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THE FEASIBILITY STUDY
FOR
THE ESTABLISHMENT OF A PULP AND PAPER MILL
IN
THE REPUBLIC OF ECUADOR

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PREFACE

In response to the request of the Government of the Republic of Ecuador, the Government of Japan decided to conduct a survey on the Establishment of a Pulp and Paper Mill Project and entrusted the survey to the Japan International Cooperation Agency (JICA). The JICA sent to Ecuador a survey team headed by Mr. Tadao Kano from 2nd Oct. to 5th Nov., 1982.

The team exchanged views with the officials concerned of the Government of Ecuador and conducted a field survey in the Esmeraldas area. After the team returned to Japan, further studies were made and the present report has been prepared.

I hope that this report will serve for the development of the Project and contribute to the promotion of friendly relations between our two countries.

I wish to express my deep appreciation to the officials concerned of the Government of the Republic of Ecuador for their close cooperation extended to the team.

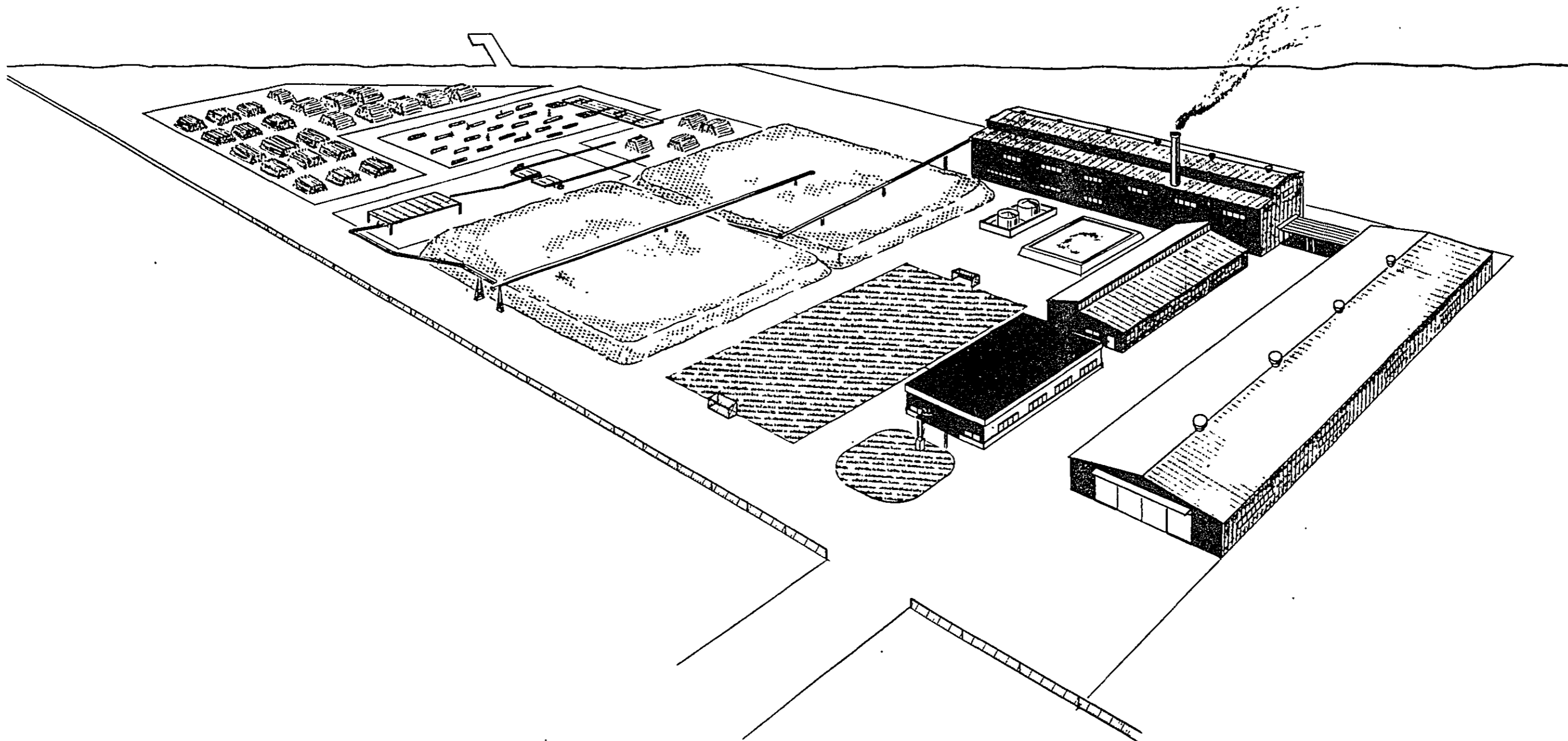
Tokyo, April, 1983

A handwritten signature in black ink, reading "Keisuke Arita", written over a horizontal line.

KEISUKE ARITA

President

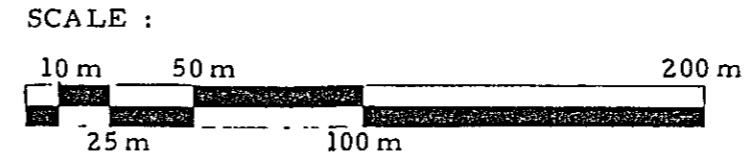
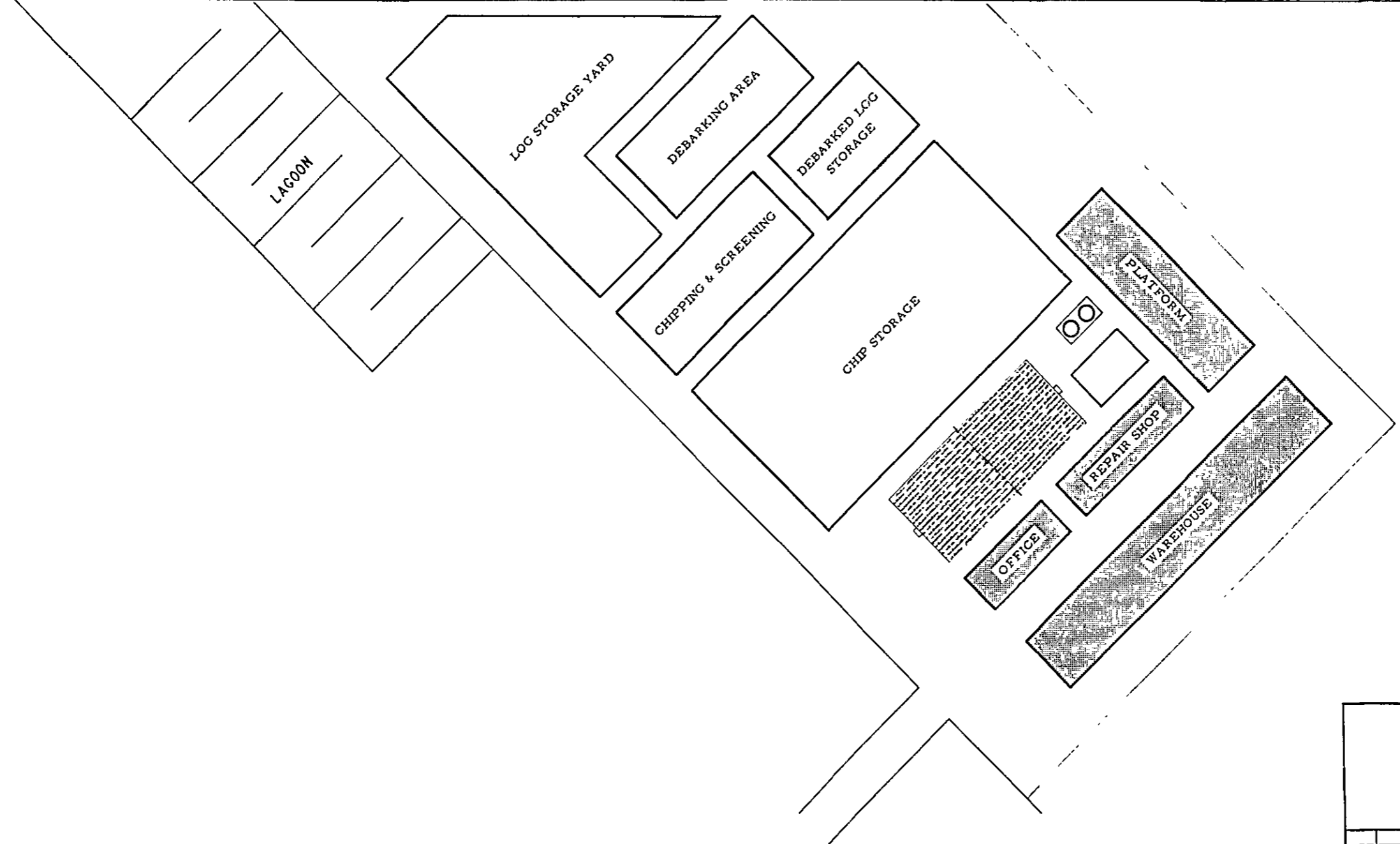
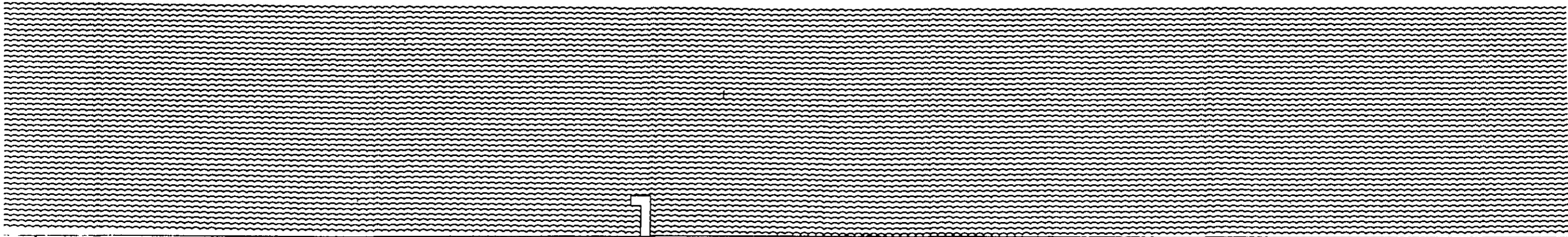
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GOVERNMENT OF ECUADOR
 PULP & PAPER PLANT
 BIRD'S EYE VIEW

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In this report the following currency exchange rates are used:

US.\$ 1 = ¥230 = Sc. 33

ABBREVIATIONS

A.D	Air Dry
A.E.D.D	Armada del Ecuador Dirección Dragado
A.E.I.O	Armada del Ecuador Instituto Oceanográfico
A.P.E	Autoridad Portuaria de Esmeraldas
A.P.G	Autoridad Portuaria de Guayaquil
bb1	Barrel
B.C.E	Banco Central Del Ecuador
B.D	Bone Dry
B.H.D	Breast Height Diameter
BKP	Bleached Kraft Pulp
B.O.D	Biochemical Oxygen Demand
B.S	Paper Bottom Side
C	Chlorination
c.c	Cubic Centimeter
CENDES	Cetro de Desarrollo Industrial del Ecuador
CEPE	Corporación Estatal Petrolera Ecuatoriana
C.D	Paper Machine Cross Direction
C.F.N	Corporación Financiera Nacional
C.I.F	Cost, Insurance and Frieght
cft	Cubic Feet
cm ²	Square Centimeter
C.O.D	Chemical Oxygen Demand
CONADE	Consejo Nacional de Desarrollo
C.S.F	Canadian Standard Freeness
°C	Degree Centigrade
d	Day
D.C.F	Discounted Cash Flow
D.D.F	Dirección de Desarrollo Forestal
E	(Caustic) Extraction
E.I.R.R	Economic Internal Rate of Return
E.R.D	External Resources Division
F.A.O	Food and Agriculture Organization
F.O.B	Free on Board
ft ²	Square feet
°F	Degree Fahrenheit

g	Gramme
gal	Gallon
H	Hypochlotite
h	Hour
ha	Hectare
HEC	Holanda Ecuador Cía. Ltda.
hp	Horsepower
Hz	Hertz
I.B.R.D	International Bank for Rebuild and Development
I.E.O.S	Instituto Ecuatoriano de Obras Sanitarias
I.F.C	Industrial Forestal Cayapas Compañía de Economía Mixta
INCAESA	Industira Cartonera Ecuatoriana S.A.
INCASA	Industria Cartonera Asociada S.A.
I.R.R	Internal Rate of Return
I.R.R.O.E	Internal Rate of Return on Equity
I.R.R.O.I	Internal Rate of Return on Investment
J.I.C.A	Japan International Cooperation Agency
J.I.S	Japan Industrial Standards
kg	Kilogramme
klit	Kilolitter
km	Kilometer
km ²	Square Kilometer
KP	Kraft Pulp
KSC	Kraft Semichemical
KSCP	Kraft Semichemical Pulp
kV	Kilovolt
kVA	Kilobolt Ampere
kW	Kilowatt
kWh	Kilowatt Hour
L.BKP	Hardwood Bleached Kraft Pulp
lbs	Ponds
lit	Litter
L. UKP	Hardwood Unbleached Kraft Pulp
m	Meter
m ²	Square Meter
m ³	Cubic Meter
mA	Mili-ampere
Max.	Maximum

MICEI	Ministerio de Industrias Comercio e Integracion
Min	Minute
Min.	Minimum
M.D	Paper Machine Direction
M.D.F	Ministerio de Finanzas
m.l	Mili-litter
mm	Millimeter
mm ²	Square Millimeter
MW	Megawatt
NSSC	Neutral Sulfite Semichemical
NSSCP	Neutral Sulfite Semichemical Pulp
N. UKP	Unbleached Softwood Kraft Pulp
N. BKP	Bleached Softwood Kraft Pulp
PANASA	Papelera Nacional S.A.
PPI	Pulp and Paper Institute
ppm	Perts per Million
PRCASA	Productora Cartonera S.A.
PVC	Polyvinyle Chloride
REFORMA	Fábrica de Papel La Reforma C.A.
Sc.	Sucre
Sec	Second
SCP	Semichemical Pulp
SS	Suspended Solid
t	Ton
TAPPI	Technical Association of Pulp and Paper Institute
T.S	Paper Top Side
UKP	Unbleached Kraft pulp
U.S.A	United States of America
US.\$	United States Dollar
V	Volt
y	Year
¥	Yen
%	Percent
°C	Degree Centigrade

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SUMMARY

SUMMARY

1. The Government of the Republic of Ecuador requested the Government of Japan to conduct a Feasibility Study on the establishment of an integrated pulp and paper plant for utilizing a vast National Resource of primeval forest containing mixed tropical hardwood in the Region of San Lorenzo, Province of Esmeraldas, in the northwest coast of Ecuador.

