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FORM 3

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PRELIMINARY STUDY ON
THE INDUSTRIAL UTILIZATION OF BAGASSE
IN THE PROVINCE OF TUCUMAN
ARGENTINA

S/F BAGASSE
C/F ARGENTINE

FOR

UNITED NATIONS INDUSTRIAL
DEVELOPMENT ORGANIZATION

VIENNA, AUSTRIA

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PRELIMINARY STUDY ON THE
INDUSTRIAL UTILIZATION OF BAGASSE
IN THE PROVINCE OF TUCUMAN - ARGENTINA

A. INTRODUCTION

A 1 Contract and Parties Involved

Having received from the Government of Argentina a request for assistance in administration of a study, on the integral industrial utilization of bagasse in Tucumán province, the United Nations Industrial Development Organization issued an international tender call for proposals for the preparation of a study.

Subsequent evaluation of submissions received resulted in award of the study to Stadler Hurter Limited, Montreal, Canada, and a contract (UNIDO No 71/53) for performance of the necessary investigations was accordingly effected between UNIDO and Stadler Hurter Limited. By prearrangement, Stadler Hurter retained the Argentine firm of COARA, Consultores Asociados, Buenos Aires, to assist with the work.

A.2 Background Information

a) General

The province of Tucumán is located approximately due North and 1200 km. from Buenos Aires and is among the group of "Northwest Provinces" whose development potential is of current interest. The other provinces in the group are

Catamarca, Salta, Jujuy, and Santiago del Estero. A comprehensive program (NOA Program) has been and is being planned to stimulate and accelerate growth in the region and thus improve its economic position relative to other more advanced parts of Argentina.

In the North-South direction Tucumán lies completely between parallel 26° and parallel 28° South which renders the climate suitable (though not ideal) for the cultivation of sugar cane. Based on this agricultural resource a large cane sugar industry has developed over the years to such an extent that, despite the fact that it is the smallest of all of the provinces of Argentina, Tucumán has in the past supplied up to 60%, and at present contributes over 50% of sugar produced in Argentina. Its sixteen operating sugar mills (or "Ingenios") in 1970 manufactured over 491,000 metric tons of a national total of 908,000 tons of sugar.

Due principally to the sub-tropical nature of the climate the crushing season (zafra) in Tucumán is unfortunately limited to less than four calender months. The general economy of the province is in consequence adversely affected by the problems arising from the relatively short periods of seasonal productive activity and the corresponding lack of employment which exists between crushing seasons.

b) Sugar Cane Bagasse

When sugar cane is crushed to extract the juices containing the sugar a fibrous residue is left which is known as sugar cane bagasse. Regarded essentially as waste, this material has traditionally been utilized as the primary fuel for generation of process heat requirements thus solving the disposal problem in a manner which yields a benefit to the overall economy of sugar production. Since, on a dry basis, the ratio of bagasse to sugar in Tucumán is approximately 1.5 : 1 it is evident that large quantities are produced and burnt in the ingenios of Tucumán.

In comparatively recent times a number of potentially more profitable ways in which sugar cane bagasse can be utilized have been developed and implemented in many sugar producing areas. Bagasse being essentially fibrous in nature these developments generally have been oriented towards manufacture or substitution of existing products which use cellulose fibre as the basic raw material although other applications have also been found.

Since the bagasse which is generated represents a convenient, reliable, economical and readily available fuel for the sugar mill boilers, it is obvious that, if it is to be diverted for other purposes, an acceptable substitute fuel of at least equally desirable characteristics must be provided. The availability of such alternative fuel is the fundamental and major factor in determining the cost of the bagasse and, therefore, the practicability of utilizing it for establishment of other industries.

The existence of an adequate supply of natural gas and a conveniently located distribution system in Tucumán should eliminate any problem with regard to substitute fuel.

A.3 Aim of the Study and Scope of the Work

From the terms of reference in the Contract and pertinent information in other documents the aim of the study, in broad definition, has been interpreted to be to determine the manner in which the bagasse from the ingenios of Tucumán can most effectively be utilized to improve the economy of Argentina in general and conditions in the province of Tucumán in particular.

The scope of the work has accordingly been related to this concept and the study has been developed to indicate, technically, financially and socially, the most advantageous course along which the industrialization of bagasse should be directed and, at the same time, the aspects which would merit exploration in finer detail through specific feasibility studies.

The basic assumption has been made that in order to have a significant economic effect on a national and provincial scale the projects to be considered must be of substantial magnitude and must use the largest possible quantities of the bagasse available. For this reason, attention has been concentrated on the possibilities of manufacturing pulp, paper, and board products. Other types of product can be made from a bagasse base but markets are very limited and the consumption of the bagasse is accordingly relatively minor. Conversely, the scale and rate of development of paper and board products manufacture are in general limited only by the continuous and rapid growth of market demand or by the availability of the bagasse itself. Progress in this type of industry has, moreover, accelerated rapidly in the past two decades and bagasse-based pulp, paper and board mills are presently operating profitably in many parts of the world using proven and well-known technology.

In accordance with the specification in the Contract and the above assumptions, cost models have been developed for small, medium and large pulp and paper mills, the selection of the relative capacities and the products to be manufactured being based generally on the indications of the market study and, for the largest mill, the most economical availability of bagasse.

These cost models (referred to in the report as Model I, Model II and Model III) are presented in adequate detail to permit valid comparisons to be made in reference to technical, economic, financial and social aspects.

The approximate timing of the first project has been determined and the direction which future development should follow has also been explored. Lacking information concerning when or how much capital will be available we can only speculate as to which alternative might be selected for initial implementation. Consequently, the planning of the overall development program can only be presented on a contingency basis.

Based on the results of the complete investigation, conclusions have been stated and recommendations made.

A.4 Evaluation of Study Results

Argentina, in common with most Latin American nations, has traditionally had a rather volatile economy although, in a relative sense, it has been more stable than most. Within the last two years, however, this condition has deteriorated seriously to the point where, during 1971, the Argentine rate of inflation was among the highest in the world and little indication of substantial improvement appears likely for 1972. As a consequence of this rapid inflationary trend such factors as salary and wage rates, product prices, costs of fuel and power, foreign exchange ratios, etc., have been in a state of constant flux during the period of the subject study, varying not only in value but also according to different rates of exchange. Unpredictable adjustments have thus been occurring at frequent and irregular intervals and in almost all of the factors relevant to financial analysis.

Under such circumstances it has been considered impractical to attempt analysis incorporating current figures as they evolve. As the only practical alternative, all such factors have therefore been referred to their values in the last quarter of 1971.

The rate of exchange to be used for converting $\$^a$ into US \$ and vice versa presents particular problems. Not only has Argentine currency been subject to continuous change in value referred to the US \$, but the US \$ itself has recently been devalued. For these reasons, the commercial rate of 5 $\$^a$ per US \$ which preceded introduction of the financial rate on September 19, 1971, has been used throughout the report.

Since financial appraisal will apply to conditions as they were at the reference period, later interpretation will require an analytical approach, exercise of sound judgment, and a thorough knowledge of the changes which have subsequently occurred. If all factors have inflated in proportionate ratio, the conclusions derived in the report will remain valid. If, on the other hand, one or more of the important values has varied disproportionately, the results of the financial analysis will have to be adjusted accordingly.

B. SUMMARY OF CONCLUSIONS AND RECOMMENDATIONS

B.1 Conclusions

(a) For maximum effect on national and provincial economy, only the largest possible projects should be considered

(b) Realistic estimate of time required to implement a large project places initiation of operation early 1977 and full production 1979

(c) Market analysis and projections indicates substantial demand for printing and writing papers, tissue, sack, bag and wrapper, linerboard and corrugating medium.

(d) Demand for linerboard and corrugating medium is increasing more rapidly than for other papers and manufacture utilizes maximum quantity of bagasse thus these are the products to be investigated.

(e) Paper machines trimming 3.2 meters and 5 meters will yield maximum flexibility and economy in conversion of products to containerboard.

