	*4.40	6.60
Limestone LT	1.08	@	**3.30	3.56
Ammonia, lbs	2.0	@	0.075	0.15
Sodiun sulfide, lbs	2.0	@	0.10	0.20
Coke, lbs	1,45	@	0.02	2.90
Fuel, million B.t.u.	6.1	@	1.45	8.90
Direct labour, man-hrs.	1.50	@	2.00	3.00
Supervision, man-month	0.006	@	8.00	4.80
Maintenance, equivalent labour, man-hour	1.50	@	2.00	3.00
				$33.11

*Based on Mr. Sharawy's (UNIDO expert) estimate of cost of production of solar salt at West Harbour being $2.60 per ton, adding 50% and $0.50 for transportation.

**Limestone production in USA is $1.60 per ton, adding 75% and $0.50 for transportation.

COST OF PRODUCTION OF CAUSTIC SODA

Basis: Per LT Caustic Soda in 50% solution (equivalent to 2 LT 50% NaOH solution)

Limestone, LT	1.4	@	$3.30	$4.62
Soda Ash, LT	1.38	@	33.11	45.69
Fuel, million B.t.u.	5.8	@	1.45	8.41
Direct Labour, man-hr.	0.3	@	2.00	0.60
Maintenance, equivalent labour, man-hour	0.3	@	2.00	0.60
				$59.92

	$59.92
Add Indirect Costs :	
Depreciation of All Plants in 15 yrs. $\frac{65,000,000}{15 \times 300,000}$	14.44
Interest on Capital Investment 6% per annum $\frac{65,000,000 \times 0.06}{300,000}$	13.00
Cost of Production of NaOH	$87.36

SELLING PRICE OF CAUSTIC SODA

In order that the subject project would be able to repay the bank loan in ten years, it must make an annual net profit of at least $450,000, or $15 per ton of caustic sold. This would make the selling price of caustic to be $103 per ton ex-factory.

CONCLUSION

It has been pointed out in an above paragraph that the main raw materials limestone and salt are either abundantly available or readily made on the island. All technical know-hows involved in the manufacturing processes are well established and a number of chemical engineering firms around the world are capable of offering them. And so it is clear that it is technically practicable and physically possible to establish such a caustic soda plant on Jamaica; the remaining question is whether it is economically viable to do so.

Currently the landed cost of one LT Caustic Soda is :

c.i.f. cost	$70.153
Import duty 10%	7.015
c.i.f cost plus duty	$77.168
Consumption tax 5.9%	4.553
Surcharge $0.10 per hundred weight	2.000
Wharfage	1.000
Landed Cost	$84.721

In developing countries a certain form of government protection is usually necessary to allow the infant industry to live and to grow. The Government protection can take the form of customs duty and/or control of import. In Taiwan, for example, it was somehow worked out that generally a new product made locally would be able to sustain if it is allowed to sell at a price 55% over and above the c.i.f. value of the imported product; and the government imposes a duty-tax combination totalling 55%. Of course, in cases where local cost of production is especially high, the industry can present its reasons and request for a higher selling price. And so it is suggested that the Government would raise the import duty and/or the consumption tax to make a total of 55% and permit the subject plant to sell its caustic at the above-proposed price of $103 per LT or thereabouts to be decided after more accurate estimations are possible in a later stage of the progress of project. As far as the alumina plants are concerned the increase of caustic price from $84.72 to $103.00 would mean an increase of $1.3 per ton of alumina, (2% of current price) which should not cause them any difficulty.

Moreover it is to be noted that in the above estimated cost of production for caustic soda $27.44 is for depreciation and interest on investment. After 15 years of operation when the book value of plant is wholly written off and bank loan repaid in full, the subject plant would also be able to sell its product at $70 a ton and still make a profit. This is a convincing reason why an infant industry needs government protection in its early stage.

To conclude, the manufacture of caustic soda via Solvay soda ash and lime-soda process in Jamaica is both technically practical and, with some Government assistance, economically viable. In view of the magnitude of foreign exchange drain involved, it is strongly urged that appropriate steps be immediately taken toward/realization. /its

KCL/ber

March 1974

ANNEX V

IMPORTS OF FERTILIZER 1978/1979*

FERTILIZER:	1978 SHORT TON	1979 SHORT TON	
Ammonium Sulphate	23 727	19 319	
Urea	1 050	2 868	
Triple Superphosphate	1 050	1 042	Antilles Chemical
Muriate of Potash	9 500	5 579	
Diammonium Phosphate	1 498	1 495	
6-18-27	2 500	1 000	
12-24-12	700	900	
16- 8-21	600	-	
16-11-22	500	-	
18- 5-18	1 800	-	
16- 0-24	-	1 000	Shell Chemicals
22- 0-22	3 600	2 500	
18- 9-18	-	700	
7-14-28	300	2 000	
Magnesamon	200	200	
Other	100	700	
T O T A L	47 125	39 303	

* September - December data are based on actual orders placed by the importing agents, therefore data included as estimates.

ANNEX VI

20/1.

December 11, 1979

Mr. Yacoub J. Joury
Resident Representative
United Nations Development Programme
1 Lady Musgrave Road
Kingston 5

Dear Mr. Joury:

Following discussions with Dr. William H. Tanaka, which were prompted by requests for technological guidance and assistance from the Small Business Sector, the Council wishes to indicate its intention to explore the concept of the Technical Services Delivery System (TSDS) which is meeting some degree of success in the Philippines.

We are convinced that it is in the best interest of National development that the expressed technological needs of small and medium-scale enterprises be satisfied as expeditiously as possible by marshalling all the available resources on the Island, as well as those to be found in the region and those available internationally.

A network such as the TSDS will also provide direction for the strengthening and selection of local research and experimental development efforts. Without appearing to be over-ambitious at this stage, it also appears that a functional TSDS in Jamaica may find relevance among the small states in the region.

We therefore use this medium to officially request an exploratory mission from UNIDO to help develop the TSDS Programme concept here. It is anticipated that a three-week mission by an international expert will suffice to complete such an exploration which will form the basis for the institution of a local TSDS Programme. Also, we visualise that funding for this programme could conceivably come from UNDP or any other appropriate funding agency.

Yours sincerely,
SCIENTIFIC RESEARCH COUNCIL

Arnaldo K.Ventura
Technical Director

AKV:wjm:1

CC: Dr. William H. Tanaka.

COST ESTIMATE OF MHG PLANTS NOS 2-8 (in US$)

MHG Plant

No. 2 (140 kW)	18,000	8,800	26,800
No. 3 (231.5 kW)	23,000	12,800	35,800
No. 4 (495 kW)	27,790	10,500	38,290
No. 5 (13.5 kW)	11,470	2,300	13,770
No. 6 (18 kW)	11,750	2,300	14,050
No. 7 (49.5 kW)	12,830	2,500	15,330
No. 8 (183 kW)	20,300	12,050	32,350
T O T A L	$ 125,140	$ 51,250	$ 176,390