Upon the request of the Government of Japan, the Japan International Cooperation Agency undertook to assign a Study team to Ecuador, to evaluate the feasibility of the Project.

2. A Pre-feasibility Study mission was dispatched to Ecuador in Advance of the above-mentioned Study team, and consulted with the Ecuadorian counterpart organizations on the basic items to be taken up by the envisaged Feasibility Study, and agreed upon and signed contracts with the Ecuadorian counterpart organizations during a visit extending from July 10 to 24, 1982.
3. Based on the above-mentioned contracts, the present Study team visited the regions associated with the envisaged location of the Plant, and upon return to Japan, detailed examination was made of the assembled information and data.

The present Report embodies the results of this examination.

4. The present Feasibility Study has an objective to evaluate the feasibility of a Project for utilizing the mixed tropical hardwood obtainable from the Cayapas Forest Concession of the national forest in the Region of San Lorenzo, Esmeraldas Province through the establishment of an integrated pulp and paper plant to produce either (a) corrugated board (kraft liner and corrugating medium), or (b) printing/writing paper, with a view to (a) saving the outflow of foreign currency by reducing imports of corresponding products, (b) enhancement of employment opportunities, (c) assimilation of papermaking technology, and at the same time to contribute to (d) economical development of the Region of Esmeraldas.
5. The Feasibility Study is to cover an integrated evaluation - based on technical and economical criteria - of the alternative cases of adopting as final product (a) corrugated board

(kraft liner and corrugating medium) and (b) printing/writing paper, to appraise the business prospects and to examine the means of realizing the projected Plant.

6. For achieving the objectives and for covering the scope of the Feasibility Study set forth in the preceding item, the following items have been taken up as subject of investigation.

- 6.1 Established Ecuadorian national policy

To ascertain the established Ecuadorian national policy concerning the pulp and paper industry, and to find out the priority that should be expected to be accorded to the present Project among other national development plans; to determine the impact expected to be exerted by the Project on the Ecuadorian national economy.

- 6.2 Market study

To ascertain the market that exists for paper and paperboard, and with consideration given to the available supply of pulpwood, to determine the optimum scale of operation for the envisaged Plant individually for the alternative cases of manufacturing kraft liner, corrugating medium and printing/writing paper.

To survey also the market for sawlog and plywood, with the view to integrated utilization of the available timber, and to determine the possible outlets for the wood susceptible to utilization as sawlog and plywood, as generated by the exploitation of the existing forest; to determine also the optimum volume of such supplies.

- 6.3 Raw materials – Forest resources and auxiliary materials

To survey the existing forest volume, the effectively utilizable portion thereof, the means of logging and transfer of pulpwood to pulp plant; to conduct pulping tests to determine the species adapted to use as material for pulpmaking.

To survey also the practical means of procuring the requisite auxiliary materials, their market prices, and possible problems in ensuring their stable supply.

- 6.4 Technical considerations

To select the site most adapted for installing the envisaged Plant; to study also the

means of ensuring the requisite supply of utilities, of realizing the requisite infrastructure.

To further select the most suitable process for pulpmaking, on the basis of pulping test results; elaborate outline plans on the requisite production equipment, organization and personnel; select the most adapted system of plant construction; draw up the guiding principles for plant operation.

6.5 Reforestation

To establish plans for the reforestation of area cleared for pulpwood supply, with consideration given to environment conservation.

6.6 Total investment cost for Project implementation

The total investment costs for Project implementation are estimated based on the combination of product and construction system.

The financing of funds required for Project implementation are envisaged based on the consultation with the Ecuadorian counterpart.

6.7 Financial and economic analysis

The envisaged Project is analyzed and evaluated from the financial and economical aspects.

The most suitable Project is selected from the financial analysis based on the combination of product and construction system.

The selected project is analyzed and evaluated from the financial aspects by sensitivity analysis.

The Project is further conducted the economic analysis to evaluate the Project for its national and social impacts.

6.8 Overall evaluation

The overall evaluation for the envisaged Project is conducted from technical and economical aspects.

7. The choice of final product to be manufactured by the projected Plant is to be made among (a) kraft liner, (b) corrugating medium and (c) printing/writing paper.

Each of these 3 alternative products are examined for their comparative merits based on both technical and economical criteria, to determine the final selection of most suitable product.

With this view, the study proceeded in general outline in the following manner.

7.1 Concordance with the established Ecuadorian national policy

As mentioned in Chapter 1. "Background of Feasibility Study" of the Report, the rapidly rising trend of paper consumption in Ecuador has made it a matter of prime urgency to enhance indigenous production of pulp and paper, and the establishment of an integrated pulp and paper plant has been taken up officially as national project.

For this reason, proceeding with implementation of the present Project without delay should directly and immediately contribute to reducing the outflow of foreign currency, and the realization of this Project is anxiously awaited in Ecuador.

The prerequisite conditions for adoption of a scheme as national project are:

- Effective utilization of nationally available resources
- Possibility of letting the envisaged product replace currently imported articles
- Contribution to promoting exports
- Benefit to regional development.

The present Project was planned to satisfy all of the foregoing criteria.

7.2 Market study

- The current annual demand for corrugated board in Ecuador is approximately 115,500 tons, of which 67% is that of kraft liner and 33% corrugating medium.

A largely predominant part – 103,500 tons – of this demand is consumed in the production of carton boxes for packing export banana, remaining 12,000 tons is consumed in the production of carton boxes for domestic use.

- Corrugated board of 103,500 tons consumed in the production of export carton boxes is today entirely covered by imports from U.S.A and Canada to satisfy the stringent quality requirements specified for this carton.
- Corrugated board of 12,000 tons consumed in the domestic market is produced in locally from the board wastes derived from the production of export carton boxes and recycled waste papers in the country as raw materials.
- A figure of approximately 132,000 tons a year is estimated as the total demand for corrugated board for the year 1990.

104,000 tons of the estimated consumption figure of 132,000 tons will be consumed in the production of carton boxes for packing export banana, and 28,000 tons will be consumed in the production of carton boxes for domestic use.

The above estimation means that the demand for corrugated board for export carton boxes cannot be expected to rise to any extent in the coming years, in view of the stagnant outlook of the international banana market, but appreciable increase of 10 percent a year is anticipated of domestic consumption.

- Subtracting from this the 12,000 tons a year already being supplied by local manufacturer, there would remain approximately 120,000 tons a year to be additionally supplied as follow, based on the existing statistic datas:

Approximately 80,000 tons a year of kraft liner
Approximately 40,000 tons a year of corrugating medium.

- The prices of imported corrugated board in 1982 are:

US.\$440 per ton of kraft liner, C.I.F Guayaquil
US.\$430 per ton of corrugating medium, C.I.F Guayaquil.

- From the current market situation in Ecuador, the establishment of a yearly production of 80,000 tons of kraft liner plant or a yearly production of 40,000 tons of corrugating medium plant will be able to save the outflow of foreign payments amounted from the above production rates and imported prices of each products.
- The total domestic consumption of printing/writing paper was approximately 19,000 tons in 1981.

The total domestic consumption of printing/writing paper in 1990 is estimated approximately 45,000 tons based on the forecast of the steady annual increasement of 10 percent.

- Printing/writing paper consumed in Ecuador is today entirely covered by imports from Brazil, Argentine, U.S.A and other countries.
- Printing/writing paper is marketed in a wide range of varieties combining different values of basis weight, quantity of added clay, whether or not coated, and other factors affecting the paper grade.

In the above range of grades, printing/writing paper of which the largest demand can be expected and not to be special, is estimated approximately 23,000 tons based on the statistic datas.

- The price of US.\$851 per ton is envisaged for the above grade of printing/writing paper, based on the current C.I.F Guayaquil values.
- From the current market situation in Ecuador, the establishment of a yearly production of 23,000 tons of the above grade of printing/writing paper plant

will be able to save the outflow of foreign payments amounted from the above production rate and imported price.

- With the view of forest type of Concession, source of pulp wood supply for present Project, – mixed forest of including species suitable as pulp wood, and as plywood and as sawlog –, the actual logging operation, and to maximizing effective utilization of the available forest resources, it is envisaged for the present Project to divert to plywood manufacture and to sale as sawlog part of the logged wood most adapted to such other uses, based on the discussion with the Ecuadorian counterpart.
- Study of the wood species and timber size occurring in the envisaged forest Lot has revealed that 25% of the available wood volume is suitable as plywood and as sawlog.
- An average selling price of US.\$28 per m³ has been estimated to apply for plywood and sawlog, taking the average paid currently in the region to loggers.

7.3 Forest resources

- The Cayapas Forest Concession is covered by tropical rain forest of mixed hardwood occupying a total area of 213,337 ha.
- The Concession comprises terrains classified into Montafioso (mountainous), Quebrado (broken), Ondulado (undulating), Plano (plain) and Costero (coastal), of which the largest forest volume is the mountainous terrain, and 128,747 ha is accessible for exploitation in considering the terrain type.
- The Concession is divided into 9 lots, of which Lots 2, 3 and 3a possess advantages over the remaining lots of large forest volume and absence of difficulties in log conveyance to Plant site.

These lots present net exploitable forest areas of:

14,600 ha in Lot 2
48,700 ha in Lot 3
11,000 ha in Lot 3a.

- Of the above 3, Lot 2 was chosen for the present site survey on account of the advantages it offers of permitting full utilization of the highways now under construction as logging road, as well as proximity to the envisaged Plant site in San Lorenzo.
- Lot 4 also can be considered eligible as source of pulpwood, but this lot has been laid aside for its having to be reserved for supplying the existing Cayapas plywood mill and projected new sawmill.
- The available wood volume from Lot 2 should be utilized, according to wood quality, as pulpwood, as sawlog/plywood material, and as fuel.

Wood suitable for pulping should present a basic density in the range of 300 to 600 kg/m³, of pale color, with little latex content, and should possess small vessels.

- The net available wood volume from Lot 2, separated into the 3 qualities respectively intended for the uses cited above would be approximately:

For pulpwood	1,138,800 m ³
For sawlog and plywood	467,200 m ³
For fuel	277,400 m ³
Total	1,883,400 m³

7.4 Envisaged product and production scale of Plant

- The final product to be manufactured by the projected Plant was decided and agreed by Preliminary Study team and the Ecuadorian counterpart to be made among (a) kraft liner, (b) corrugating medium and (c) printing/writing paper.

To obtain data for determining species suitable for pulping and for examining production process suitable for the actual operation for each of these 3 alternative products, pulping tests were conducted on specimens of wood sampled in the Cayapas Forest Concession.

- 16 typical specimens of wood from different species in the Cayapas Forest Concession were sampled and examined basic densities, and pulping tests were conducted on 10 specimens of wood out of the total 16 species sampled.

The 10 samples were blended together for the pulping tests.

For purpose of comparison, blended samples of comparable hardwood occurring in the Island of Hokkaido, Japan, were also subjected to pulping tests under identical conditions.

The pulping tests yielded the following results.

- Wood suitable for pulping should present a basic density in the range of 300 to 600 kg/m³, of pale color, with little latex content, and should possess small vessels.

These species are able to produce pulp in mixture form.

- There are species which presented excessive basic densities of 600 kg/m³ and conversely had extremely light and corky tissue.

These species should be used for sawlog or plywood materials, light-weight package boxes, toys and buoys.

- Except for pulp wood and sawlog or plywood materials, the Cayapas Forest Concession includes off-specification logs, these logs should be used as fuel required for steam generation of envisaged Plant operation.

- The wood ratio from Lot 2, separated into the 3 qualities respectively intended for the uses cited above would be as follows:

For pulpwood	60%
For sawlog and plywood	25%
For fuel	15%

- Pulping test to produce kraft liner by KP process indicated that the mixed Capayas wood is suitable for this purpose when blended to 30 to 40% with N.UKP.

- Pulping test by both KSC and NSSC processes proved the Ecuadorian samples to provide higher yield as well as higher pulp strength compared with the Japanese equivalent.

The tests also proved NSSC process to be more suitable for pulping the present samples.

It is to be further noted that for corrugating medium, a product possessing ample pulp strength and other requisite qualities is obtainable from the Cayapas wood without necessity of blending with imported N.UKP.

- Pulping tests by KP process followed by bleaching (chlorine - caustic extraction - hypo - caustic extraction - hypo) indicated the mixed Cayapas wood to be susceptible to the production of pulp of quality comparable to the Japanese material upon blending with 10% of N. BKP.

The brightness obtainable with the above five stage bleaching reached 84 and it means the mixed Cayapas wood has marketable brightness as printing/writing paper.

- The foregoing results of pulping tests have been integrated with considerations on the factors cited below for evaluating the comparative merits of the 3 products taken up, to prove the superiority of (a) corrugating medium and (b) printing/writing paper, in preference to kraft liner, as product for the Plant, and the financial analysis will be applied for 2 above products and selection will be made for the most advisable product for the envisaged Plant.

- To choose of alternative products following factors are considered in the comparative evaluation.

- N. BKP and N. UKP required to be blended to ensure requisite pulp properties

Kraft liner	N. UKP 30 to 40%
Corrugating medium	Nil
Printing/writing paper	N. BKP 10%

- Pulping yield (%)

Kraft liner	50
Corrugating medium	75
Printing/writing paper	40.5

- Plant construction cost for equal production scale (index 100 for corrugating medium)

Kraft liner	170
Corrugating medium	100
Printing/writing paper	255

- Market price of product (US.\$/ton, C.I.F Guayaquil)

Kraft liner	440
Corrugating medium	430
Printing/writing paper	851

- Plant operating skill

Kraft liner	Operator skill required
Corrugating medium	Relatively simple to operate
Printing/writing paper	Operator skill required

- Quality required of product

Kraft liner	Equivalent to softwood pulp
Corrugating medium	Equivalent to hardwood pulp
Printing/writing paper	Normal quality

- The disqualified reason of kraft liner are:
 - Kraft liner requires blending N. UKP
 - Plant construction cost
 - Same level of market price
 - Operator skill is required

- High quality of product is required.
- As mentioned in preceding Sections, an annual demand of approximately 40,000 tons in 1990 is expected for corrugating medium for export banana carton boxes, and the quasi-totality of this article is today imported.

For this reason, in view of the savings that will be made on foreign payments, the entire above demand is envisaged to be supplied by the projected Plant.

The resulting envisaged production scale of the Plant is 39,600 tons a year (120 tons a day).

- A figure of approximately 45,000 tons a year has been given in preceding Sections, as national demand for printing/writing paper in 1990.