(f) Cost models to be developed:

(i) 166 ADTD corrugating medium

(ii) 330 ADTD linerboard

(iii) 496 ADTD both products

(g) Bagasse produced in Tucumán is more than adequate for two mills of the largest capacity.

(h) Substitute fuel would be natural gas.

(i) Chemicals, water, power, and transportation facilities are available in necessary quantities and at reasonable costs.

(j) Any project would employ mainly Argentine personnel but some training in pulp and paper manufacture and temporary assistance from foreign specialists will be required.

(k) Logical division of the province would be two zones - one in the North and the other in the South. Sufficient bagasse will be available in either zone for supply of the largest mill considered. Indications are that costs would be somewhat higher in the Southern zone.

(l) The soda process would be the most suitable and economical for manufacture of bagasse pulp. Handling transportation and storage of bagasse would be in bulk form.

(m) Estimated total capital requirements (Direct, Indirect and Working capital) would be

Model I	-	US $	36,810,000	($a 184,050,000)
Model II	-	US $	65,060,000	($a 325,300,000)
Model III	-	US $	91,800,000	($a 459,000,000)

(n) Financial analysis indicates Model II and Model III to be viable projects and about equally profitable. Model I (corrugating medium only) is not viable under the conditions assumed for financial analysis.

(o) Programs for future development would be based on Model II or Model III.

(p) There is no doubt that the bagasse from the sugar mills of Tucumán can be utilized much more profitably than at present.

(q) A definitive feasibility study must be made to permit specific selection of the project to be carried out.

B.2 Recommendations

(a) This report shows definitely positive results thus immediate action should be taken to initiate implementation of Model II or Model III.

(b) In view of the rapidly changing condition of the Argentine economy during the progress of the study the financial analysis should be adjusted to present conditions to verify that the financial indications remain valid.

(c) The remaining steps to be taken are outlined and explained in Section R.

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C. MARKET SURVEY AND ANALYSIS

C.1 General

(a) Discussion of Products that can be produced from Bagasse

A wida range of pulp and paper products can be made entirely or largely from bagasse and many are being produced commercially today. It must, howevar, always be ramembered that pulp produced from bagasse is a short fibre pulp rather similar in characteristics to hardwood kraft. Consequsntly it has certain limitations in its applications beceuse of its lowar strangth properties. Short fibra pulps ere well suited for the production of papers and boards where high strength is not a prime requisite. Where high strength is required as in the ceae of wrepping, bag and sack pepers, short fibra pulps cannot be used at all or only in limited quantities if tha highest grades of such pepers are to be producad.

Countries which heva axtensive resources of raw materiels suiteble for the production of short fibre pulp end limitad eveilability of raw materials suitebla for the production of long fibre pulp tand to use substantially higher then normal proportions of short fibra pulp in thsir paper products. While, from the end use point of view, satisfactory paper producta can be mada in many cases, using a major proportion of short fibre, the sele of most of these products is limited to the national market because, on a quality basis, they could not compete abroad with equivalent papers utilizing a higher proportion of long fibre pulp.

Therefore, in such nations, when considering the manufacture of paper products utilizing largely bagasse pulp, the papers and paperboards should be divided into two categories - those which could possibly be exported, and those which would be very difficult to sell anywhere but on the national market.

In general, papers that are exported internationally are standard grades produced in large quantities in integrated pulp and paper mills on large high speed paper machines at the lowest possible cost. Corrugating medium produced from bagasse is fully equivalent in every respect to the best produced from wood and could certainly be exported if markets can be found. Also, some of the lower grades of standard business bond papers (mimeograph) and glassine can be produced in qualities equivalent to international standards and might find a market abroad. The use of glassine in packaging is, however, declining as this paper is increasingly being replaced by plastic film.

Newsprint is another possibility. The study included in Appendix I reproduces some conclusions included in our report of the "ESTUDIO DE INVERSION DE UNA PLANTA DE PAPEL PRENSA (PAPEL PARA DIARIO)" prepared by our firm for the Argentine Government in 1970. The production of newsprint from bagasse is still in a very early stage of development. On the other hand, the national market for newsprint will be completely covered with the projects for manufacture of it with poplar and willow from the Delta, which have already started, according to the decision of the Argentine Government on the basis of the Investment Study for a Newsprint Mill.

However, if export of newsprint is to be considered, the newsprint would have to be of a quality matching international standards. To date any newsprint produced from bagasse, while quite suitable as a substitute for standard wood pulp newsprint in protected markets, has differed so obviously from standard newsprint in opacity, ink absorbency, printability and brightness that it could not be run mixed with newsprint from other sources without being very noticeable. Advertisers object rather strongly if their advertisements do not show up as well as those of others in a newspaper issue. This difficulty could of course be overcome if publishers or markets could be found that would use only bagasse newsprint, but usually publishers like to be free to purchase at the best price from several sources so that, in the end, the best way to assure the possibility of export is to produce a product matching standard newsprint in appearance, printability and runability.

All these reasons make it impossible for us to recommend its selection for the bagasse plant.

In some instances where paper of internationally acceptable quality can be made using a high proportion of short fibre pulp, other factors may limit the sale to local or national markets. Sanitary tissue paper, for example, is bulky and this places limitation on the distances over which it can be shipped economically. Bond, book and writing papers are produced in a very large variety of grades, weights, and finishes (it is not unusual for a paper mill to produce 400 to 600 different grades) and are ordered by the customer in small lots to precise specifications, which makes sales difficult beyond a certain range. With minor exceptions such papers are produced and sold in regional markets.

Papers such as linerboard, sack, bag and wrapping paper, when made largely from bagasse are saleable only on the national market. For these products high strength is required, and if these products are produced largely from bagasse pulp the strength of papers and boards produced is not great enough to make them acceptable on the international market in competition with the same products made from long fibre softwood pulps.

Bagasse pulp is not sold on the market in appreciable quantities. At present almost all bagasse pulp produced is used in integrated mills manufacturing paper as the end product. However, as a market has developed for hardwood pulps in recent years, it should be possible to market bagasse pulp since its properties are similar to those of hardwood kraft.

Only bleached bagasse market pulp can be considered. The market for unbleached pulp of any kind is very small. The mills using unbleached pulp in large quantities are those producing linerboard, sack and wrapping paper, for which bagasse pulp is not well suited, and in any case such mills almost invariably produce their own pulp in an integrated operation. Corrugating medium can, of course, be produced from unbleached bagasse pulp, but it is always produced in an integrated operation and consequently cannot be considered as a market for unbleached pulp.

Bleached short fibred pulps are used extensively in mills producing fine papers such as bond, writing and white printing papers, specialty papers, tissue paper and specialty boards.

Bleached bagasse pulps are very similar in characteristics to bleached hardwood kraft pulps for which (in spite of the generally depressed condition of the paper products industry), there is an appreciable and increasing demand on an international basis. The marketing of hardwood pulps is, however, well established and production facilities are in general being expanded with the increasing demand so that bleached bagasse pulps would be placed in the position of breaking into an existing and highly competitive situation. There appears to be little doubt that such bagasse pulps could eventually capture a portion of the bleached short fibre pulp demand but since the product is relatively new to export markets the development of substantial sales potential would be difficult.

Dissolving pulp, despite the inroads made by plastics and other synthetic fibres and films, is in continuing demand for the production of rayon, tire cord, cellulose acetate, cellophane, CMC (Carboxy Methyl Cellulose) and nitrocellulose. The market is, however, currently depressed and the rate of growth is small. Unlike paper pulp, fibre length is of little or no importance in the case of dissolving pulp (in most applications the pulp is actually chemically dissolved), and it is the chemical and molecular properties that are of importance, hence dissolving pulp may be produced from short or long fibred cellulosic raw materials.

The term "dissolving pulp" is a generic name. There are many varieties; each with properties to suit a particular end product. Dissolving pulp for the production of cellulose acetate, for example, is quite different from that used for the production of cellophane. And although dissolving pulps of some types can be made economically from a particular raw material, it does not follow that all types of dissolving pulp can be made from the same raw material. Depending on end use, dissolving pulps vary in alpha cellulose content from 88% to 98.8% and in pentosan content from 1 to a maximum of 5%. There are also wide differences in molecular chain length and chain length uniformity, viscosity, and tolerance of impurities.