Further consideration for maintaining production efficiency, for obtaining a good balance of plant construction cost and finance evaluation, for expected operator skill and other pertinent factors indicate a figure roughly half this total demand – 23,100 tons a year or 70 tons a day – as the proper production scale to be envisaged for this kind of paper.

The production scale of 23,100 tons a year meets with the volume of 23,000 tons of papers which has been given in preceding Section 7.2.

- The annual requirements of pulpwood to feed the Plant for maintaining production on the scales envisaged above for corrugating medium and printing/writing paper are respectively 113,548 and 112,192 m³.

7.5 Plant site

- San Lorenzo, envisaged as Plant site for the present Project, is situated 01°18'N, 78°51'W, not far from the Mataje River forming the frontier with Colombia.

The key industries supporting the economy of San Lorenzo are forestry, sawing and fishery and the population is approximately 18,000 and there are 14 schools including colleges.

- The subsoil in the plain and coastal terrains is mainly argillaceous layer averaging 2 meters in depth covering alluvial deposit.

There appears to be little presence of soil presenting particularly poor bearing capacity.

- The climate is hot and humid throughout the year, registering yearly average of 25°C temperature, minimum of 85% humidity and 2,500 mm rainfall and heavy storms and other natural calamities are rare.
- Water supply, indispensable for the Plant, is considered ensurable from deep wells to be sunk, based on information on underground water obtained from I.E.O.S.

It should be noted, however, that further boring studies will be necessary to ascertain the availability throughout the year of the requisite quantity of 8,400 ton per day of water for plant operation.

To provide against the event of this well water proving inadequate for supplying the Plant, a survey was made also of the volume of water flowing in the Tululbí River flowing about 15 km from San Lorenzo.

It was found that the river flow presented a volume of 1.2 million tons per day, quite ample if adopted as substitute source of water supply.

- In respect of water quality, analysis of well and river water samples proved both to be free of chlorine, and low in turbidity and hardness, and thus to present no foreseeable problems in treatment for drinking and as industrial water, through subject to verification on water sampled in other season of the year.
- Electric power for the Plant will not be available from the public network.

This will call for provision of a private power station.

The same applies to plant steam supply, which will require the installation of an industrial boiler, to be fueled with wood, which will be available as men-

tioned in Sections 7.3 and 7.4.

This boiler will also require to burn as auxiliary fuel heavy oil, which will be procured from Esmeraldas together with the much smaller quantities of diesel oil and gasoline required for motor vehicles and other machinery.

- The infrastructure available in the San Lorenzo district comprises its port facility and highway system.

The San Lorenzo port can accommodate shipping up to 2,000 tons, but possesses only one pier, at present being reconditioned, for completion in 1984.

The reconditioned pier facilities will very opportunely serve for unloading the construction equipment during the installation work and auxiliary materials after the Plant enters service, and also for loading the product from Plant.

Two highways are under construction, emanating from San Lorenzo and which are to be completed also in 1984.

These highways will run right across the Cayapas Forest Concession, and in particular the Lot 2 will be traversed roughly through its center.

This will very appreciably benefit logging operations in this lot.

- As site for the Plant, the choice has been made for a location on the bank opposite the existing plywood mill operated by the I.F.C.
- The factors considered in determining this site selection were:
 - Convenience of pulpwood supply
 - Water supply
 - Supply of auxiliary materials, chemicals, and utilities
 - Suitability to adoption of platform-mounted system of construction
 - Available infrastructure
 - Means of conveyance and transportation
 - Labor supply

- Convenience of plant construction
 - Anti-pollution measures
 - Distance from market
 - Concordance with basic national policy
- This Plant site will call for the construction of an access road about 3.5 km long, and partial dredging of the water channel to permit the floating platform incorporating the Plant to reach the site.

7.6 Conceptual design

- The conceptual designs of the plant for the 2 alternative cases are based on the following data.

(1) Corrugating Medium

Production rate	39,600 tons/year (120 tons/day)
Yearly operating days	330 days for plant operation 220 days for logging operation
Raw material	Mixed pulpwood from Cayapas Forest Concession
Wood consumption	
Pulpwood	113,548 m ³ /year
Fuelwood, including barks, etc.	76,000 m ³ /year
Pulping process	NSSC process
Paper machine	Fourdrinier with cylinder dryers
Chemical recovery	Brown stock washing - black liquor evaporation - chemical recovery boiler - direct oxidation
Effluent treatment	Flocculation and sedimentation in lagoon, to bring effluent water quality within limits of regulations applied in Japan
Power station	Main boiler, recovery boiler, condensing extraction turbine generator

Make-up chemicals	
Sodium sulfite	2,138.4 tons/year
Sodium carbonate	534.6 tons/year
Papermaking chemicals	
Dry strength resin	594 tons/year
Wet strength resin	198 tons/year
Utilities	
Process water	8,400 tons/day
Electric power	7,700 kW
Steam	
Main boiler	50 tons/hour
Recovery boiler	7.5 tons/hour
Heavy oil	13,200 tons/year

(2) **Printing/writing Paper**

Production rate	23,100 tons/year (70 tons/day)
Yearly operating days	330 days for plant operation 220 days for logging operation
Raw material	Mixed pulpwood from Cayapas Forest Concession and N. BKP
Wood consumption	
Pulpwood	112,192 m ³ /year
Fuelwood, including barks, etc.	76,000 m ³ /year
Imported N. BKP for blending	2,524 tons/year
Pulping process	KP process and C-E-H-E-H 5-stage bleach- ing
Paper machine	Fourdrinier with cylinder dryers
Chemical recovery	Brown stock washing - black liquor evaporation - chemical recovery boiler - recausticizing - lime kiln
Effluent treatment	Flocculation and sedimentation in la- goon, to bring effluent water quality with limits of regulations applied in Japan
Power station	Main boiler, recovery boiler, condensing extraction turbine generator

Make-up chemicals	
Salt cake	1,818 tons/year
Limestone	726 tons/year
Bleaching chemical	
Industrial salt	2,781 tons/year
(from which to produce within Plant the necessary bleaching chemicals)	
Papermaking chemicals	
Clay	2,145 tons/year
Sizing agent	231 tons/year
Alum	693 tons/year
Starch	346.5 tons/year
Dyestuff	1.4 tons/year
Utilities	
Process water	14,000 tons/day
Electric power	6,000 kW
Steam	
Main boiler	35 tons/hour
Recovery boiler	25 tons/hour
Heavy oil	6,105 tons/year

- Layouts considered separately for the cases of producing corrugating medium and printing/writing paper have resulted in a plant area of 18 ha for both cases.

7.7 Raw materials, chemicals and utilities

- The requisites for producing either corrugating medium or printing/writing paper – cited in the preceding Section 7.6 – are envisaged to be procured in the following manner:
- Pulpwood will be supplied from the Cayapas Forest Concession Lot 2, for which timber dues will be paid as stipulated in the contract for felling.

The Lot 2 carries a forest volume that would permit its continuing to ensure pulpwood supply during 10 years.

- N. BKP, required for blending to produce printing/writing paper of requisite quality, is not obtainable domestically, and must be imported from U.S.A or Canada.

The current C.I.F Guayaquil price is US.\$791 per ton.

- All chemicals are imported and their current C.I.F Guayaquil prices are:

- Sodium sulfite	US.\$531/ton
- Sodium carbonate	US.\$430/ton
- Salt cake	US.\$327/ton
- Limestone	US.\$58/ton
- Industrial salt	US.\$236/ton
- Clay	US.\$351/ton
- Sizing agent	US.\$3,760/ton
- Alum	US.\$213/ton

- The boiler fuels comprise (a) fuelwood and (b) heavy oil.

Fuelwood will include off-specification logs, waste from plywood mill, bark, screening rejects, all generated in the logging, wood preparation or processing stages of plant operation.

The heavy oil will be brought from Esmeraldas at a price delivered at the plant site of US.\$95 per ton.

7.8 Pulpwood supply

- Wholesale deforestation is envisaged with a view to reforestation and to maintenance of adequate efficiency in the felling and logging operations.

Deforestation will proceed at a rate of 1,467 ha a year.

- The logs felled by mechanized means will be gathered at an intermediate station, where they will be sorted out according to species and log diameter, and further grouped separately for the different destinations of pulp plant, sawmill, plywood mill and for burning as fuel.

- These operations necessary for ensuring pulpwood supply will depend heavily on the availability of adequate logging roads, whose construction and maintenance therefore will be of vital importance, and adequate equipment and work force must indispensably be reserved for the purpose.

7.9 Reforestation

- Wholesale indiscriminate felling to be applied to Lot 2 should not present problems of environmental deterioration, judging from the generally flat terrain presented by this lot and from the climatic conditions.

This judgement is substantiated by the firm generation observed of secondary outgrowths in clearings remaining from wholesale felling exercised in Lot 4.

- Reforestation activity will be undertaken from the first year of Plant operation.

Plantation of species of tree most suitable as pulpwood will permit 600 ha of forest to furnish the wood volume required for keeping the Plant in full operation.

This amount of forest will be ultimately reforested every year, after following the preliminary experimental steps of (a) trial plantation for selecting the species most suitable for reforestation, (b) pilot plantation for studying the economical and technical problems to be solved in plantation, and (c) industrial plantation in which the problems of full-scale reforestation will be further studied and solved.

- Among the numerous varieties of eligible tree species occurring in the region and others successfully planted in various parts of the world, 13 species have been tentatively selected for testing in step (a) referred to above.

7.10 Plant Construction

- Of the 2 alternative systems of (a) conventional piece-meal installation at site and (b) platform-mounted system of bringing in the Plant installation to site already completely mounted on a floating platform, the alternative (b) has

been selected, for the advantages it offers in terms of shorter required construction period, lower construction cost, freedom from dependence on available local infrastructure and skilled labor.

This selection is justified from the financial analysis presented further on in Section 7.14, which is undertaken on both systems (a) and (b) above for purpose of comparison between the 2 systems.

- The period required for construction is estimated to be 33 months from the contract effectuation, including 3 months for test operation if system (b) is adopted for construction, and in the case of system (a) the corresponding period will be 45 months.

Consequently, assuming the contract for Plant construction to become effective on July 1, 1984, the Plant will enter commercial operation on April 1, 1987 with system (b) adopted for construction, and on April 1, 1988 with conventional system (a).

- Work requiring to be done in association with the Plant construction will include dredging, excavation, foundation, buildings, installation of equipment, road, building and other civil work, for most of which amply qualified contractors are available in Ecuador and installation will be undertaken with supervisory services provided by the equipment manufacturer.
- As integral part of the Plant, there will be furnished and installed equipment covering the following functions (common to both cases of corrugating medium and printing/writing paper production, except where otherwise specified):
 - Felling, logging, transporting and logging road construction
 - Log handling and chipping
 - Cooking and refining
 - Washing and screening
 - Bleaching (for printing/writing paper only)
 - Stock preparation
 - Paper making and finishing
 - Chemical recovery

- Bleaching chemical preparation (for printing/writing paper only)
- Power generation and distribution
- Electrical equipment and instrumentation
- Process water treatment
- Plant effluent treatment
- Plant air service system
- Plant outer piping
- Maintenance shop
- Laboratory
- Firefighting
- Communication equipment
- Office facilities
- Vehicles
- Industrial platform and ancillary installations.

As an associated work, followings will be covered:

- Dredging and excavation
- Civil work, including foundations
- Buildings
- Installation and adjustment
- Access road construction
- Battery limit fencing.

7.11 Organization and Staffing

- The organization described below has been drawn up on the basis of studies made on the actual organizations observed in various paper mills operating in Ecuador.
- The organization is divided into 2 major divisions charged respectively with forestry and manufacturing operations.
- Forestry Division undertakes the operations of (a) felling, (b) logging and log conveyance, (c) forest conservation, (d) reforestation, (e) administration and general services.

These 5 departments are staffed by a personnel numbering 205, supplemented by a subcontracted labor force of about 330 undertaking manual work in reforestation.

- Manufacturing Division comprises the 4 departments for (a) production, (b) administration, (c) maintenance and (d) labor, health and safety, with a total personnel of 543 for the case of corrugating medium production and 679 for printing/writing paper production.
- The foregoing personnel figures add up to an aggregate permanent staff for the 2 divisions of 748 for corrugating medium and 884 for printing/writing paper, which, with the additional subcontracted labor force of 330 in both cases, will provide work, respectively, for approximately 1,100 and 1,200 persons.

The above work force is estimated assuming the adoption of 24-hour operation of the Plant in 3 shifts.

- Selected staff will undergo professional training, which will commence 3 years before Plant commissioning.

This selected staff will number 162 in the case of corrugating medium and 301 for printing/writing paper, to complete their training course 2 months before the commissioning.

Of this staff, 30 will in both cases undergo a 6-month training course abroad in special skills.

- After commencement of Plant operation, technical assistance by foreign experts will be provided during a period of 4 years on key matters in both administrative and technical aspects.

The technical assistance will extend to 44 persons in the case of corrugating medium and 50 persons for printing/writing paper.

7.12 Plant Operation

- The Plant is envisaged to operate with capacity utilization factors gradually rising to full capacity with succeeding years, in the following manners.

(1) Platform-mounted construction system

1st. year	65% capacity
2nd. year	95% capacity
3rd. year onwards	100% capacity

(2) Conventional piece-meal construction system

1st. year	60% capacity
2nd. year	85% capacity
3rd. year	95% capacity
4th. year onwards	100% capacity

- The above learning curve data have been derived from analysis of actual records on initial plant operation obtained in the past in Latin American countries on installations constructed by both systems.

7.13 Total Investment Cost

- The total investment cost for Project implementation has been derived separately for the 4 cases tabulated below, representing different combinations of marketed product and system of plant construction.

Case "A"

Product	Corrugating medium and sawlog or plywood materials
Production capacity	
Corrugating medium	39,600 tons a year
Sawlog or plywood	47,312 m ³
Construction system	Platform-mounted

Case "B"

Product	Corrugating medium and sawlog or plywood materials
Production capacity	
Corrugating medium	39,600 tons a year
Sawlog or plywood	47,312 m ³
Construction system	Conventional piece-meal

Case "C"

Product	Printing/writing paper and sawlog or plywood materials
Production capacity	
Printing/writing paper	23,100 tons a year
Sawlog or plywood	47,312 m ³
Construction system	Platform-mounted

Case "D"

Product	Printing/writing paper and sawlog or plywood materials
Production capacity	
Printing/writing paper	23,100 tons a year
Sawlog or plywood	47,312 m ³
Construction system	Conventional piece-meal

- The investment cost analysis has been conducted assuming that a turn-key lump-sum contract for implementing the Project is brought into effect on July 1, 1984.

The cost estimates are based on currency value prevailing in December 1982.

- For purposes of cost estimation, the currency exchange rate adopted is:

US.\$1 = ¥230 = Sc.33.

- The total investment cost thus analyzed is presented in the Table on the following page, together with detailed breakdown.
- Based on consultation with the Ecuadorian counterpart, the funds required for Project implementation are envisaged to be financed by funds on hand and by long-term and short-term loans in the following proportions.

Equity (Funds on hand)	20%
Long-term loan	80%

The conditions of long-term loan are:

Interest	11.0% per year
Repayment	10 equal installments on capital in 10 years
Grace period	3 years after commissioning of Plant.

Short-term loans will be obtained on the terms of:

Interest	14.0% per year
Repayment	Lump-sum settlement in the following year.

7.14 Financial Analysis and Evaluation

- Basic conditions assumed for analysis

- Operating cost

Annual plant operating cost estimated for the years after the Plant has entered normal operation, and during the initial years prior to attaining stable operation, are respectively detailed in the 2 Tables in the following pages.

The currency value adopted in this analysis is that prevailing on the year of Plant commissioning, the same currency value being adopted for all the remaining years covered by the analysis.

Summary Breakdown of Total Investment Cost By Case

(Unit: US.\$1,000)

	Case "A"	Case "B"	Case "C"	Case "D"
<u>Plant Cost</u>				
Equipment & machinery	51,470	38,066	61,679	43,566
Equipment erection	4,690	6,848	5,527	7,806
Site preparation	1,866	11,414	1,866	11,641
Civil works & building	7,565	10,729	7,565	11,094
Ocean freight & insurance	2,315	2,739	2,745	3,150
Inland transportation	-	9,587	-	9,678
Contingency	2,227	2,824	2,570	3,062
Sub-total	70,169	82,207	81,952	89,997
<u>Land Acquisition</u>	5	5	5	5
<u>Preoperation Cost</u>				
Preinvestment studies, tendering & evaluation, project implementation	4,190	5,410	4,659	5,768
Recruitment & training	300	300	362	362
Contingency	135	171	150	184
Sub-total	4,625	5,881	5,171	6,314
<u>Interest During Construction</u>	10,122	17,545	11,822	19,265
<u>Initial Working Capital</u>				
Spare parts	1,679	1,679	1,823	1,823
Cash	7,779	7,575	9,124	8,865
Sub-total	9,458	9,254	10,947	10,688
Total Investment Cost	94,379	114,892	109,897	126,269

Note: Import tax and duties will be exempted, as stipulated by the "LEY DE LA CORPORACION FINANCIERA NACIONAL"

**Summary Breakdown of Annual Plant Operating Cost
after Attainment of full Production**

(Unit: US.\$1,000)

	Case "A"	Case "B"	Case "C"	Case "D"
<u>Variable Cost</u>				
Raw materials cost	748	748	3,863	3,863
Timber dues	(86)	(86)	(86)	(86)
Imported softwood pulp	(-)	(-)	(3,115)	(3,115)
Reserved cash (Reforestation)	(662)	(662)	(662)	(662)
Auxiliary materials cost	5,182	5,182	6,985	6,985
Chemicals	(3,202)	(3,202)	(5,182)	(5,182)
Fuels	(1,584)	(1,584)	(1,318)	(1,318)
Sub-materials	(396)	(396)	(485)	(485)
Total Variable Cost	5,930	5,930	10,848	10,848
<u>Fixed Cost</u>				
Labor cost	5,532	5,532	6,506	6,506
Management cost	777	874	906	970
Insurance	(561)	(658)	(656)	(720)
General expenses	(216)	(216)	(250)	(250)
Repair and maintenance	1,679	1,679	1,823	1,823
Total Fixed Cost	7,988	8,085	9,235	9,299
<u>Technical Assistance</u>	(-)	(-)	(-)	(-)
Total Operation Cost	13,918	14,015	20,083	20,147

**Progress of Annual Operating Cost during Transient Initial Years of
Operation before Attainment of Full Production**

(Unit: US.\$1,000)

	1st. year	2nd. year	3rd. year	4th. year	5th. year and after
Case "A"					
Variable cost	3,857	5,634	5,930	5,930	5,930
Fixed cost	7,988	7,988	7,988	7,988	7,988
Technical assistance	2,704	1,644	1,078	548	—
Total Operation Cost	14,549	15,262	14,996	14,466	13,918
Case "B"					
Variable cost	3,559	5,043	5,634	5,930	5,930
Fixed cost	8,085	8,085	8,085	8,085	8,085
Technical assistance	2,704	1,644	1,078	548	—
Total Operation Cost	14,348	14,772	14,797	14,563	14,015
Case "C"					
Variable cost	7,051	10,304	10,848	10,848	10,848
Fixed cost	9,235	9,235	9,235	9,235	9,235
Technical assistance	3,016	1,900	1,078	676	—
Total Operation Cost	19,302	20,439	21,161	20,759	20,083
Case "D"					
Variable cost	6,511	9,218	10,304	10,848	10,848
Fixed cost	9,299	9,299	9,299	9,299	9,299
Technical assistance	3,016	1,900	1,078	676	—
Total Operation Cost	18,826	20,417	20,681	20,823	20,147

The plant utilization factors attainable during the initial years prior to stable operation is, as given in Section 7.12.

– Product sales and assumptions adopted

The estimated year-to-year sales of Plant products are presented in the Table on the next page.

The assumptions adopted in deriving these figures are that all products are sold in the domestic market, which is assumed to maintain a demand exceeding the envisaged rate of production.

Prices – as for the currency value – are those prescribed for the year of Plant commissioning, and are maintained at the same level throughout the project life.

The prices for the year of commissioning are derived from those prevailing at end 1982, i.e.

US.\$430 per ton for corrugating medium
US.\$851 per ton for printing/writing paper
US.\$28 per m³ for sawlog/plywood material.

– Other conditions

Project life	15 years after commissioning
Business year	January 1 to December 31
Taxes	
Corporate tax	20%
Tax exemption	During 10 years from commissioning
Other taxes	All exempted
Worker dividend	15%
Depreciation	Period of depreciation term and average values at term are as given in the following Table.

Schedules of Annual Sales for Four Cases

(Unit: US.\$1,000)

	1st. year	2nd. year	3rd. year	4th. year	5th. year and after
Case "A"					
Corrugating medium	16,552	24,911	26,517	26,572	26,572
Sawlog/plywood materials	1,444	2,173	2,313	2,318	2,318
Less sales expenses	370	557	593	594	594
Total Sales Revenue	17,626	26,527	28,237	28,296	28,296
Case "B"					
Corrugating medium	15,279	22,309	25,132	26,517	26,572
Sawlog/plywood materials	1,333	1,946	2,193	2,313	2,318
Less sales expenses	342	499	562	593	594
Total Sales Revenue	16,270	23,756	26,763	28,237	28,296
Case "C"					
Printing/writing paper	20,217	30,427	32,388	32,456	32,456
Sawlog/plywood materials	1,444	2,173	2,313	2,318	2,318
Less sales expenses	216	325	346	347	347
Total Sales Revenue	21,445	32,275	34,355	34,427	34,427
Case "D"					
Printing/writing paper	18,661	27,249	30,698	32,388	32,456
Sawlog/plywood materials	1,333	1,946	2,193	2,313	2,318
Less sales revenue	199	291	328	346	347
Total Sales Revenue	19,795	28,904	32,563	34,355	34,427

Depreciation and Amortization

Item	Period (Year)	Salvage Value (%)	Method
1. Machinery & Equipment of Forest Operation			
a. Log handling equipment (Skidders, loaders, etc.)	5	0 (Zero)	Straight line
b. Transportation equipment (Trucks, vehicles, etc.)	8	0 (Zero)	Straight line
c. Other facilities	15	0 (Zero)	Straight line
2. Machinery & Equipment of Mill	15	0 (Zero)	Straight line
3. Civil & Building	40	0 (Zero)	Straight line
4. Preoperation Cost	10	0 (Zero)	Straight line
5. Interest During Construction	10	0 (Zero)	Straight line

Remarks: Land acquisition, site preparation and initial working capital are non depreciable.

Working capital

As given in the following Table.

Working Capital

1. Current assets	
a. Cash	One month of fixed production cost
b. Accounts receivable	One month of annual sales revenue
c. Products inventory	Half month of annual production cost
d. Materials inventories	One month for raw materials cost and three months for auxiliary materials cost
e. Work in progress	Negligible
2. Current liabilities	
a. Accounts payable	One month for raw materials and auxiliary materials cost

- The financial analysis is based on D.C.F method applied to the cases defined at the head of this Section, to derive the internal rates of return, the financial statements and indicators.

The results of analysis are presented in the Table on the following page.

It is revealed that only for Case “A” are the cash flow and other financial indicators found to present generally sound lines, with I.R.R appreciably higher than in the other 3 cases, and indicating a profitability that would justify the investment.

The other cases cannot be considered to present the requisite aspects for a project justifying investment.

In the following sensitivity analysis, therefore, the Case “A” alone is taken up for examination to complete the financial evaluation.

- The foregoing financial analysis has indicated the Case “A” – i.e. plant construction by platform-mounted system and producing corrugating medium – as the most suitable form for the Plant.

Parametric analysis has been conducted on the Case “A” to determine the sensitivity of I.R.R to variations of $\pm 10\%$ to the external factors of:

- Sales prices
- Investment cost
- Operation cost (limited to variable expenses)
- Interest on long-term loan.

What calls for note here is that, apart from the expected sensitivity shown by the profitability to change in price, a decisive influence is also exerted by the conditions of long-term loan.

Thus, if this interest could somehow be reduced to 5%, I.R.R.O.E will at once attain 23.02%.

Under such circumstance, even a price reduction to the extent of 10% could

Summary of Profitability and Financial Indicators

Item	Case "A"	Case "B"	Case "C"	Case "D"
Investment cost (US.\$1,000)				
Equity	18,876	22,978	21,979	25,254
Debt	75,503	91,915	87,918	101,015
Total	94,379	114,892	109,897	126,269
I.R.R.O.I (%)				
Before tax	10.62	0.91	6.76	0.00
After tax	10.33	0.91	6.60	0.00
I.R.R.O.E (%)				
After tax	8.16	0.00	0.00	0.00
Payout period (Year)				
Before tax	8.19	-	10.33	-
After tax	8.19	-	10.34	-
After tax profit to sales revenue (%)	8.7	-	-3.6	-
After tax profit to stock holder equity (%)	14.2	-	23.7	-
After tax profit to share capital (%)	12.9	-	-5.6	-
Break even point (utilize %)	84.3	-	101.6	-

still ensure an I.R.R exceeding 12%.

7.15 Economic Analysis and Evaluation

- The Case “A” (plant construction by platform-mounted system and producing corrugating medium) – found best from financial analysis – has been evaluated from the standpoint of national and social interest in respect of public benefit expected from its implementation.
- The economic impact has been evaluated from the anticipated effect on the balance of foreign trade, and also from an analysis of the internal economic rate of return reflecting the economic premiums of:

Foreign currency	0.50
Skilled worker	0.00
Unskilled worker	(-)0.60
Fuel oil	0.50
Other indigenously procured materials	0.00

- The results of analysis, presented in the diagram on the next page, reveal that E.I.R.R comes to a figure of 15.72%.
- The sensitivity analysis, also performed, indicates that a reduction of 10% in selling price would still leave approximately 13% E.I.R.R, which exceeds the corresponding I.R.R.O.I of 10.62%, thus conclusively evidencing the very significant contribution to Ecuadorian national economy that can be expected from this Project.
- In respect of the beneficial effect on the balance of foreign trade, more than US.\$153 million should be accumulated during the life of this Project, which is definite proof of the immense contribution to savings in foreign currency that will be brought by the successful implementation of the Project.

Net Foreign Currency Flow

(US.\$1,000)

Year	Input (A)	Output (B)	Balance (A-B)	Cumulation
-4 (1983)	1,057	1,311	-254	-254
-3 (1984)	13,379	15,574	-2,195	-2,449
-2 (1985)	32,361	34,498	-2,137	-4,586
-1 (1986)	28,706	25,967	2,739	-1,847
1 (1987)	16,552	14,352	2,200	353
2 (1988)	24,911	14,635	10,276	10,629
3 (1989)	26,517	14,391	12,126	22,755
4 (1990)	26,572	21,546	5,026	27,781
5 (1991)	26,572	23,863	2,709	30,490
6 (1992)	26,572	19,472	7,100	37,590
7 (1993)	26,572	18,641	7,931	45,521
8 (1994)	26,572	17,810	8,762	54,283
9 (1995)	26,572	16,980	9,592	63,875
10 (1996)	26,572	16,149	10,423	74,298
11 (1997)	26,572	15,319	11,253	85,551
12 (1998)	26,572	14,488	12,084	97,635
13 (1999)	26,572	13,658	12,914	110,549
14 (2000)	26,572	5,277	21,295	131,844
15 (2001)	26,572	5,277	21,295	153,139
Total	462,347	309,208	153,139	-

CONCLUSION AND RECOMMENDATIONS

CONCLUSION AND RECOMMENDATIONS

1. Integrated assessment – based on technical, financial and economic criteria – of the alternative products of kraft liner, corrugating medium and printing/writing paper, and of the alternative construction system of platform-mounted system and conventional piece-meal construction has yielded the conclusion that a pulp and paper plant constructed on the platform-mounted system to produce corrugating medium is positively feasible.
2. The outline of the most suitable Plant is as follows:

– Plant name	Corrugating medium manufacturing plant
– Production rate	39,600 tons/year (120 tons/day)
– Yearly operating days	330 days for plant operation 220 days for logging operation
– Raw material	Mixed pulpwood from Cayapas Forest Concession
– Plant site	San Lorenzo
– Plant construction system	Platform-mounted construction system
– Plant construction period	33 months from the contract effectuation, including 3 months for test operation
– Total investment cost	US.\$94,379,000
3. The present Project amply satisfies all of the four conditions that require to be met to qualify as Ecuadorian national project.
4. The 39,600 tons a year of corrugating medium envisaged to be produced by the projected Plant matches the amount of this material expected to be imported into Ecuador in 1990. Thus, the projected Plant should prove to be in a position to completely replace this imported material with indigenous product, without concurring with any other Ecuadorian manufacturer.
5. The sawlog and plywood materials generated in association with the operation of the Plant in manufacturing corrugating medium will find an outlet in the San Lorenzo district, where sawmills and plywood factories are currently in operation.
6. The envisaged forest lot in the Cayapas Forest Concession carries amply adequate forest

volume to keep the projected Plant stably supplied with raw material throughout its years of operation.