No dissolving pulp is currently produced from bagasse. There is, however, considerable published literature on laboratory studies and tests on the production of dissolving pulp from bagasse by the kraft or soda process with acid, steam, or water prehydrolysis. Tha research data available is largely of an axploratory nature and not all of the pulp propertias that are critical were evaluated. From the data availabla it can be sean that although it is readily possible to obtain a pulp with an alpha contant well above tha minimum requirements for tha lower grades, the pentosan content is cloee to the maximum ellowable for the lowest grade of dissolving pulp. Tha pentosan content no doubt could be decreased by more rigorous prehydrolysis at the expense of yield, or by cold caustic axtraction in the bleach plant, agein at the expense of yield, (plus a vary high capital coet). A lower pentosan content, however, in itself does not necessarily mean a satisfactory dissolving pulp. Reactivity end chain length uniformity ara criticel factors for many applications and, as bagasse is a rather hetero-genous raw material, there are no doubt some limitations. Moreover, impurities in bagasee are high and whether these can be reduced to the tolerancee required remains to be proven.

Based on the evaluation of the published data available, we believe it may be possible to produce the lower grades of dissolving pulp suitable for the production of staple fibre viscose and perhaps cellophane. We believe it would be impossible to produce acetate, polynosic, super tire cord, and tire cord grade dissolving pulp from bagasse, and we greatly doubt that nitrating, CMC or continuous filament super viscose grades can be made from bagasse. Even in the case of dissolving pulp for staple fibre viscose, considerably further research work is required to definitely prove the technical feasibility of the production of dissolving pulp from bagasse. We do not think that the production of dissolving pulp from bagasse should be considered because of the high technical risk and the currently depressed market.

Particle board (aglomerado) and fibre-board can be produced from bagasse. Plants which have been built are, in general, of relatively small capacity averaging about 50 tons/day or 15,000 tons/year. For all intents and purposes, except possibly in the wood-poor countries, the commercialization of such board has not yet made appreciable inroads into the potential particle and fibreboard applications. In the construction industry, for instance, which represents a major source of demand for this type of material, wood based composition boards and plywoods dominate the market. The products made from wood have superior strength, better dimensional stability, generally more rugged characteristics and, in most cases, lower overall cost.

Several Argentina construction firms stated that they hed made trials using bagasse particle board for formwork but had found it to be less economical than traditional wood-based materiels.

Bagasse particle boerds and hardboarde have in some cases bean successfully usad as filler material for venaer ovarley in the manufacture of furniture, doors, decorative paneling, atc. This market, however, obviously has very limited scope.

In their present form it is felt that construction boarde from bagasse would ba limited to national and even regional markets becauee of cost and quality consideretions and that before lerger markets can ba captured they must break into the esteblished trade in wood-basad composition boards and plywoods on the basis of euparior quality end/or lower prices.

Continuoue research and experimentation is in progress towards the development of more economical and better bonding materials, more efficient manufacturing processes and general overall improvement in quality and cost. It is foreseen that bagasse construction board may eventually be competitive at least with wood particle boards and hardboards, and even with plywood, in national markets.

An interesting note is that during the period of this study negotiation was in progress towards the possibility of manufacturing some 10,000 tons/year of bagasse particle board at Ingenio Ñuñorco in the province of Tucumán. The principal feature of the proposed product would be the use of a soya bean glue binder which has been developed through government sponsored research and which shows promise of improved quality at reduced cost. The market for this board is, however, expected to be confined to furniture manufacture.

Aside from paper and board, other potential uses for bagasse have been, and are being, investigated. Among these the principal ones are furfural, activated carbon, yeast and animal fodder.

Recent studies by Stadler Hurter reveal the following general information concerning these products:

Furfural as, a chemical intermediate, is used principally for tetrahydrofuran which, to a large extent, is being replaced by acetylene and formaldehyde. It is also used to produce resins to be used as moulding powders, and in the production of asphaltic battery cases, laminating varnishes and furfuryl alcohol. Until recently, it was used as raw material for manufacture of adiponitrile (for nylon 66). This application has, however, almost disappeared with the introduction of less costly ciclohexane and butadeine.

The world demand is estimated at about 150,000 tons/year, and production capacity at 180,000 tons/year. Approximately 50% of the total demand is supplied by the Quaker Oats Co. Markets are principally in the U.S.A. and Europe and difficult to enter.

Although no furfural is being produced from bagasse at present it should be possible to make furfural from bagasse. The process would consume approximately 15 tons of O.D. bagasse per ton of furfural produced. The studies made on the economice of producing furfural from bagasse have shown that it is at best a marginal operation.

Production of furfural from bagasse pith, as a by-product of paper manufacture, is questionable from a technical point of view and also not very economical.

Activated carbon, or activated charcoal, is an amorphous form of carbon which is treated to present a very large surface area. It is porous in structure and it is this characteristic which provides its ability to absorb gases or vapours from gases or dispersed substances from liquids.

The major demand is for use in sugar refining. Estimated quantity consumed by the Argentine sugar industry is 2,000 tons/year maximum. It is quite lik-.y that this consumption will decrease if recent technological developments for reactivation are applied.

Our studies have shown that it is unlikely that production of activated carbon from pith would be economical considering collection and transportation problems, the calorific value of the pith, and the need for development of suitable technology. It is possible that production from whole bagasse could be profitable provided that sufficient unsatisfied demand exists.

Bagasse contains, together with other carbohydrates which are reducible, 18-20% of pentosens, mainly xylose and di- and tri-saccharides, which are readily fermentable to yeast. It would appear more practical, however, to utilize molasses or molasses residues as a culture for yeast production if the need for such manufacture is indicated.

Animal fodder has been, and is being, produced from sugar manufacture by-products, i.e. molasses and pith.

The molasses has excellent nutritive value for cattle but must be mixed with pith to permit the animals to digest it properly The pith exposes a large surface area and can absorb up to thirty times its weight. A common mixture is 30% wet separated pith and 70% of 80° Brix molasses, which is pellatized for marketing

The market for such foddar is usually of relativaly small siza and such an enterprise would appear to be better adapted to exploitation by an individual inganio rathar than on a provincial basis.

The mentioned products and some mora minor ones such as gardening mulch, chicken litter, etc. all present limited markets, limitad bagassa utilization, and doubtful if not negativa economy.

b) Products and Markets Studied

For reasons givan in the discussion C.1.(a) market pulp, dissolving pulp, furfural, activated carbon, yeast, animal fodder are not considered worth further study, and the study has baan limited to nine catagories of papar, pulp and/or board products have been studied in detail in the market survay. These are as follows:

- Printing and Writing (See also Appendix AX.5 a)
- Tissue and Sulfito (See also Appendix AX.5 b)
- Pulp (See also Appendix AX.5 b)

- Sack, bag and wrapper (See also Appendix AX.5 d)
- Linerboard (See also Appendix AX.5 e)
- Corrugating medium (See also Appendix AX.5 e)
- Particle board (See also Appendix AX.5 f)
- Hardboard (Fiberboard) (See also Appendix AX.5 g)
- Newsprint (See also Appendix AX.5h)

All nine of the products have been carefully investigated to determine historical apparent consumption and future growth potential both on a national basis and for the LAFTA Pact and other nations bordering on or near Argentina. The results of preliminary analysis indicate that, in general, the LAFTA nations either have or will have sufficient productive capacity to satisfy expanding market demand for most of the products considered, or alternatively, that for products that must be imported by these nations, Argentina would not be able to enter the markets on a competitive level with established suppliers. Considerations of export markets have thus been eliminated.