7. The Concession carries timber containing wood species that are suitable as pulpwood, as well as other species adapted to use as sawlog and as plywood materials.
8. The location near San Lorenzo envisaged for siting the Plant is extremely well suited from considerations of pulpwood supply, plant construction by platform-mounted system, and of regional economical development.
9. Felling is envisaged to proceed by wholesale deforestation, followed by reforestation to the extent of 600 ha annually.
10. The platform-mounted system is the most suitable for constructing the projected Plant. This system of construction should permit the Plant to attain production at 100 percent plant capacity within 3 years of plant commissioning.
11. Additional employment opportunities numbering approximately 1,100 will be newly created by the implementation of this Project, to exert a significant beneficial impetus to regional economic development.
12. The total investment cost for implementing the Project is estimated at US.\$94,379,000.

The financial and economic analyses are based on the assumption of financing with funds on hand and with long-term loan, in the proportion of 20 : 80.

13. The Plant realized as described above has been shown to promise an internal rate of return on investment before tax of 10.62%, and an economic internal rate of return of 15.72%, as well as saving foreign currency during Project life exceeding US.\$153 million.

These results of analysis indicate this Project to be immense benefit to the Ecuadorian economy upon successful realization.

14. Concomitantly, operation of the envisaged Plant will aid in the assimilation of advanced papermaking technology, and the reforestation activities will further enhance the level of silvicultural techniques in the country.

15. The foregoing observations lead to a solidly justified recommendation for prompt and firmly supported authorization on the part of the Ecuadorian Government to take this Project in hand.
16. For smooth implementation of the envisaged Project, it will be indispensable to realize the following conditions.
 - To establish concrete plans for Project implementation at the very earliest opportunity, and to immediately initiate action for securing the necessary funds.
 - To make every effort to secure long-term loans at advantageous conditions, in order to ensure stabilized financial position for the Project operation.
 - Immediately upon decision to implement the Project, to carry out a detailed hydrographic survey of the water channels around San Lorenzo along the waterway to be followed by the floating platform, together with similarly detailed survey of the plant site subsoil, including boring tests, as well as investigation of the underground water sources.

The detailed topography of the land in and around the plant site should also be surveyed.

Chapter 1.

INTRODUCTION

Chapter 1. INTRODUCTION

1.1 Background and History of the Feasibility Study

1.1.1 Background of the Study

The Region of San Lorenzo, Province of Esmeraldas, in the Northwest coast of the Republic of Ecuador, possesses a vast national resource of primeval forest containing approximately 200 species of mixed tropical hardwood.

Since 1969, the Government of Ecuador, with the assistance of F.A.O and I.B.R.D, undertook a survey of forest resources and of development possibilities, with the view to promoting the economic development of the under-developed Province of Esmeraldas through full utilization of its forest resources. The results of this survey were embodied in a report which recommended the establishment of a sawmill as a first step, and a plywood mill as a second step, which two mills have already been realized, and are today effectively contributing to the economic development of the region.

As Step 3, the report recommended the establishment of an integrated pulp and paper plant for manufacturing final paper products. In Ecuador, the consumption of paper has paralleled the country's economic development, and the supply to meet the rising demand has so far been met by increasing dependence on imports, which reached 83% in 1981. The extension of domestic paper production capacity has thus come to be a requirement of primary urgency for the country.

To meet this need, the establishment of a pulp and paper plant has been adopted as a National Project in the 1980 – 1984 Five-Year Plan, and is at present under study by C.F.N.

1.1.2 History of the Study

In view of the circumstances described in the preceding Section, the Government of the Republic of Ecuador requested the Government of Japan, through the Japanese Embassy in Quito, in December 1981, to conduct a Feasibility Study for evaluating the various aspects of the Project in question.

The above request to the Japanese Government was implemented, under Government instruction, by J.I.C.A, which organized a Preliminary Study team headed by Mr. Michimoto Gotoh, which visited Ecuador from 10 through 24 July, 1982.

The team conducted the preliminary study, and in consultation with I.F.C, the Ecuadorian counterpart selected for the Project, compiled the basic scope of work to be undertaken in the proposed Feasibility Study in an agreement document which was signed on July 20, 1982 by both parties and which was entitled "Scope of Work for the Feasibility Study on the Establishment of a Pulp and Paper Mill in the Republic of Ecuador".

The present Feasibility Study team has conducted the survey in implementation of the above agreement document of the Preliminary Survey team.

Earlier, J.C.I undertook a Pre-feasibility Survey by a team which visited Ecuador in August 1980, based on which a report entitled "Industrial Exploitation of Forest Resources in the Cayapas Forest Concession, Preliminary Feasibility Study Report" was presented in March 1981 to C.F.N and I.F.C.

1.2 Objective and Scope of the Feasibility Study

The objective and scope of the present Feasibility Study was defined in the agreement document referred to above established between I.F.C, and the Preliminary Study team. The items specified were as follows.

1.2.1 Outline of the Project

- Case 1. : Corrugated Board (kraft liner and corrugating medium)
- Case 2. : Printing/writing Paper

Market

The Project will hold in view solely the domestic market.

Production

The recommended rate of production will depend on the results of the Feasibility Study.

Raw Material

Mixed tropical hardwood produced in the Cayapas Forest Concession of the national forest located in the northwest Region of Ecuador is envisaged to be utilized in the present Project.

Plant Site

The Region of San Lorenzo, Province of Esmeraldas.

1.2.2 Objective of the Feasibility Study

The present Feasibility Study has an objective to evaluate the feasibility of a project for utilizing the mixed tropical hardwood obtainable from the Cayapas Forest Concession of the National Forest in the region of San Lorenzo, Esmeraldas Province through the establishment of an integrated pulp and paper plant to produce either (a) corrugated board (kraft liner and corrugating medium), or (b) printing/writing paper, with a view to (a) saving the outflow of foreign currency by reducing imports of corresponding products, (b) enhancement of employment opportunities, (c) assimilation of papermaking technology, and at the same time to contribute to (d) economical development of the region of Esmeraldas.

In undertaking the present Study, use has been made of part of the results emanating from Pre-Feasibility Survey undertaken by J.C.I.

1.2.3 Scope of the Study

The Feasibility Study is to cover an integrated evaluation - based on technical and economical criteria - of the alternative cases of adopting as final product (a) corrugated board (kraft liner and corrugating medium) and (b) printing/writing paper, to appraise the business prospects and to examine the means of realizing the projected Plant.

1.2.4 Substance of Survey

For achieving the objectives and for covering the scope of the Feasibility Study set forth in the preceding Section, the following items have been taken up as subject of investigation.

- 1) Ecuadorian national policy concerning the pulp and paper industry
- 2) Market study
 - Paper and paperboard supply and demand: Current trends and forecast of future market
 - Paper and paperboard market prices and trends
 - Paper and paperboard distribution channels and costs
 - Sawlog and plywood supply and demand: Current trends and forecast of future market
 - Sawlog and plywood market prices and trends
 - Sawlog and plywood distribution channels and costs
- 3) Forest resources
 - Review of available reports and documentary material on forest resources
 - Site survey of existing forest volume and practical means of logging and transportation
 - Pulping tests on representative samples of pulpwood from Cayapas Forest Concession
 - Selection of tree species suitable for pulping
- 4) Selection of final product and scale of production of the envisaged Plant
- 5) Raw materials
 - Pulpwood: Available wood volume and pulpwood cost
 - Auxiliary materials: Quantities required, prices and means of procurement
- 6) Plant site
 - Geographical environment
 - Water supply
 - Electric power, steam supply
 - Transportation facilities (port, highway and railroads)
 - Selection of plant site
- 7) Conceptual design of envisaged Plant
 - Basic data
 - Selection of manufacturing process

- Conceptual design of plant
 - Conceptual design of auxiliary installations
 - Plant layout
- 8) Means fo pulpwood conveyance and infrastructure
 - 9) Reforestation and environmental considerations
 - 10) Organization and manpower distribution
 - 11) Construction and operation of envisaged Plant
 - Means of shipping the plant and construction equipment
 - Labor market
 - Construction materials and contractors
 - Selection of construction system (choice between platform-mounted and conventional piece-meal construction systems)
 - Plant equipment
 - Period required for construction
 - 12) Total investment cost for project implementation
 - 13) Financial analysis
 - 14) Evaluation of economic and social impacts
 - 15) Overall evaluation and recommendations

1.3 Execution of the Feasibility Study : Outline of Same Study

1.3.1 Execution of the Feasibility Study

Throughout the period of field survey*, the Study team** conducted an analysis of all the data and information received with the collaboration of its Ecuadorian counterpart***,

* Period of field survey: See Appendix 1-1.

** Study team: List of members of the Study Team is given in Appendix 1-2.

*** Ecuadorian counterpart: List of members charged with contacts with the Study Team are given in Appendix 1-3.

with which the team undertook detailed discussions on the various possible means of implementing the present Project, based on which information and the data were requested covering such aspects as market, feed stock supply, alternative processes to be adopted, auxiliary materials required, site conditions, available labor, as well as the financial, economical, and political policies affecting the envisaged Project.

During their stay in Ecuador, the Study team further undertook field surveys of the actual site, the available forest resources, the water channels for the access to site of the floating platform, quality and adequate quantity of available water supplies, local general contractors based on the guiding information made available by the Ecuadorian counterpart.

The Study team further visited Ecuadorian paper and box manufacturers including PANASA, as well as printing firms and importers of chemical products, for the purpose of surveying market for paper products and availability of auxiliary materials.

The establishments visited by the Study team and from whom information and data were made available to the team included the M.D.F and other Government Authorities as also A.E.D.D, as well as private enterprises.

1.3.2 Outline of the Feasibility Study

The items studied in the range defined under Section 1.2.4 "Substance of Survey" comprises the major fields of:

- Ecuadorian national policy concerning the pulp and paper industry
- Survey of product market
- Survey of raw materials
- Study of technical aspects
- Study of reforestation
- Calculations of capital requirements and production costs
- Financial analysis and economic analysis
- Overall evaluation and recommendations

The items examined in the Feasibility Study are the following:

(1) Ecuadorian national policy concerning the pulp and paper industry

Ascertain the established Ecuadorian national policy concerning the pulp and paper industry, and to find out the priority that should be expected to be accorded to the present Project among other national development plans; to determine the impact expected to be exerted by the project on the Ecuadorian national economy.

The rapidly rising trend of paper consumption in Ecuador has made it a matter of prime urgency to enhance indigenous production of pulp and paper, and the establishment of an integrated pulp and paper plant has been taken up officially as national project.

For this reason, proceeding with implementation of the present Project without delay should directly and immediately contribute to reducing the outflow of foreign currency, and the realization of this Project is anxiously awaited in Ecuador.

The prerequisite conditions for adoption of a scheme as national project are:

- Effective utilization of nationally available resources
- Possibility of letting the envisaged product replace currently imported articles
- Contribution to promoting exports
- Benefit to regional development.

The present Project satisfies all of the foregoing criteria, and this is undoubtedly why the Ecuadorian Government has taken it up as national project.

(2) Market study

The following domestic market studies were conducted:

- Products, production volumes, qualities, raw material supplies, and sales outlets and prices of products manufactured by existing pulp and paper mills.
- Qualities, quantities, C.I.F prices and countries of origin of imported paper and paperboard; import statistics.

- Study of paper and paperboard marketing system adopted by existing mills in the country; quality requirements specified by carton box makers.
- Study of the systems of paper and paperboard distribution and transportation; cost of transportation.
- Production volume, sawlog consumptions and supplies, and prices of sawlogs manufactured by existing sawmills and plywood mills in Esmeraldas province.
- Study of sawn and plywood products marketing system adopted by existing mills in Esmeraldas province.
- Study of the systems of sawn and plywood products distribution and transportation; cost of transportation.

In addition to the foregoing market and statistical surveys, further studies were conducted on:

- Domestic demand for paper and paperboard
- International market prices of paper, paperboard and pulp
- International forecast on the demand and supply for pulp, paper and paperboard
- Demand for sawn and plywood products in Esmeraldas province.

Based on the results on the above surveys, forecasts of demand were derived for paper and paperboard, and sawlog and plywood.

(3) Forest resources study

The following studies were made on forest resources:

- Review of available documentation containing forest resource information relevant to the present Project initiated in 1976.
The documentation included those issued by CENDES, F.A.O and I.B.R.D, as well as J.C.I.
- Wood species occurring in the Cayapas Forest Concession Lot 2.
- Stock volume and net utilizable volume in the Cayapas Forest Concession Lot 2.
- Logging sequence

- Means and cost of log transportation
- Pulpwood cost
- Pulping tests on samples of the following 10 representative species enumerated with view to production of kraft liner, corrugating medium and printing/writing paper.