The present internal situation is that, except for newsprint and long-fibre pulps, demand is essentially satisfied by existing productive capacity. Preliminary projections indicate that increase in demand for particle board and fiberboard will be relatively slow, and that, even in 1979, unsatisfied demand will not be appreciable and will probably be supplied from existing sources. Consumption of newsprint, of course, shows a continuously increasing trend at a substantial growth rate. However, the technical inconvenients for its production using bagasse as raw material, and the fact that the Argentine Government is at present taking positive action to start up newsprint plants using willow and poplar from the Delta, to cover the total needs of the country, make us reject this type of paper as a final product for the bagasse plant.

Of the products which have been investigated there remain only printing and writing papers, tissue, sack and bag papers, and linerboard and corrugating medium. The indicated increase in demand for these papers is progressing at a more or less rapid rate, particularly for the so-called "industrial papers", i.e. sack, bag, wrapper, linerboard and corrugating medium.

The information collected concerning markets, and demand for all nine products, and pertinent economic and social statistics is presented in the Appendix for reference. The remainder of this chapter, for the sake of brevity and clarity, will analyze only those products which are of primary interest which are, as mentioned above:

- Printing and Writing papers
- Tissue

- Sack, Bag, and Wrapper

- Linerboard and Corrugating Medium (*)

  (*) These are considered together because, being the components of corrugated containerboards, they are complementary to each other.

C.2 Historical Data

(a) General

The consumption of paper products throughout the world has maintained a continuously increasing trend throughout many decades and, it appears, will continue to increase in the foreseeable future. The average overall increase in global demand for all papers has been estimated at 5% per year during the 1970's. Being an average, this figure varies over a wide range according to specific products and different nations. Total demand for Latin America it is expected will be higher than the average at 7.3% with Argentina estimated at 7%. General indications are that world demand for paper products of all kinds will have doubled within the next 20 years.

In Argentine paper manufacture dates back to 1873, making it one of the oldest established industries in the nation. Development, however, has been generally limited to satisfaction of internal demand and no appreciable export trade in paper has developed. Mills are therefore of relatively small capacity and specialized in the manufacture of the most essential types of paper. The industry as a whole has a certain lack of flexibility to absorb major market fluctuations. Variations either upward or downward can have serious effect on the industry as it presently exists.

The existing fibrous resources of the country, although lacking the vast volumes of long fibre woods found in North America and the Scandinavian countries, have however been exploited to only a minor extent up to the present.

(b) Apparent Consumption

In reference to statistics concerning historical consumption of paper products in Argentina the interpretation of recorded data and segregation according to individual products has been rendered most difficult due to differences in the format used in classifying various types of paper products and a tendency to include some products under irrelavant headings or simply under "Other Papers". Each official, and presumably reliable, statistical source appears to have its own unique system of categorizing paper products and quite often under similar headings data from different sources show grossly dissimilar figures. For instance, Ministry of Trade and Commerce tables include "sulfitos" under Kraft although sulfito, as the name implies has little or nothing in common with kraft papers. In recent years INDEC has been showing these two papers separately but no indication is given as to how they were classified previously. Similarly the Ministry records include Liner and Corrugating under Kraft papers - a generally correct classification, but not very useful when attempting to separate out data about these specific papers.

As a consequence of this confusion in statistics from different sources it has been necessary to correlate the figures from relevant governmental agencies and industrial associations and to use judgement and reasoning in arriving at realistic estimates of consumption according to specific products. In some cases the figures which have been educed might, therefore, show appreciable differences when compared with those of other agencies or associations. Such differences are in most attributable to lack of precise definition for the papers to be included in a given category with consequent inclusion of irrelevant papers, and/or omission of types which properly fit into the category.

The values for historical consumption shown in Table 1-C (below) are considered to be reasonably accurate and realistic.

TABLE 1-C

HISTORICAL APPARENT CONSUMPTION (THOUSANDS OF TONS)

Year	Printing and Writing	Tissue	Sack and Wrapper	Linerboard and Corrugating Medium
1960	66.61	8.77	53.11	-
1961	95.03	14.44	78.86	-
1962	86.36	18.21	67.57	-
1963	78.13	13.78	65.62	-
1964	93.07	17.33	79.23	71.41
1965	110.90	23.07	106.04	55.52
1966	125.39	18.80	115.68	84.44
1967	98.96	22.19	100.67	107.48
1968	105.39	24.55	116.55	129.21
1969	104.24	31.32	130.63	141.60
1970	123.81	33.09	140.44	134.34

SOURCE: INDEC AND OTHER

(c) <u>Population and Gross National Product</u>

TABLE 2-C

HISTORICAL DATA - GNP AND POPULATION

Year	Population (Thous. of Inhab.)	GNP Pesos Ley 1960 (000,000's)
1960	20,669	10,063,4
1961	20,923	10,777,9
1962	21,180	10,596,8
1963	21,441	10,345,2
1964	21,705	11,422,0
1965	21,972	12,468,6
1966	22,242	12,559,2
1967	22,516	12,871,1
1968	22,793	13,464,9
1969	23,073	14,531,6
1970	23,364	15,229,0

SOURCE: CIDIE on data from BCRA

The tabulated figures for population, which are obviously estimates, show a uniform increase of approx 1.23% per year. The accepted value for use in statistical calculations has been taken as 1.5%, however, as used in recent studies made by United Nations and Studies for International Collaboration Bureau (Oficina de Estudios para la Colaboracion Economica Internacional), and CEPAL.

Analysis of GNP figures for the period 1960/70 shows an average increase in total GNP of 3.9% or 2.7% per capita, referred to the value of the peso in 1960.

C.3 Market Projection

(a) General

Many factors such as rate of increase in literacy, rate of increase in industrial development, rate of increase in disposable income, rate of increase in GNP, and rate of increase in population can be entered into calculation of future demand or consumption. Of these, the two most significant indicators are rate of increase in GNP and rate of increase in population and these are the values which have been applied in projecting demand for the four categories of paper being studied here.

Argentina has a high degree of literacy (92%) so any increase in this respect would be insignificant. Rates of increase in industrial development and also in disposable income are reflected in GNP, thus attempts to apply these other factors would needlessly complicate projection calculations.

Population increase, for all practical purposes, is considered to be 1.5%/yr. and is not expected to change significantly during the period under study.

The historical average rate of increase in GNP over the past ten years has been 2.7% per capita (Appendix Page AX/5). The future average rate of increase in GNP has been estimated by CONADE (National Development Council) at essentially 5.5% total or 4.0% per capita (CONADE Development Plan 1970/74). The arithmetical average of the historical GNP per capita increase of 2.7% and the Government agency estimate of 4.0% in future has thus been used as a reasonable value for projection of future consumption, i.e. 3.35% GNP increase/yr.

The way in which this figure is applied will be discussed subsequently in this chapter.

It should be noted that 1971 rate of increase in GNP was 2.4% but since last year was characterized by a very rapid inflationary trend this figure probably would have little significance over the long term.

Further information regarding market information may be found in Appendix Section AX.1, AX.2, AX.3 and AX.4

(b) Promedios Moviles

In order to reduce the effect of the normally large fluctuations which invariably are found in annual figures the statistical device of "promedios moviles" (literally "moving averages") has been applied to historical data Successive five-year periods have been averaged for historical apparent consumption and also, for the purpose of maintaining uniformity, to population data. Since in the case of apparent consumption many of the fluctuations are caused by inventory, incomplete statistics or poor estimates, the figures derived are essentially realistic and, because the averaging produces a more uniform progression of consumption values, they are easier to work with for projection purposes.

Tables 3-C, and 4-C show historical consumption and population data adjusted by this method.

TABLE 3-C

APPARENT CONSUMPTION ADJUSTED BY PROMEDIOS MOVILES

(Thousands of Tons)

Years	Printing and Writing	Tissue	Sack and Wrapper	Linerboard and Corrugating Medium
1960/64	83.84	14.51	68.88	
1961/65	92.70	17.36	79.46	
1962/66	98.77	18.24	86.83	
1963/67	101.29	19.03	93.44	
1964/68	106.74	21.19	103.42	89.61
1965/69	108.98	23.98	113.69	103.65
1966/70	111.55	25.99	120.57	119.41

SOURCE: Own Preparation

TABLE 4-C

POPULATION ADJUSTED BY PROMEDIOS MOVILES

(Thousands of Inhabitants)

1960/64	21.183,6
1961/65	21.444,2
1962/66	21.708,0
1963/67	21.975,2
1964/68	22.245,6
1965/69	22.519,2
1966/70	22.743,6

(c) Per Capita Consumption

Since GNP has been considered in (a) on a per capita basis, Table 5-C (using promedios moviles of historical consumption and population) shows average per capital consumption for the four paper categories.

TABLE 5-C

ANNUAL APPARENT PER CAPITA CONSUMPTION

Years	Printing and Writing	Tissue	Sack and Wrapper	Linerboard and Corrugating Medium
1960/64	3.95	0.68	3.25	
1961/65	4.32	0.80	3.71	
1962/66	4.55	0.84	3.99	
1963/67	4.61	0.87	4.26	
1964/68	4.80	0.95	4.64	4.03
1965/69	4.86	1.06	5.06	4.60
1966/70	4.90	1.14	5.30	5.25

SOURCE: Own Preparation

(d) <u>Elasticity of Demand Referred to GNP</u>

The elasticity of demand referred to GNP is the rate of increase in demand for a given product per 1% increase in GNP. Thus, dividing the average percent increase in per capita consumption derived from figures in Table 5-C by the historical average increase in GNP per capita (2.7%) the following elasticity coefficients may be calculated:

Printing and Writing	1.37
Tissue	3.33
Sack & Wrapper	3.16
Liner and Corrugating	5.22

The elasticity coefficient of 5.22 for corrugating medium and linerboard, when derived in this manner, appears excessively high. The % demand increase per year using this elasticity would be almost 19% which yields very large and almost incredible future demand quantities especially in the last few years of projection. This distortion is probably caused partially by the shorter series of historical data and partially by the rapid adoption of a relatively new product at a rate which is not likely to continue.

If, as shown below, the coefficient of elasticity in this case is calculated using the historical figures from Tables 1-C and 2-C a more rational value is derived:

TABLE 6-C

COEFFICIENT OF ELASTICITY - CORRUGATING MEDIUM AND LINERBOARD

	App. Cons. (000's of tons)	Population (000's)	Cons/Cap (Kg)	Change (%)
1964	71.41	21,705	3.28	
1965	55.52	21,972	2.52	(23.2)
1966	84.44	22,242	3.80	50.5
1967	107.48	22,516	4.78	25.8
1968	129.21	22,793	5.66	18.4
1969	141.60	23,073	6.15	8.65
1970	134.34	23,364	5.76	(6.35)
			Total	73.80
			Average	12.30%

Coefficient of Elasticity $= \frac{12.3}{3.66} =$ 3.46

Note: It is estimated that the average increase in GNP per capita for the period 1964-1970 would be in the order of 3.46% rather than the 2.7% used for the period 1960-70.

Check calculations of elasticity for the other three papers, made in the same manner as those in Table 6-C and covering only the period from 1964-70, give the following results:

Printing and Writing	1.31
Tissue	3.30
Sack and Wrapper	2.83

These values correspond well to those shown on page C/25 thus indicating that the elasticity of 3.46 for liner and corrugating would be more accurate than that derived by the promedio movil method (viz. 5.22)

It is considered, however, that for printing and writing papers, tissue, and sack and wrapper, where the historical series covers a longer period the original method of computation would be somewhat more accurate. The elasticity values to be used for projection would thus be as follows:

Printing and Writing	1.37)	
Tissue	3.33)	See Page C/23
Sack and Wrapper	3.16)	
Liner and Corrugating	3.46	

As additional indication concerning the relative validity of the projections shown in Table 7-C (below), the projected figures for Argentina in 1970 and 1979 relate to recorded Canadian consumption for the year 1970 as follows:

	Kg/Capita			% of 1970 Cdn. Consumption	
	Canada	Argentina			
	1970	1970	1979	Arg.1970	Arg.1979
Printing & Writing	30	4.9	7.8	16	26
Tissue	11	1.14	2.8	10	25
Wrapper & Packaging	75	5.30	11.3	7	15
Liner & Corrugating	36	5.25	15.8	15	45

It is the Consultant's opinion that the above comparison with Canada lends credence to the projected demand values which have been calculated for Argentine. It appears reasonable to predict that over a period of nine years the consumption in Argentina for the papers considered will increase in the proportions indicated under the heading " % of 1970 Canadian Consumption".

(e) <u>Projected Rate of Demand Increase</u>

Using the pertinent factors thus far derived the projected rate of future demand increase in percent per year can be computed according to the formula:

Estimated future rate of demand increase.

GNPX elasticity and annual % increase in population

TABLE 7-C

DEMAND PROJECTIONS

(Thousands of Tons) (*)

Year	Printing and Writing	Tissue	Sack and Wrapper	Liner and Corrugating
1975	166.39	47.14	213.24	265.41
1977	187.27	59.82	267.87	349.39
1979	210.77	75.91	336.50	449.74
1980	223.61	85.51	377.15	506.32
1985	300.51	155.13	667.03	894.29
Basis of Projection	123.81	25.99	120.57	119.41
Elast. coeff.	1.37	3.33	3.16	varies
Per capita GNP	3.35	3.35	3.35	3.35
% increase in pop.	1.5	1.5	1.5	1.5
GNP x Elast. coeff. + annual % increase in pop.	6.09	12.65	12.08	18.99

(*) Applying elasticity coefficient to the last historical consumption for printing and writing and to the last promedio movil of consumption for the remaining papers, and the rate of increase of GNP resulting from the arithmetical average of per capita historical GNP and that projected by CONADE

(f) Unsatisfied Demand

The tonnages shown in Table 7-C indicate estimated total future demand for each of the paper products. In order to arrive at figures indicative of mill capacities which would be installed it is necessary to deduct the portion of this future requirement which can be supplied by operating mills the idle manufacturing capacity which could be reactivated, and also any expansions of existing facilities or new mills which are planned for manufacture of any of the products we are considering.

Present manufacturing capacities are a matter of record and may be determined quite accurately. Estimation of the proportion of idle capacity which it might be possible to reactivate is a somewhat more complicated matter since it is difficult to know without complete details just how much of such capacity could be economically put into operation and, of that which could be started up again, the proportion which might be applied to each product. Similarly, plans for expansion or for new facilities can only be evaluated approximately from the point of view of which are most likely to go ahead, which are doubtful, and which might never be realized or may only be implemented subsequent to the period under consideration.

The manner in which future manufacturing capacity was estimated is discussed in the Appendix and estimates are considered to be realistic. (Sub-Sec. AX.17)

TABLE 8-C

UNSATISFIED DEMAND (000's OF TONS)

Year	Printing and Writing			Tissue			Sack and Wrapper			Liner and Corr.		
	Proj. Demand	Est. Prod.	Unsat. Demand	Proj. Demand	Est. Prod.	Unsat. Demand	Proj. Demand	Est. Prod.	Unsat. Demand	Proj. Demand	Est. Prod.	Unsat. Demand
1975	166.39	128.00	38.39	47.14	40.58	6.56	213.24	198.34	14.90	265.41	234.33	31.08
1977	187.27	163.00	24.27	59.82	40.58	19.24	267.87	198.34	69.53	349.39	234.33	115.06
1979	210.77	163.00	47.77	75.91	40.58	35.33	336.50	198.34	138.16	449.74	234.33	215.41
1980	223.61	163.00	60.61	85.51	40.58	44.94	377.15	198.34	178.81	506.32	234.33	271.99
1985	399.51	163.00	137.51	155.13	40.58	114.55	667.03	198.34	468.69	894.29	234.33	659.96

Table 8-C (page C/31) shows estimated unsatisfied demand which may be expected to exist at various times in the future.

The estimated 1979 tonnages of unsatisfied demand for each product are those which have been used in determining the mill capacities which could be installed for each of the four products - assuming of course that no new facilities of which we have no knowledge at this point would be brought into production.