Sande
 Cuángare
 Aníme
 Jigua
 Guabo
 Chalviande
 Uva
 Carra
 Chillalde
 Galza

- Selection of suitable species for pulp manufacturing based on the results of pulping tests

(4) Study of technical aspects

The following items were surveyed:

- Selection of final product and scale of production of the envisaged Plant
 - o Examination and evaluation of the results from pulping tests
 - o Quality of commercially marketed kraft liner, corrugating medium and printing/writing paper
 - o Selection of final product and scale of production of the envisaged Plant based on the study results of market, forest resources, and pulping tests
- Plant site
 - o Site survey in San Lorenzo area on conditions for plant siting, including topography, ground water level, geology, climate, available utilities and infrastructure

- o Volume and quality of available water sources
- o Electric power supply capacity; power supply tariff; specification of power supply
- o Oil as energy source: Available volume, composition, price, means of transportation to site
- o Water way for access of industrial platform
- o Transportation facilities (port, highway and railroads)
- o Communication systems
- o Public facilities: Schools, hospitals, etc.
- o Choice of plant site among 3 alternative locations in the San Lorenzo area
- Production process and plant design
 - o Strength, brightness and other target qualities for the kraft liner, corrugating medium and printing/writing paper to be produced
 - o Scope of plant facilities
 - o Process to be adopted
 - o Collection and examination of basic design data
 - o Conceptual design
 - o Plant layout
 - o Degree of technical achievement to be demanded of employees
 - o Labor force
 - o Comparison between grounded and moored forms of platform-mounted construction
 - o Estimation of equipment cost
- Transportation of plant components, pulpwood, auxiliary materials and products
 - o Present status and projects for extending San Lorenzo jetty as facility for unloading plant components and for shipping finished products
 - o Distance, means and cost of transportation of plant components and finished products between San Lorenzo jetty and plant site
 - o Access road to plant site from highway linking San Lorenzo and Ibarra
 - o Transportation between logging area and plant site: Means and cost

- o *of transportation; construction of logging road*
 - o Means and cost of transporting finished products to locality of consumption (Guayaquil)
 - o Storage of pulpwood, auxiliary materials and finished products based on the transportation means: Scale of layout of storage yard and warehouse

- **Procurement of auxiliary materials**
 - o Imported N. UKP or N. BKP required for blending with locally produced pulp to ensure required quality of kraft liner and printing/writing paper: required quality, C.I.F prices, customs duties and charges
 - o Storage capacity required for the above imported N. UKP or N. BKP estimated from expected constancy of imported supply
 - o Chemicals required for cooking, bleaching and other processes: Domestic production, production capacity, quality and prices
 - o Quality, C.I.F prices, customs duties and charges of the above chemicals, when imported
 - o Storage capacity required for the above imported chemicals estimated from expected constancy of imported supply
 - o Other auxiliary materials required for plant operation: Domestic production, production capacity, quality and prices
 - o Quality, C.I.F prices, customs duties and charges of the above auxiliary materials, when imported
 - o Storage capacity required for the above imported auxiliary materials estimated from expected constancy of imported supply

- **Personnel organization and training for plant operation**
 - o Size of labor force recruitable in the area surrounding plant site; technical skill; wage levels
 - o Plan for personnel organization conforming with the construction and operation program of plant
 - o Availability of engineers from other domestic pulp and paper mills
 - o Plan for training conformable with available labor force and level of technical capability (in Ecuador and abroad)

- o Plan for technical assistance including plant operation and plant management
- Plant construction
 - o Estimation of construction period in consideration of such factors as size and scope of plant, construction method, labor force, condition of climate and of transportation
 - o Availability and cost of construction machinery to be procured locally
 - o Availability and cost of dredgers and port tugboats for access of industrial platform
 - o Availability and cost of construction materials (sand, gravel, aggregate cement, brick, lumber, concrete piles, etc.)
 - o Technical capability of local sub-contractors
 - o Necessary importation of construction equipment and material based on the foregoing studies
 - o Plan for plant operation program

(5) Plans for reforestation

- Reforestation projects in Ecuador
- Forest soil in Cayapas Forest Concession
- Climatic and environmental conditions in San Lorenzo area
- Vermins; ecology
- Choice of tree species suitable for reforestation
- Recommendable plan of reforestation

(6) Estimation of capital cost and production cost

- Plant construction cost (equipment cost, transportation cost, civil engineering and erection cost, etc.)
- Pre-operation cost
- Working capital
- Interest during construction
- Production cost: Raw materials, wages and salaries, overhead, depreciation, insurance premium, interest, etc.

- Other expenses: Pulpwood cost, labour cost, management cost, other miscellaneous expenses, depreciation insurance and interest, etc.
- Financing plan

(7) Financial analysis

- Prerequisites
- Various financial statements
- Internal rate of return (I.R.R), pay-out period, etc.
- Selection of the most suitable Project
- Sensitivity analysis on the most suitable Project

(8) Economic Analysis

- Economic internal rate of return (E.I.R.R) on the most suitable Project
- Sensitivity analysis on the most suitable Project
- Social benefits gained through this Project

(9) Overall evaluation and recommendations

- Selection of the most suitable Project based on the considerations of final product and construction system
- Evaluation on the most suitable Project
- Recommendations on the Project implementation

1.4 Acknowledgements

We would like to thank

Sr. Miguel Arcadio Caicedo T, Presidente del Municipio de San Lorenzo

Lcdo. José Iturralde Arteága, Presidente Industrial Forestal Cayapas, C.E.M.

Lcdo. Edmundo Estupiñan Maldonado, Gerente Administrativo Industrial Forestal Cayapas, C.E.M.

Professor Principal, Luís S. Valverde C.

Sr. Angel Eduardo Vallejo G., Industrial Forestal Cayapas, C.E.M.

Sr. Antonino Sáenz Fernandez, Gerente General Chapas y Maderas S.A.

For their valuable advice and kind assistance as well as the following Government Authorities and other organizations for their enormous cooperation and kind assistance, without which the present Feasibility Study could not have been executed.

Ministerio de Finanzas

Ministerio de Industrias Comercio e Integración – MICEI

Ministerio de Agricultura y Ganadería, Programa Nacional del Bananano

Consejo Nacional de Desarrollo

Centro de Desarrollo Industrial del Ecuador

Minicípio de San Lorenzo

Banco Central del Ecuador

Corporación Financiera Nacional

Instituto Ecuatoriano de Obras Sanitarias

Autoridad Portuaria de Esmeraldas

Armada del Ecuador - Dirección Dragardos

Armada del Ecuador - Instituto Oceanográfico

Papelera Nacional S.A.

Industria Cartonera Ecuatoriana S.A.

Productora Cartonera S.A.

Fábrica de Papel La Reforma C.A.

Industria Cartonera Asociada S.A.

Holanda Ecuador Cía. Ltda.

TECNAC

Estudios y Construcciones

Cámara de Industrias de Guayaquil

Industrial Forestal Cayapas, C.E.M.

Chapas y Maderas S.A.

Labores Agrícolas S.A.

Chapter 2.

MARKET

Chapter 2. MARKET

2.1 General

The present market study follows on the Pre-Feasibility Study conducted in 1980 by J.C.I, and has been performed with particular reference to kraft liner, corrugating medium and printing/writing paper, based on the trends registered during the past two years.

For earlier records concerning pulp and paper consumption up to 1978, reference has been made to the Estudio del Sector Pulpa y Papel en Ecuador, published by the CENDES; statistics covering the period 1981 to 1982 have been cited mainly from material and information made available by M.D.F, B.C.E, and CENDES.

The current status of production was observed through visits of the representative papermills PERFORMA, PANASA and INCASA, and in respect of conversion into carton boxes, through visits of the INCAESA and PRCASA.

In respect of data concerning lumber, information was derived from material received from I.F.C, which is operating a plywood mill in the country.

2.2 Current Status of Paper and Board Market in Ecuador

2.2.1 Demand of Paper and Board

As shown in Table 2-1, the demand for paper and board in Ecuador rose from 153 thousand tons in 1970 to 216 thousand tons in 1980. Of this demand, corrugated board represented 117 thousand tons in 1970, 111 thousand tons in 1975 and 119 thousand tons in 1980, revealing an extremely stable demand through these years. This demand has been almost totally generated for the manufacture of cartons to pack export banana.

The demand for paper and board other than for banana box manufacture has been, in comparison relatively small, but is showing a rapidly rising trend, having passed from 35 thousand tons in 1970 to 57 thousand tons in 1975 and to 97 thousand tons in 1980. The annual increase during the past 5 years has amounted to 11.2% in average.

Table 2-1. Production and Importation of Total Paper and Board

(Unit 1,000 tons)

	Total Consumption			Indigenous Production			Importation		
	Liner and Medium for Cor. Board	Others	Subtotal	Liner and Medium for Cor. Board	Others	Subtotal	Liner and Medium for Cor. Board	Others	Subtotal
1970	117.2	35.5	152.7	—	7.6	7.6	117.2	35.5	152.7
1971	116.2	87.3	203.5	—	9.4	9.4	116.2	87.3	203.5
1972	118.2	38.0	156.2	—	11.0	11.0	118.2	38.0	156.2
1973	115.7	52.5	168.3	—	13.0	13.0	115.7	52.5	168.3
1974	115.2	49.8	165.0	—	19.3	19.3	115.2	49.8	165.0
1975	111.2	56.7	167.9	—	21.5	21.5	111.2	56.7	167.9
1976	97.3	70.9	168.2	0.02	22.2	22.2	97.3	70.9	168.2
1977	102.0	82.0	184.0	0.2	27.6	27.8	102.0	82.0	184.0
1978	111.8	95.3	207.1	1.4	34.3	35.7	111.8	95.3	207.1
1979	124.1			11.8			124.1		
1980	118.8	Average		12.0	Average		118.8	Average	
1981	113.1	927.2		12.0	45.5		113.1	97.2	

- Notes:
- 1) Imported corrugated board: The figures representing imported corrugated board are not included in the official Ecuadorian statistics, for the reason that this material is ultimately re-exported with the banana for which the material serves as export container.
 - 2) Subtotal for total consumption: For the same reason the statistics generally published do not include the imported quantities which are included in the figures given here.

2.2.2 Indigenous Production of Paper and Board

As seen from Table 2-1, indigenous production of paper board has rapidly risen from 7,600 tons in 1970 to 21,500 tons in 1975 and to 57,500 tons in 1980. The portion occupied by this production in the total market has risen in keeping from 5 to 13 and to 27 percent during this period.

Paper manufacture in Ecuador is ensured by 8 mills, of which 3 supply the majority of the production, the remaining 5 being mills of very small scale, mostly producing material such as tissue paper mainly from waste paper.

The 3 principal mills are the following:

- (1) Fabrica de Papel La Reforma C.A.

This is the largest paper manufacturer in Ecuador. As raw material, apart from some hardwood used for producing kraft pulp, the sources of fiber are mainly waste

paper — both imported and recovered from surrounding communities — as well as shavings and cuttings of corrugated board obtained from carton makers. Products include wrapping and tissue paper, as well as some corrugated board for domestic consumption. Printing/writing paper also has come to be produced of recent, though still in small quantity.

The published production capacity is 25,000 tons per year.

(2) **Papelera Nacional S.A.**

This second largest papermill in Ecuador uses pulp produced within the mill from bagasse as well as shavings and cuttings from carton makers, to manufacture principally heavy wrapping paper for cement and sugar bags. Conversion into bags is also undertaken in the mill.

Published production capacity is 20,000 tons per year.

(3) **Industria Cartonera Asociada S.A.**

In contrast to the 2 above-cited mills located in the district of Guayaquil, this mill is situated near Quito, and utilizes waste paper recovered from this area as well as imported waste paper. Products include various boards as well as tissue and light wrapping paper.

Production capacity is 6,000 tons per year.

Apart from the foregoing 3 mills, which total a production capacity of 51,000 tons per year, it is reported that a new plant with a capacity of 10,000 tons per year is under construction near Cuenca, to produce bond paper. No information, however, is available on the expected commencement of production.

2.2.3 Importation of Paper and Board

The statistics on the paper and board market cited in the preceding Sections reveal that the bulk of paper and board consumed in Ecuador has been supplied by imported material. During the 3 years from 1979 to 1981, importations have averaged about 159 thousand tons, comprising mainly

- 106 thousand tons of kraft liner and corrugating medium
- 23 thousand tons of newsprint
- 21 thousand tons of printing/writing paper

the total figure representing approximately 95 percent of the 159 thousand tons of total import.

It is clear that a significant contribution to the reduction of foreign payments would be brought by realizing indigenous production of paper, and in particular, kraft liner and corrugating medium.

2.2.4 Indigenous Production of Carton Boxes

There currently exist in Ecuador the following 3 manufacturers of corrugated carton boxes:

- (1) Industria Cartonera Ecuatoriana S.A.

This mill furnishes 40 percent of the carton box demand for packing export banana.

- (2) Productra Cartonera S.A.

This mill supplies 30 percent of the banana box demand, and in addition, also produces carton boxes for other domestic uses from board furnished by La Reforma.

- (3) Macarsa

This mill provides the remaining 30 percent of the demand for banana boxes.

The foregoing 3 carton box manufacturers possess an aggregate production capacity exceeding 130 thousand tons, for which the carton material is currently totally imported, except for a small fraction of domestic material used for producing boxes to serve general domestic use.

These box manufacturers have declared that there should be no problem in converting to the use of indigenously produced board for manufacturing export banana boxes, so long as no appreciable difference is seen in quality compared with the imported material.

2.3 Kraft Liner and Corrugating Medium

2.3.1 Quantities Produced and Imported

The statistical data made available by CENDES gave the following figures for the quantities produced and imported of kraft liner and corrugating medium.

Table 2-2 Production and Importation of Kraft Liner and Corrugating Medium

(Unit: tons)

Year	Indigenous Production	Temporary Importation
1974	—	115,166
1975	—	111,213
1976	24	97,288
1977	170	101,875
1978	1,378	110,458
1979	11,800	112,336
1980	12,000	106,843
1981	12,000	101,052

The indigenous production is largely based on recycled waste paper as fiber source, to manufacture carton boxes for domestic consumption.

The figures in the above Table 2-2 for temporary importation represent almost entirely the material used for producing export banana boxes.

The figures in the above Table 2-2 reveal a level demand from year to year of corrugated board for export banana cartons, in contrast to the rising domestic demand for the same material to manufacture carton boxes for general domestic use.

2.3.2 Source Countries of Kraft Liner and Corrugating Medium

The United States currently furnishes 60 percent of the export market for kraft liner and corrugating medium. Imports into Ecuador also are largely sourced from the U.S.A.

2.3.3 Estimated Future Uses and Demand

2.3.3.1 For Export Banana Carton Boxes

Banana has for long years been the principal export item of Ecuador, and while very recently the top item of export has become petroleum, banana still ensures a stable export commodity and source of foreign currency.

Ecuadorian exports were constituted in 1982 as given in the accompanying Table 2-3.

Table 2-3. Breakdown of Ecuadorian Exports

Item	Value Exported (US.\$1,000)	Distribution Ratio (%)
1. Petroleum products	1,256,534	60.27
2. Banana	182,475	8.75
3. Cacao	26,474	1.27
4. Coffee	94,029	4.51
5. Other articles	525,437	25.20
Total	2,084,949	100.00

Carton boxes for export banana are manufactured in the 4 sizes listed in Table 2-4; the current trend is toward increasing concentration on the largest 22-XU size. An average of 83 kg of kraft liner and corrugating medium are used for packing 1 ton of export banana.

Table 2-4. Types of Standard Export Banana Boxes and Annual Consumption

Unit: 1,000 boxes

Type	22-XU	115K	208	25-27
Capacity	19.5 kg	15.5 kg	12.7 kg	11.8 kg
1974	50,240	6,971	21,548	285
1975	46,752	20,502	10,998	1,960
1976	42,045	15,495	6,161	5,344
1977	48,084	16,527	4,559	2,661
1978	48,269	16,928	8,590	3,689
1979	56,720	10,179	6,694	3,477
1980	63,651		5,783	
1981	59,515		6,527	

To serve as indication, the past trend of banana exports from Ecuador are cited in Table 2-5 from material obtained from the Programa Nacional del Banano. It is seen that the figures roughly coincide with those given in the preceding Table 2-2.

Table 2-5. Export Banana; Export Banana Packing Boxes

Year	Export Banana (tons)	Banana Packing Boxes (tons)
1974	1,357,135	113,320
1975	1,362,352	113,756
1976	1,200,991	100,283
1977	1,260,516	105,253
1978	1,362,822	113,796
1979	1,386,045	114,065
1980	1,318,225	110,072
1981	1,246,827	104,065

It is estimated by CENDES and the Programa Nacional del Banano that banana exports should maintain the present level during the coming years, and this would point toward a more or less stable future demand of around 103,500 tons/year of kraft liner and corrugating medium. Corrugated board is made up of 67 percent kraft liner and 33 percent corrugating medium, so that the above demand for liner and medium would break down into:

69,350 tons/year of kraft liner
 34,150 tons/year of corrugating medium.

2.3.3.2 Corrugated Board for Domestic Consumption

In the past, carton boxes found only extremely limited use in Ecuador apart from banana packing, and their consumption was not even accounted for as an independent item in national statistics. This situation has radically changed after 1967, in which year for the first time 24 tons of corrugating medium were produced indigenously, and which was followed in the ensuing years by an extremely rapid rise of domestic demand for this product. Also, production of liner and medium reached 11,800 tons/year by 1979, but has since maintained the level of 12,000 tons/year, which is attributable more to limitation of production capacity rather

than to saturation of domestic demand.

Corrugated board made with the indigenously produced liner and medium is used for such purposes as packing butter and other dairy products, batteries, soap, liquor, cooking oil and household wax, but many other uses can be expected to be found in the future. A box manufacturer in Guayaquil declared that he was considering the production of boxes for packing cans.

Consequently, the domestic market for carton board can be expected to expand considerably in the future. Thus, forecasts for the period 1980 – 1990 given by Weyerhaeuser (U.S.A) indicate that, whereas the demand for corrugated board would rise by only 3 percent per year in the world as a whole, the rate would be 5 percent per year for Latin America. For Ecuador, CENDES cites a figure of 18 percent per year. Based on these estimates, a value of 10 percent per year is adopted in this instance as a realistic estimate for yearly increase of carton board demand in Ecuador, which corresponds to the actual annual rise in the overall demand in Ecuador for both paper and board. This rate of expansion would bring the demand for liner and medium in 1990 to 28,300 tons/year, made up of:

18,960 tons/year of kraft liner
9,340 tons/year of corrugating medium.

2.3.3.3 Estimated Total Demand for Liner and Medium

The foregoin estimates of the liner and medium demand in 1990 for both banana boxes and domestic use add up to a total figure of 131,800 tons/year. Subtracting from this the 12,000 tons/year already being supplied by REFORMA from shavings/cuttings and collected waste paper, there would remain 119,800 tons/year to be additionally supplied, made up of:

80,300 tons/year of kraft liner
39,500 tons/year of corrugating medium.

The above figures are adopted in the present study.

2.3.4 Market Prices of Kraft Liner and Corrugating Medium

Kraft liner and corrugating medium is imported into Ecuador under the category of temporary importation, and as such it does not figure in official importation statistics, nor do these articles figure in the customs tariff.

Under such circumstances, no figures exist that correspond to a normal market price: The prices in Ecuador of kraft liner and corrugating medium are based on the prices paid by the Ecuadorian carton box manufacturers for purchasing the imported board. Consequently, the market prices for these materials are largely determined by the F.O.B price ex-U.S. port plus freightage.

The quoted F.O.B prices for the American products have remained largely unchanged since 1981 at US.\$ 330 to 340 per ton for kraft liner and US.\$ 320 to 330 per ton for corrugating medium, but prices actually paid by consumers are known to have fallen far short of the quotations – down to US.\$ 290 to 280 per ton, respectively in the current disturbed U.S. market.

Such low prices, however, must be considered a transient occurrence; moves have already appeared in Europe for raising the floor price of imported carton up to a level around US.\$ 330 to 370 per ton.

PPI has published in its Annual Review of July 1982 the following forecast of rising prices for kraft liner.

Table 2-6. Predicted Market Prices for Kraft Liner

1983	US.\$ 370/ton
1984	US.\$ 400/ton
1985	US.\$ 500/ton

For the purposes of the present study, the following prices have been adopted, based on the currently quoted F.O.B prices in the U.S. market increased by US.\$130 per ton to cover freightage and other charges for importation into Ecuador.

Kraft liner	US.\$ 440/ton
Corrugating medium	US.\$ 430/ton

2.4 Printing/Writing Paper

2.4.1 Quantities Produced and Imported

No printing/writing paper was produced in Ecuador until 1981. It is learned that REFORMA has come to produce certain grades of printing/writing paper, but their production figures do not appear as yet in available statistics.

It can thus be considered that even today the supply of printing/writing paper is practically wholly dependent on importation.

The statistics made available by CENDES give the following figures for the importation of printing/writing paper:

Table 2-7. Imported Quantities of Printing/Writing Paper

1974	6,130 tons
1975	8,162 tons
1976	8,365 tons
1977	9,108 tons
1978	11,470 tons
1979	No data available
1980	16,816 tons
1981	19,363 tons

The above statistics reveal a steadily rising consumption of this type of paper in Ecuador during the past years, with an annual growth rate amounting to roughly 18%.

The composition of the figures for 1980 and 1981 by tariff number is as follows.

Table 2-8. Imports of Printing/Writing Paper by Tariff No.

(Unit: tons)

Tariff No.	Basis Weight (g/m ²)	1980	1981
48.01.02.01	Watermarked paper	100	310
48.01.02.11	18	20	23
48.01.02.12	18 – 30	468	2,007
48.01.02.13	30 – 60	9,506	10,526
48.01.02.14	60 – 80	3,850	2,934
48.01.02.15	80 – 120	1,347	1,661
48.01.02.99	Others	1,525	1,902
Total		16,816	19,363

2.4.2 Sources of Importation

The composition by countries of origin is as follows.

Table 2-9. Imports of Printing/Writing Paper by Country

(Unit: tons)

Country	1980	1981
Brazil	6,630	10,596
Argentina	2,205	2,542
Colombia	2,119	123
U.S.A	3,078	2,027
Other countries	2,784	4,075
Total	16,816	19,363

It is seen that importations from Brazil occupy a predominant position.

2.4.3 Estimated Future Demand

The estimates published by CENDES indicate that the present rate of rising demand (approx. 18% per year, see Section 1.1.2) should continue for 4 to 5 years to come, to reach approximately 42,300 tons in 1986.

While it is evident that demand of printing/writing paper in Ecuador should be

increasing considerably during the coming years, considering that today the per capita consumption does not exceed 2 kg/year, it may still be somewhat unrealistic to expect a sustained rise at the above-mentioned annual rate of 18%.

The long-term forecast published by F.A.O indicates a rate of increase of printing/writing paper demand in the period up to 2,000 of 5% for the world as a whole, and 6.3% for all countries excluding North America, Europe, and Japan.

For Latin American countries, the figure should be appreciably higher than these F.A.O estimates for world coverage. In the present instance, it has been envisaged that the 10% per year increase in demand recorded in the past in Ecuador as average for all kinds of paper and board should be applicable to printing/writing paper during the coming years, to reach approximately 45,000 tons/year in 1990.

Printing/writing paper is demanded in large variety for different uses, and for given basis weight different qualities of paper have to be supplied to cover differences in the amount of clay addition and whether or not coated. It should not be practical to attempt producing all these different grades of paper on a single paper machine. This applies particularly to a newly established mill, where frequent changes in product grade should very seriously impair operating efficiency.

Based on the foregoing observations, it is envisaged in the present instance to limit production to standard quality printing/writing paper of around 40 – 80 g/m² basis weight, which represents a grade of paper susceptible of commanding the largest market. The demand for this quality of paper is estimated by assuming that about 65% of the total printing/writing paper demand in Ecuador would fall in the above-envisaged range of basis weight, of which about 80% would be represented by standard quality paper not requiring coating or other special treatment. These assumptions bring the demand for 40 – 80 g/m² printing/writing paper of standard quality paper to

$$45,000 \times 0.65 \times 0.8 = 23,400 \text{ tons/year,}$$

which is the figure envisaged for the present Project.

2.4.4 Selling Price

Data obtained from B.C.E give the following figures as import prices of printing/

writing paper of different grades manufactured with not more than 70 percent mechanical pulp.

Table 2-10. Import Prices of Printing/Writing Paper

(Unit: US.\$/ton, CIF)

Tariff No.	1980	1981	1982
48.01.02.01	823	729	—
48.01.02.11	2,544	2,805	1,852
48.01.02.11	1,109	*206	1,147
48.01.02.13	871	895	853
48.01.02.14	843	916	901
48.01.02.15	811	872	753
48.01.02.99	703	768	866

Note: *206 : Possibly a typing error that should correctly read 1,206.

The quality of paper envisaged for this Project (40 – 80 g/m² basis weight) would correspond to the Tariff Nos. 13, 14 and 15. From the prices given in the above Table, the average import price of the 3 qualities of paper in question – weighted in proportion to the quantities imported – amounts to US.\$ 896 per ton. Presuming the proportion of quantities imported to have been the same for 1982, the corresponding average price would be US.\$ 851 per ton.

The latter figure of US.\$ 851 per ton has been adopted in the present instance.

2.5 Lumber

2.5.1 Demand

Of the 190,000 m³/year of wood logged for the present Project, it is envisaged to sell ¼ – or 47,300 m³/year (see Chapter 8, "Pulpwood Supply") – as lumber to plywood and/or saw mills.

(1) Plywood

Plywood is produced in the Esmeraldas Province by 3 enterprises including the Chapas y Maderas S.A. (owned to 99.4% by I.F.C), their aggregate production capacity being 42,800 m³/year, constituted as follows:

Table 2-11. Plywood Production in the Esmeraldas Province

(Unit: m³/year)

Enterprise	Nominal Capacity	Lumber Consumption
CEDESA	19,000	42,200
CHAPAS	16,000	36,900
CREART	7,200	16,000
Total	42,800	95,100

The lumber consumption figures cited Table 2-8 have been derived assuming full capacity production with a yield of 45%.

All 3 of these mills are said to be currently operating at only 60 – 65 percent capacity, and one reason for this is reported to be shortage of feed. This would mean that, apart from the 36,900 m³/year that would be furnished by Cayapas to fully feed its own Chapas y Maderas mill, the remaining two outsider mills could also absorb a further 35 – 40 percent of their respective feed requirements to bring them to full operation. This will represent a total demand for plywood feed amounting to 53,700 m³/year.

(2) Sawlog

Esmeraldas Province has about 50 saw mills in operation today, with an average consumption of about 3,000 m³/year of lumber.

Against this supply, there is a fairly large demand in the country for sawn log, and it is known that I.F.C is planning to establish a new saw mill to produce 50,000 m³/year of sawn log.

When this projected mill comes into operation, it will alone require the supply of 85,000 m³/year of lumber, assuming 60% yield.

2.5.2 Price

Data made available by Cayapas indicates that Chapas y Maderas is purchasing lumber for plywood at prices of:

Sc. 970 per m³ for Quality A (approx 60% of supply)

Sc. 870 per m³ for Quality B (ditto 25%)

Sc. 670 per m³ for Quality C (ditto 15%).

It should be noted in this connection that Quality A lumber is being traded in Quito at prices as high as Sc. 1,850 per m³, while on the one hand, there are said to be cases where only Sc. 600 per m³ are paid by large firms to individually operating loggers.

In the present instance, a lumber price of Sc. 920 (US.\$ 28) per m³ has been adopted, taking the average between Quality A and B prices paid by Chapas y Maderas.

Chapter 3.

FOREST RESOURCES

Chapter 3. FOREST RESOURCES

3.1 Cayapas Forest Concession

3.1.1 Cayapas Forest Concession

The Cayapas Forest Concession occupies an area of 213,337 ha, situated in the northwest part of the province of Esmeraldas, bounded to the west by the Pacific Ocean and to the north by the Columbian border formed by the Rio Mataje.

The climate is humid tropical, and the surface is covered by tropical rain forest composed of mixed species.

3.1.2 Forest Area

The surface area occupied by the Concession would be as given in the below Table 3-1, which has been derived from measurements made on a map provided by D.D.F.

Therefore, topographical conditions of the Concession would limit the utilizable area to 128,747 ha.

Table 3-1. Area of Cayapas Forest Concession

(Unit: ha)

Classification	Forested	Non-forested	Total
Accessible	128,747	31,486	160,233
Inaccessible	43,401	9,743	53,144
Total	172,148	41,229	213,377

For further details see following Table 3-2.

Table 3-2. Cayapas Forest Concession Areas Represented by Different Types of Terrain

(Unit: ha)

Terrain	Forested	Non-Forested	Total
<u>Mountainous</u>			
Accessible	* 43,128	310	43,438
Inaccessible	17,477	—	17,477
Sub-total	60,605	310	60,915
<u>Broken</u>			
Accessible	* 25,924	9,742	35,666
Inaccessible	25,924	9,743	35,667
Sub-total	51,848	19,485	71,333
<u>Undulating</u>			
Exploited	* 7,703	1,955	9,658
Unexploited South	* 8,142	2,116	10,258
Unexploited North	* 19,467	326	19,793
Sub-total	35,312	4,397	39,709
<u>Plain</u>	* 9,651	3,594	13,245
<u>Coastal</u>	* 14,732	13,443	28,175
Total	172,148 * 128,747	41,229	213,377

* Figures thus marked represent the areas that are accessible.

Source: Mapping by D.D.F.

Terrain Classification and planimetry by H.A. Simons (International) Ltd.

3.1.3 Lots Constituting the Concession; Topography

The map referred to above indicates the Concession to be divided into 9 lots, which can be classified according to nature of terrain into the following 5 Categories.

Lots 1, 2a, 2b, 2c, and 4a	Coastal
Lot 2	Plain, Undulating, and Coastal
Lot 3	Mountainous, and Broken
Lot 3a	Mountainous, Broken, and Undulating
Lot 4	Undulating, and Coastal

The amounts of average forest volume by terrain are shown in Table 3-3.

Table 3-3. Amounts of Average Forest Volume by Terrain

(Unit: m³/ha)

Terrain	B.H.D		Aggregate
	10-50 cm	50 cm+	
Undulating	72.67	117.83	190.50
Mountainous	74.99	84.58	159.57
Plain	56.52	89.54	146.06
Broken	63.61	72.97	136.58
Coastal	50.41	43.45	93.86

Source: Project F.A.O/SF: 76/ECU 13

For further details, see attached Map 3-1 and Table 3-4.

The source of Table 3-4 was recompiled by J.C.I from data by H.A. Simons (International).

Table 3-4. Cayapas Forest Concession Terrains Comprising the Lots in the Concession

Lot No.	Terrain	Forest Potential when considered as Pulpwood Source for the Pulp/Paper Production Operations
Lot 1	Coastal	Lowest forest volume in the Concession (93.86 m ³ /ha). Only possible means of transportation is by raft and/or barge along waterways.
Lot 2	Plain Undulating Coastal	Undulating terrain offers the highest forest volume. (190.50 m ³ /ha), and Plain the third highest (146.06 m ³ /ha). No transportation difficulty except for Coastal.
Lots 2a, 2b and 2c	Coastal	Same remarks as for Lot 1.
Lot 3	Mountainous Broken	High forest volume (Mountainous: 159.57 m ³ /ha; Broken: 136.58 m ³ /ha). No transportation difficulty.
Lot 3a	Mountainous Broken Undulating	Highest forest volume in the Concession. No difficulty for transportation.
Lot 4	Undulating Coastal	Undulating has highest potential.
Lot 4a	Coastal	Same remarks as for Lot 1.