C.4 <u>Miscellaneous</u>

(a) <u>Paper Product Prices</u>

In view of the generally public nature of market prices for paper products in countries which have highly developed paper industries it has been somewhat surprising to find that, in Argentina, such information is not readily and freely available. This situation, we believe, is temporary and has been caused by the rapid inflationary trend of the past few years, but it has, nevertheless, introduced difficulty and complications into the evaluation of projects proposed in this report.

The costs of manufacturing in any country or for any product are usually difficult to ascertain for legitimate business reasons but they can usually be approximated by indirect methods. In this case such indirect methods had to be applied to determine market prices.

The procedure used was to determine the ratio of mark-up considered reasonable by paper suppliers and brokers and to work backward from this to calculate the prices charged by the manufacturers. The firms and individuals approached proved most reluctant to reveal even "order of magnitude" figures (presumably because such information might later be detrimental to their own interests) and, it is suspected that in some cases information obtained was misleading.

It is felt however that analysis of information from a number of sources combined with judgement as to the reliability of each source has permitted reasonably accurate estimates to be made. These are shown in Sub-Section AX.5 of the Appendix and have been used in evaluating the financial viability of proposed projects.

(b) <u>Official Sources of Information and Statistical Data</u>

Many agencies and associations have been quoted and referred to in various parts of the report and the Appendix. These are listed below with abbreviations which have been used.

Abbreviations

A.F.P.: Asociacion de Fabricantes de Papel
ALALC : Asociacion Lation-Americana de Libre Comercio
BIRA - BND : Banco Industrial de la Republica Argentina - Banco Nacional de Desarrollo
B.C.R.A.: Banco Central de la Republica Argentina
C.I.D.I.E.: Centro Internacional de Investigaciones Economicas

C.I.F.: Cost, Insurance and Freight
C.F.I.: Consejo Federal de Inversiones
CONADE: Consejo Nacional de Desarrollo
DENEI: Direccion Nacional de Estadistica Industrial
FOB: Free on Board
INDEC - INEC: Instituto Nacional de Estadisticas y Censos
N.U.: Naciones Unidas
N.A.B.: Nomenclador Aduanero
NABALALC: Nomenclador Aduanero de la Alalc
O.E.C.E.I.: Ofincina Estudios para la Colaboracion Economica Internacional
P.B.I.: Producto Bruto Interno
S.N.F.: Servicio Nacional Forestal

Sources of Information

Secretaria de Transportes, Ferrocarriles Argentinos

Asociacion de Fabricantes de Papel

Asociacion Latino-Americana de Libre Comercio

Banco Nacional de Desarrolla-Banco Industrial de la Rep. Argentina

Banco Central de la Republica Argentina

Centro Internacional de Investigaciones Economicas

Consejo Federal de Inversiones

Direccion Nacional de Estadisticas Industriales

Instituto Nacional de Estadisticas y Censos

Ministerio de Comercio

Ministerio de Hacienda

Direccion Nacional de Aduanas

Centro Azucarero Argentino

Oficina de Estudios para la Colaboracion Economica Internacional

Servicio Nacional Forestal

Ministerio de Agricultura y Ganaderia de la Nacion

Gobierno de Tucuman

Centro Argentino Azucarero

Centro Argentino del Cemento Portland

Federacion de Obreros y Empleados de la Industria del Papel, Carton, Quimicos y Afines

Instituto Argentino de Racionalizacion de Materiales

Agua y Energia Electrica, Empresa del Estado

Gas del Estado

Centro de Estudio del Transporte

Asociacion Mutual y Gremial de Transportadores de Carga de Tucuman

Federacion Argentina de Entidades Empresarias del Autotransporte de Cargas

C.5 Discussion and Conclusions

(a) General

Before additional discussion of the products which have been detailed above some consideration must first be given to the time at which a project or projects based on this study could be put into operation. This is necessary in order to be able to judge the magnitude of unsatisfied demand which will exist at that time, and thus to know mill capacity limitations.

Subsequent to acceptance of the study report the principal additional steps to final implementation would be·

- study of report data and formulation of decisions and policy concerning the specific project on which to concentrate future attention
- request for tenders for a definitive feasibility study for the selected project, assessment of submission and award of the contract for the feasibility study
- performance of the detailed study, evaluation of the conclusions, decisions to proceed and determination of qualifying or limiting factors
- formation of a company
- arrangement of financing
- engineering, construction and start-up of the mill

The period of time required to perform all of these essential functions can be very indefinite - dependent to a great extent on the degree of urgency and priority accorded by the promoters. Assuming prompt attention and, to save time, some overlapping or "telescoping" of the various stages, it is estimated that the earliest realistic date for commencement of operation for any project would be the beginning of 1977. Dilatory action, indecision, or general inattention could, result in delays measured in years or even complete loss of interest.

However, on the assumption that all possible would be done to initiate the new industry as quickly as possible, 1977 has been assumed as the first year of operation and, estimating two years to eliminate problems and achieve full anticipated efficiency, 1979 would be the first year at full rated production.

Unsatisfied demand and all other pertinent factors such as, for instance, bagasse availability, have therefore been projected to 1979 for the initial project.

It is evident from above Table 8-C that profitable industries could possibly be implemented based on the manufacture of any of the products shown. In each case unsatisfied demand (1979) will be of appreciable magnitude and calculated rates of demand increase indicate fair-to-good future potential.

Thus, in order to select the product or products which will render optimum benefits economically and socially, they are discussed individually in the following paragraphs.

(b) Printing and Writing Papers

The estimated unsatisfied demand of 48,000 tons/yr is well within the range for a potentially profitable enterprise.

The firm of Ledesma S.A.A.I., for instance, has operated for some 7 years at a production rate of approx. 30,000 tons/yr. and proposes to more than double this production rate in the next few years.

The technology of manufacture for printing and writing papers is, however, quite complex and the consumption of bagasse (compared to the volumes available) would be relatively small.

(c) Tissue

The estimated unsatisfied [illegible] of 35,000 tons/yr. represents a large mill for manufacture of paper of this type and, quite probably production of tissue on this scale could be a feasible and profitable business. It must be pointed out however that, even at a consumption of 2.5 kg/capita, such a mill would supply the needs of over 1/2 of the population of Argentina. As mentioned previsouly, because of its bulky nature the shipment of tissue is unecomonical beyond a relatively short range thus it is usual to confine such manufacture to relatively small plants conveniently located near areas of population concentration. Tucuman unfortunately is some 1200 km from the largest population center (Buenos Aires) and savings made possible by large scale production could conceivably be offset by marketing costs.

FORM 2

(d) Printing, Writing and Tissue - Combined

Combining production of these papers into one mill is another possibility which might appear feasible, i.e. production of 83,000 T/yr. While they are quite similar in the pulp production process and in the fact that they are bleached papers, the actual conversion into papers of such diverse characteristics requires quite different technology and equipment. Printing and writing paper machines are limited in speed to about 400 meters/min. but tissue is produced at speeds approaching 1000 m/min. In practice it is normal to use two different types of paper machine for optimum economy of production. For printing and writing a machine with a multiple cylinder dryer section is required but for tissue a "Yankee" dryer is conventional. Thus for printing and writing at least one quite large machine would be required and for tissue one (and possibly two) separate machines would be necessary for the projected tonnages.

The limitations mentioned in (b) and (c) would also still apply.

(e) Sack, Bag and Wrapper

Sack, bag and wrapping papers together with corrugating medium and linerboard fall into the category usually known as "industrial papers".

In an area where some 50-70,000 tons of paper sacks are used for packaging sugar the manufacture of such paper would appear to be a natural and logical selection. Projected unsatisfied demand at 138,000 tons/yr. is, moreover, 3 to 4 times that for fine papers.

Sack paper from bagasse unfortunately, however, cannot be produced without using a large proportion (up to 50%) of long-fibre pulp to achieve satisfactory strength properties. Thus utilization of bagasse is greatly decreased and manufacturing cost is proportionately increased by the requirement for expensive long fibre pulp. Although the manufacture of these types of paper might be profitable, the lower consumption of bagasse and the increased requirement for long fibre pulp (which must be imported) combine to make these products less attractive than the other industrial papers which are discussed below.

(f) Linerboard and Corrugating Medium

These papers (or paperboards) are the compenenta which when processed and assembled form the most common type of containerboard. The normal ration of linerboard to corrugating in containerboard is 2:1 approximately; thus, although they have been tabulated under one heading in Table 8-C, the projected demand of 215,400 T/yr. in 1979 may be considered as 143,600 tons of liner and 71,800 of corrugating.

At this point in the Argentine economy the growth of demand appears very rapid which is probably due in most part to the fact that it has only relatively recently come into general use (records date back only to 1964). The figures for unsatisfied demand (Table 8-C) indicate that for the year 1979 linerboard and corrugating medium potential market will be 4.7 times that for printing and writing and tissue and 1.6 times that for sack and wrapper.

Corrugating medium requires no long-fibre pulp and linerboard only about 30% (25% in some cases), so that the requirement for costly imported kraft pulp is reduced to reasonable proportions. Although the bagasse used in such manufacture is pulped at higher yield than pulps for the other papers discussed, the consumption of bagasse is maximum because of decreased content of other pulp and the size of mill which can be built to meet the unsatisfied demand.

The technology of manufacture of corrugating medium is uncomplicated and that for linerboard is only slightly more elaborate, and production tonnages per unit width of paper machine are high. The optical qualities of both products, particularly corrugating, are relatively unimportant which means the water quality requirements are not stringent and chemical requirements are relatively low.

All these aspects are important and particularly advantageous in the province of Tucuman where bagasse is plentiful, papermaking skills are rare, water must be used several times over, and chemicals must be brought from other parts of the nation.

(g) Conclusions

Considering then the fundamental concept which has been adopted, i.e. the largest possible industry using to the maximum the quantities of bagasse available and also considering all other pertinent aspects and conditions, the decision has been made to concentrate investigation on the manufacture of linerboard and/or corrugating medium.

The remainder of this report therefore will discuss utilization of the bagasse from the ingenios of Tucuman only for production of one or the other, or both of these products.

C.6 Definition of Cost Models

The contract for this study (UNIDO 71/53) requests development of cost models for small, medium and large mills, leaving to the Consultant the decision as to which capacities might apply to each classification. The decision having bean made to concentrate on linerboard and/or corrugating medium, the definition of the three mill capacities emerged rather simply through the application of practical considerations and the more or less coincidental relationship between the production characteristics and conditions of the two papers.

Conversion facilities for manufacture of containerboard and fabrication into boxes are already in existence in Argentina and it has been assumed that these plants would expand as the market for their products increases. Since it is normally more economical to increase the capacity of existing plants than it is to plan and build new ones, it has been concluded that any paper mill proposed would produce only the materials to enable the existing converters to keep up with growing demand. Thus any new paper mill would manufacture and ship paper in rolls leaving converting to others.

In order to reduce converting waste to a minimum it is necessary to make roll widths as much as possible in multiples of the sizes of the fluting machines which are used to transform the flat corrugating medium into corrugated paper. The linerboard also must conform to these sizes. A survey of fluters in existing converting plants revealed the most common widths to be 1.40, 1.70 and 2.20 meters for paper 1.30, 1.60 and 2.10 meters wide. Computations using these latter figures revealed that sheet widths of 3.2 meters and 5.0 meters would suit the largest number of width combinations and produce the smallest loss, thus paper machines of these widths were selected.

Calculation of practical production rates for these paper machines using average sheet weights and, from experience, average operating speeds, showed that on linerboard trimming 5.0 meters average production would be 330 tons/day, and on corrugating medium at 3.2 meter trim average production would be 166 tons/day, i.e. almost precisely in the ratio of 2:1 required for container-board.

Additional calculations verified that production of both products in the same mill (496 T/D) would utilize the major portion of bagasse economically available from the ingenios located in either the Northern or the Southern region of the Tucuman sugar belt.

The most practical Cost Models to be investigated thus were determined to be:

Cost Model I - 166 T/D corrugating medium

Cost Model II - 330 T/D linerboard

Cost Model III - 496 T/D both products

The capacities are realistic taking into account market demand, bagasse availability, and practical mill sizes, and have also the advantage that a good comparison of relative financial aspects should be possible.

References to Model I, Model II and Model III in subsequent parts of the report pertain to mills as specified above.

D. AVAILABILITY OF BAGASSE

D.1 General (See also Appendix Section BX.1)

(a) Bagasse and Sugar Production

One ton of whole moist (50%) bagasse obtained from each 3.4 ton of cane processed This represents approximately 29% of the cane. In some sugar mills the amount of bagasse obtained is somewhat higher than this provincial average.

(b) Bagasse used as Fuel

Bagasse is a waste product used as fuel to generate steam, in order to fulfill steam and power in sugar mills (See Table 1-D). Steam plant installations in Tucuman sugar mills are generally old-fashioned. The ingenios produce refined sugar (*) and some have alcohol distilleries (**). Consequently, they have no surplus bagasse, and they usually have to use additional fuels, to generate sufficient steam and power (***). Supplementary fuels commonly used are natural gas, fuel-oil and wood.

In case bagasse is diverted for other uses, the need of alternative fuels must be taken into account, on the basis of calorific values and boiler efficiencies.

(*) Less than 10% of Tucuman sugar production is commercialized as cruda.

(**) Sugar mills having distillation plants are: Aguilares, Bella Vista, Concepcion, La Corona, La Florida, La Trinidad, Leslee, San Juan and San Pablo.

(***)Table 1-D shows bagasse used as fuel in the various sugar mills.

During the visit to several sugar mills in Tucuman, their representatives expressed their concern about the problem of fuel. The sugar mills should have assurance that they will have the alternative fuel in the required quantities and a somewhat higher price than the replacement fuel value should be paid in order to make it interesting to sell bagasse instead of using it as fuel.

Other uses of bagasse are presently not significant in Tucuman, and they do not amount to 2% of the total production of bagasse.

Bagasse is mainly used for paper production in Leales and Celulosa Argentina plants. Leales use 20-25% of their bagasse for a 25 T/day corrugating medium plant. Celulosa Argentina produce about 16 ton/day of corrugating and wrapper, with small quantities of bagasse obtained from the Concepcion sugar mill.

Nunorco sugar mill is studying a project for manufacture of particle board using bagasse as raw material. Production would reach 30 T/D, and the project was well received by national and provincial authorities.

(c) <u>Sugar Industry in Argentina</u>

Argentina sugar production amounts to less than one million tons in 1970, i.e., more than 1% of the world production. All sugar produced is obtained from the sugar cane. The area of production, 200 thousand Ha., is located between 22° and 28° Southern latitude (See map Fig. I-D). Cane yields are somewhat low at about 47 tons per hectare. Installed production capacity of Argentine suger mills is 2 million tons.

Since 1967 production has been regulated according to export requirements and consumption estimates, avoiding accumulation of excessive stocks, according to a system established by Law # 17163. Export requirements correspond to Sugar Act (USA) and the International Sugar Agreement, and presently these amount to more than 70 and 50 thousand tons respectively (See Table 2-D).

National production is divided into three zones:

- Tucuman province
- Northern region (Salta and Jujuy provinces)
- Littoral region (Misiones, Chaco and Sante Fe provinces)

Tucuman has 16 sugar mills in operation, which in 1970 produced 54% of total sugar production of the country. Cultivated area in 1970 is 140.6 thousand hectares (69.2% of the national total).

The situation of Argentine sugar production was completely modified in 1967 by Law # 17163. This law regulated production by a system of shares to cane producers, after having determined zonal and national totals. Quotas assigned in 1969, 1970 and 1971 were, Tucuman 52%, Northern zone 42% and 6% to the Littoral.