3.1.4 Selection of Lot to be Logged

Among the different terrains enumerated in the preceding Section, "Coastal" carries the least forest volume, and moreover, the mangrove growing on this terrain is prohibited logging on grounds of beach protection.

For this reason, the eligible lots for logging are restricted to Lots 2, 3, 3a, and 4.

Of these lots, Lot 4 is constituted of both "Undulating" and "Coastal" terrains, of which the latter occupies only a small portion, and the preponderant remainder of the surface is covered by "Undulating" carrying the largest forest volume (190.5 m³/ha).

This lot, however, will have to continue serving mainly the existing plywood mill located nearby which is owned by I.F.C, as well as the projected new saw mill.

This leaves Lots 2, 3, and 3a as finally eligible main sources for the pulpwood to feed the envisaged plant. This plant being to be located in the vicinity of San Lorenzo, it is logical to start by logging Lot 2 situated nearest the envisaged plant site, to be followed by Lots 3, and 3a in that order.

The available logging areas of these 3 lots are given in the attached Table 3-5.

3.1.5 Wood Species

As normally encountered in all tropical rain forests, the species of wood occurring in the Concession are extremely varied and numerous: Certain of its areas have counted 50 species in a single hectare.

The entire Concession would probably count several hundred species, which should be impossible to list up completely, and should not serve usefully for the present purpose. It should moreover be very difficult to selectively exploit certain given species from this highly varied mixture.

3.1.6 Forest Volume by Species – Lot 2

See attached Table 3-6, derived from data given in Project F.A.O/SF: 76/ECU 13.

Table 3-5. Logging Areas Available in the Lots Envisaged for Exploitation

Lot	Terrain	Total Area	Inaccessible	Non-Forested	Available for Logging
Lot 2	Plain	13,200	–	3,600	9,600
	Undulating	10,100	3,300	1,800	5,000
	Sub-total	23,300	3,300	5,400	14,600
Lot 3	Mountainous	58,500	16,900	300	41,300
	Broken	23,600	11,800	4,400	7,400
	Sub-total	82,100	28,700	4,700	48,700
Lot 3a	Mountainous	2,400	600	–	1,800
	Broken	26,200	13,100	4,900	8,200
	Undulating	1,900	500	400	1,000
	Sub-total	30,500	14,200	5,300	11,000
Grand Total		135,900	46,200	15,400	74,300

Unit: ha

Source: Terrain Classification and Planimetry by J.C.I.

Table 3-6. Cayapas Forest Concession Forest Volume by Species and Terrain – Lot 2

SPECIES		PLAIN				UNDULATING				SUB-TOTAL				TOTAL	
		9,600 ha				5,000 ha				14,600 ha					
(B.H.D)		10–50 cm		50 cm+		10–50 cm		50 cm+		10–50 cm		50 cm+		m ³ /ha	m ³
		m ³ /ha	m ³	m ³ /ha	m ³	m ³ /ha	m ³	m ³ /ha	m ³	m ³ /ha	m ³	m ³ /ha	m ³		
1	ANIME	2.42	23,232	11.23	107,808	4.37	21,850	6.01	30,050	3.09	45,082	9.44	137,858	12.53	182,940
2	CUANGARE	10.05	96,480	7.19	69,024	6.38	31,900	10.72	53,600	8.79	128,380	8.40	122,624	17.19	251,004
3	CHALVIANDE	1.62	15,552	7.92	76,032	2.15	10,750	10.45	52,250	1.80	26,302	8.79	128,282	10.59	154,584
4	GUAYACAN	0.83	7,968	5.25	50,400	0.88	4,400	0.38	1,900	0.85	12,368	3.58	52,300	4.43	64,668
5	LAGUNO	–	–	–	–	–	–	–	–	–	–	–	–	–	–
6	MASCAREY	–	–	0.81	17,376	–	–	5.20	26,000	–	–	2.97	43,376	2.97	43,376
7	ROBLE	2.08	19,968	1.08	10,368	–	–	0.54	2,700	1.37	19,968	0.90	13,068	2.26	33,036
8	SANDE	1.64	15,744	13.26	127,296	7.35	36,750	15.90	79,500	3.60	52,494	14.16	206,796	17.76	259,290
9	CEDRO	1.72	16,512	8.69	83,424	4.40	22,000	6.48	32,400	2.64	38,512	7.93	115,824	10.57	154,336
10	CHANUL	0.75	7,200	8.49	81,504	2.56	12,800	16.74	83,700	1.37	20,000	11.32	165,204	12.69	185,204
11	MORAL	0.46	4,416	–	–	–	–	–	–	0.30	4,416	–	–	0.30	4,416
12	MAREQUENDE	0.48	4,608	–	–	0.60	3,000	–	–	0.52	7,608	–	–	0.52	7,608
13	JIGUA	6.51	62,496	7.03	67,488	6.00	30,000	10.13	50,650	6.34	92,496	8.09	118,138	14.43	210,634
14	CAIMITILLO	3.26	31,296	3.61	34,656	2.90	14,500	3.22	16,100	3.14	45,796	3.48	50,756	6.61	96,552
15	SAJO	3.02	28,992	0.44	4,224	–	–	–	–	1.99	28,992	0.29	4,224	1.59	23,216
16	GUALANDANO	1.67	16,032	1.33	12,768	1.14	5,700	1.36	6,800	1.49	21,732	1.34	19,568	2.83	41,300
17	CARRA	0.51	4,896	–	–	–	–	0.71	3,550	0.34	4,896	0.24	3,550	0.58	8,446
18	CEIBA	–	–	1.06	10,176	–	–	0.60	3,000	–	–	0.90	13,176	0.90	13,176
19	LANA	–	–	–	–	–	–	–	–	–	–	–	–	–	–
20	PEINE DE MONO	0.09	864	0.41	3,936	0.85	4,250	3.87	19,350	0.35	5,114	1.59	23,286	1.95	28,400
21	GUABO	1.03	9,888	–	–	4.32	21,600	1.24	6,200	2.16	31,488	0.42	6,200	2.58	37,688
22	UVA	0.22	2,112	–	–	2.44	12,200	1.55	7,750	0.98	14,312	0.53	7,750	1.51	22,062
23	UNKNOWN	18.16	174,336	11.74	112,704	26.31	131,550	22.73	113,650	20.95	305,886	15.50	226,354	36.45	532,240
TOTAL		56.52	542,592	89.54	869,184	72.67	363,250	117.83	589,150	62.07	905,842	99.87	1,458,334	161.24	2,354,176

3.1.7 Basic Density

The basic densities by species are as given Table 3-7, where the species marked by asterisk are those on which pulping tests were conducted this time.

Table 3-7. Basic Densities of Cayapas Forest Concession Woods

Species	Basic Density (kg/m ³)		
	(1)	(2)	(3)
Aníme*	408	452	430
Cuángare*	409	360	385
Chalviande*	420	369	395
Guayacan		833	
Laguno		405	
Mascarey		666	
Roble		688	
Sande*	527	348	438
Cedro		425	
Chanul		724	
Moral		652	
Marequende		1,152	
Jigua*	443	423	433
Caimitillo		680	
Sajo		361	
Gualandano		315	
Carra*	517	567	542
Ceiba		207	
Lana		570	
Peine de Mono		234	
Guaba*	524	590	557
Uva*	360	306	333
Chillalde*	347	270	309
Galza*	391		

Sources:

- (1) Data from tests conducted at Central Research Laboratory, Honshu Paper Co. Ltd., Japan.
- (2) F.A.O : F.A.O/SF : 76/ECU 13, Vol. 4. and Collected data on "Strengths of wood occurring in foreign countries - Latin America" (published by Shimane University in Japan).
- (3) The arithmetic means of (1) and (2).

3.1.8 Distribution of Basic Densities – Lot 2

The composition of forest volume by categories of basic density, calculated from the values of basic density cited above and the forest volume, are as follows:

Below 250 kg/m ³	5%
250–650 kg/m ³	70%
Above 650 kg/m ³	25%

The mean basic density would be estimated from calculation to be 456 kg/m³.

The Ceiba and Peine de Mono represent light wood with basic density below 250 kg/m³, and should prove valuable for packing boxes, lightweight structures, sliced veneer, toys, ceiling panels, buoys and other where lightweight wood is required.

Among the heavier species of basic density above 650 kg/m³, wood of particularly hard and durable properties should have applications in civil and building work; other species decorative grain should prove valuable as material for furniture, flooring and paneling.

The basic density range suitable for pulping would be to be 250 to 650 kg/m³, so that considered superficially solely from this criterion, 70% of the forest volume of Lot 2 would be utilizable for pulping.

This range of basic density is also suitable for plywood and sawn log, so that it remains to seek the most effective means of exploiting species occurring in this Lot 2 that present basic density in this range.

3.2 Estimated Forest Volume and Net Exploitable Volume – Lot 2

3.2.1 Forest Volume and Net Utilizable Volume of Marketable Species – Lot 2

The marketable species* occurring in Lot 2 would be the 13 kinds comprising Aníme, Cuángare, Chalviande, Guayacan, Mascare, Roble, Sande, Cedro, Chanul, Jigua, Caimitillo, Sajo, Gualandano, whose forest volume have been calculated as given in the Table 3-8, from the data on forest volumes contained in the Section 3.1.6 in this Chapter.

Table 3-8. Net Forest Utilizable Volume of Marketable Species in Lot 2

Species	B.H.D				Total	
	10-50 cm		50 cm+			
	(m ³ /ha)	(m ³)	(m ³ /ha)	(m ³)	(m ³ /ha)	(m ³)
Aníme**	3.09	45,082	9.44	137,858	12.53	182,940
Cuángare**	8.79	128,380	8.40	122,624	17.19	251,004
Chalviande**	1.80	26,302	8.79	128,282	10.59	154,584
Guayacan	0.85	12,368	3.58	52,300	4.43	64,668
Mascare	—	—	2.97	43,376	2.97	43,376
Roble	1.37	19,968	0.90	13,068	2.26	33,036
Sande*	3.60	52,494	14.16	206,796	17.76	259,290
Cedro	2.64	38,512	7.93	115,824	10.57	154,336
Chanul	1.37	20,000	11.32	165,204	12.69	185,204
Jigua	6.34	92,496	8.09	118,138	14.43	210,634
Caimitillo	3.14	45,796	3.48	50,756	6.61	96,552
Sajo	1.99	28,992	0.29	4,224	1.51	23,216
Gualandano	1.49	21,732	1.34	19,568	2.83	41,300
Sub-total (Useful species only)	36.47	532,122	80.69	1,178,018	117.16	1,700,140
(Other species)	25.60	373,720	19.18	280,316	44.78	654,036
Grand Total	62.07	905,842	99.87	1,458,334	161.24	2,354,176

(Surface area of Lot 2: 14,600 ha)

*) Marketable species: Species of wood actually marketed in Ecuador.

***) Species marked thus in the Table 3-8 represent those actually used in I.F.C plywood mill as source of plywood.

Of the existing forest volume of the marketable species, the percentages that would represent the net salable volumes should be considered the following, depending on the diameter at breast height.

B.H.D (cm)	Percent Net Salable Volume (%)
10–50	20
50+	40

The above percentages would yield a net salable forest volume per hectare for Lot 2 of:

$$(36.47 \times 0.2 + 80.69 \times 0.4) \times 0.8 = 32 \text{ m}^3$$

Where the coefficient 0.8 represents the net utilization made of the existing forest volume.

For Lot 2 as a whole measuring 14,600 ha, the net salable volume of marketable species would amount to:

$$32 \times 14,600 = 467,200 \text{ m}^3.$$

3.2.2 Coefficient of Net Utilization

Values of 25 to 30% are currently adopted to account for losses from blights, rot, breakage and other causes at the logging site, when the wood is to be used for pulping. The reason for adopting a coefficient of the net utilization as high as 0.8 in the calculations presented in Section 3.2.1 is that in the present instance, it is envisaged to utilize waste wood as fuel for heat generation.

Application of the above-mentioned coefficient of the net utilization will give an average net utilizable overall forest volume of

$$161.24 \times 0.8 \doteq 129 \text{ m}^3/\text{ha}$$

for the entire Lot 2.

3.2.3 Selective Utilization of the Useful Species

The available species of wood should be utilized each in such manner as to gain the highest value added when offered to the market.

To this end, the properties of each available species should be examined for their marketability before determining their applications.

For the purposes of the present study, however, the following percentages were assumed for the uses to be made of the available forest volume, based on the values given in Section 3.2.1 on the net salable forest volume.

For pulping	60% amounting to approx. 78 m ³ /ha.
For plywood and sawn log	25% amounting to approx. 32 m ³ /ha.
For fuel	15% amounting to approx. 19 m ³ /ha.
Total	100% amounting to approx. 129 m ³ /ha.

In actual implementation, the above 3 categories of wood utilization would be subject to the following conditions.

3.2.4 Pulpwood

The suitable range of basic density for pulpwood, as already mentioned, would be 250 to 650 kg/m³, or better 300 to 600 kg/m³.

Moreover, the most suitable pulpwood should present a pale color, be free of latex and possess small vessels.

For the present Project, species meeting the above criteria would be selected for use to the maximum extent practicable.

For purposes of calculation, a value of 450 kg/m³ was adopted for average basic density in calculating the required pulpwood volume.

3.2.5 Sawn Log

Hard and durable wood is best suited for producing sawn log to be used in civil, building structures and for manufacturing furnitures, and wood value will be further enhanced if it possesses decorative grain and be light in weight.

3.2.6 Plywood

Sande, Chalviande, Aníme and Cuángare, which are already being utilized in existing plywood mill, should continue to be used for plywood manufacture.

3.2.7 Fuel

Material found unsuitable for the 3 above applications would be burned as fuel, including defective, waste, and insufficient diameter wood.

3.3 Net Available Wood Volume from Lot 2

The net available wood volume from Lot 2 for the 3 applications would be calculated as follows, based on the surface area and the available forest volume in Lot 2 mentioned Section 3.2.1 and 3.2.3 in this Chapter.

For pulping	Approx. 1,138,800 m ³ .
For plywood and sawn log	Approx. 467,200 m ³ .
For fuel	Approx. 277,400 m ³ .
Total	Approx. 1,883,400 m ³ .