(d) Tucuman

(i) General Information

Situation: 22°6' / 28° Southern latitude
64°30'/ 66° 11' longitude

Area: 22,524 km^2

Population (1970): 765,962 inhabitants

Population density: 34 inhab./km^2

Climate: Warm and humid. Rains per year vary from 500 mm in the Southeast to 1600 mm in the Southwest. Average annual rainfall for San Miguel de Tucuman is 933 mm.

Unemployment general rate: 10% (April and October)

(ii) Sugar Industry in Tucuman

Operating season for Tucuman sugar mills lasts between 120 and 150 days, and it usually begins during the first week of June and ends on the second week of October. Furthermore, Art. 20 of National Sugar Law states that November 15th is the last date to finish operations. About 55% of the cane is hand harvested, 42% is harvested semi-mechanically and only 3% entirely mechanically.

Table 3-D shows sugar production by sugar mill and the average for the last 10 and 3 years, this last average has been calculated in order to give an idea of the situation after the closing of some sugar mills due to 1965/66 crisis.

D.2 Bagasse

(a) Bagasse Production in Tucuman

The quantities of bagasse obtained are related by relatively fixed coefficients to the quantities of cane processed and, of course, to sugar production. This means that variations in bagasse supply are parallel to variations in sugar production. See Table 4-D.

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TABLE 1-D

MOIST BAGASSE (50%) USED AS FUEL IN TUCUMAN
(THOUSANDS OF TONS)

SUGAR MILLS	1965	1966	1967	1968	1969	1970	AVERAGES 10 YEARS (1961/70)	AVERAGES 3 YEARS (1968/70)
CONCEPCION	271.6	350.0	260.0	200.0	192.5	271.9	247.7	223.1
CRUZ ALTA	63.2	50.3	47.2	44.2	55.2	53.1	53.4	50.8
LA FLORIDA	78.8	15.0	48.9	54.0	74.6	41.2	56.0	56.6
SAN JUAN	70.7	70.8	64.1	74.5	70.9	53.7	70.5	66.4
LA CORONA	184.1	147.2	99.7	101.4	132.8	154.8	118.3	129.7
LA TRINIDAD	101.9	26.2	76.1	57.9	111.4	72.2	74.5	80.5
BELLA VISTA	141.3	51.0	100.1	104.6	103.6	91.8	102.4	100.0
LA FRONTERITA	148.0	111.4	135.5	120.0	113.7	161.5	116.9	131.7
SAN PABLO	140.1	119.6	128.4	163.1	129.9	121.6	129.9	138.2
LEALES	75.1	73.8	41.6	38.3	54.3	52.2	57.1	48.3
LA PROVIDENCIA	123.1	114.1	91.5	128.3	104.4	125.3	105.1	119.3
NUNORCO	102.4	63.6	51.8	67.2	74.0	74.7	71.0	72.0
SANTA ROSA	84.1	68.8	43.0	36.8	69.9	82.0	64.9	62.9
AGUILARES	66.1	70.0	43.1	33.0	63.9	74.9	56.4	57.3
MARAPA	74.1	48.2	18.7	26.0	56.7	38.0	44.1	40.2
STA. BARBARA	114.6	93.5	65.5	78.9	81.3	87.8	77.3	82.7
TOTAL OPERATING INGENIOS	1,839.2	1,473.5	1,315.2	1,328.2	1,489.1	1,561.7	1,445.5	1,459.7

SOURCE: On the Basis of Data from the CENTRO AZUCARERO ARGENTINO

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TABLE 2-D

SUGAR PRODUCTION IN ARGENTINA, IMPORTS, EXPORTS, CONSUMPTION & STOCKS
PERIOD: 1/VI - 31/V - 1960/61 TO 1970/71

	UNITS	1960/61	1961/62	1962/63	1963/64	1964/65	1965/66	1966/67	1967/68	1968/69	1969/70	1970/71
PRODUCTION	Ton	782,374	644,908	735,656	990,391	921,883	1211,480	963,222	731,975	871,867	906,428	908,306
IMPORTS	Ton	-	5,900	-	-	-	-	-	-	-	-	-
CONSUMPTION	Ton	630,429	794,217	710,663	716,267	829,609	809,191	787,480	811,091	808,959	820,156	906,366
EXPORTS	Ton	185,135	87,091	62,699	313,359	32,748	60,283	53,125	94,136	95,400	106,135	80,169
DISTILLATION	Ton	-	-	-	-	-	-	-	33,914	3,974	9,043	-
STOCKS AT 31/V	Ton	324,728	92,534	52,216	10,632	66,642	405,275	524,402	303,719	256,920	217,463	125,523
CONSUMPTION/ CAP.	Kg.	31.50	39.10	34.47	34.23	39.06	37.53	35.98	36.52	35.88	35.84	39.02

SOURCE: On the basis of data from the CENTRO AZUCARERO ARGENTINO

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TABLE 3-D

SUGAR PRODUCTION IN THE PROVINCE OF TUCUMAN
(THOUSANDS OF TONS)

SUGAR MILLS	1965	1966	1967	1968	1969	1970	AVERAGES 10 YEARS (1961/70)	AVERAGES 3 YEARS (1968/70)	MAXIMUM(*) PRODUCTION
CONCEPCION	73.2	96.6	69.6	62.2	65.5	79.5	65.4	69.1	96.6 (66)
CRUZ ALTA	19.5	17.4	15.3	15.5	19.2	17.2	17.3	17.2	20.7 (58)
LA FLORIDA	24.5	4.4	15.1	16.6	23.8	13.3	16.0	17.9	30.1 (58)
SAN JUAN	21.6	21.1	18.6	25.2	22.1	14.8	20.5	20.7	26.7 (58)
DPT. CRUZ ALTA	138.8	139.5	118.6	119.5	130.6	124.8	119.2	125.0	
LA CORONA	56.2	44.0	28.1	36.7	46.6	51.7	35.6	45.0	56.2 (65)
LA TRINIDAD	27.6	7.2	17.1	16.4	30.7	19.9	19.3	22.3	35.5 (58)
DPT.CHICLIGASTA	83.8	51.2	45.2	53.1	77.3	71.6	54.9	67.3	
BELLA VISTA	36.9	14.4	23.3	30.6	29.6	23.8	25.9	28.0	43.5 (58)
LA FRONTERITA	44.8	38.0	39.1	41.6	40.8	54.1	35.9	45.5	54.1 (70)
SAN PABLO	50.3	42.3	32.0	58.8	46.9	37.8	40.6	47.8	58.8 (58)
DPT. FAMAILLA	132.0	94.7	131.0	117.3	115.7	115.7	102.4	121.3	
LEALES	23.2	20.0	11.4	16.3	22.4	19.0	17.6	19.2	23.3 (58)
LA PROVIDENCIA	39.2	38.1	28.0	45.8	38.6	39.5	32.7	41.3	45.8 (68)
NUNORCO	31.6	21.0	13.7	23.3	25.2	25.0	22.1	24.5	31.6 (65)
SANTA ROSA	24.4	20.7	11.9	13.9	22.9	26.9	19.3	21.2	26.9 (65)
DPT. MONTEROS	95.2	79.8	53.6	83.0	86.7	91.4	74.1	87.0	
AGUILARES	20.6	21.8	10.2	11.0	21.7	23.7	16.4	18.8	23.7 (70)
MARAPA	22.2	13.2	5.3	12.6	17.0	12.4	12.5	14.0	22.2 (65)
STA. BARBARA	34.5	28.7	18.5	31.7	30.8	32.6	24.5	31.7	34.5 (65)
DPT. RIO CHICO	77.3	63.7	34.0	55.3	69.5	68.7	53.4	64.5	
TOTAL PRODUCED BY ABOVE SUGAR MILLS	550.3	448.9	357.2	458.3	503.7	491.2	415.5	484.4	
TUCUMAN TOTAL	749.6	541.1	378.2	472.9	503.7	491.2	489.3		

(*) Figure in parenthesis indicates the year in which the maximum production was reached

SOURCE: On the basis of data from the CENTRO AZUCARERO ARGENTINO

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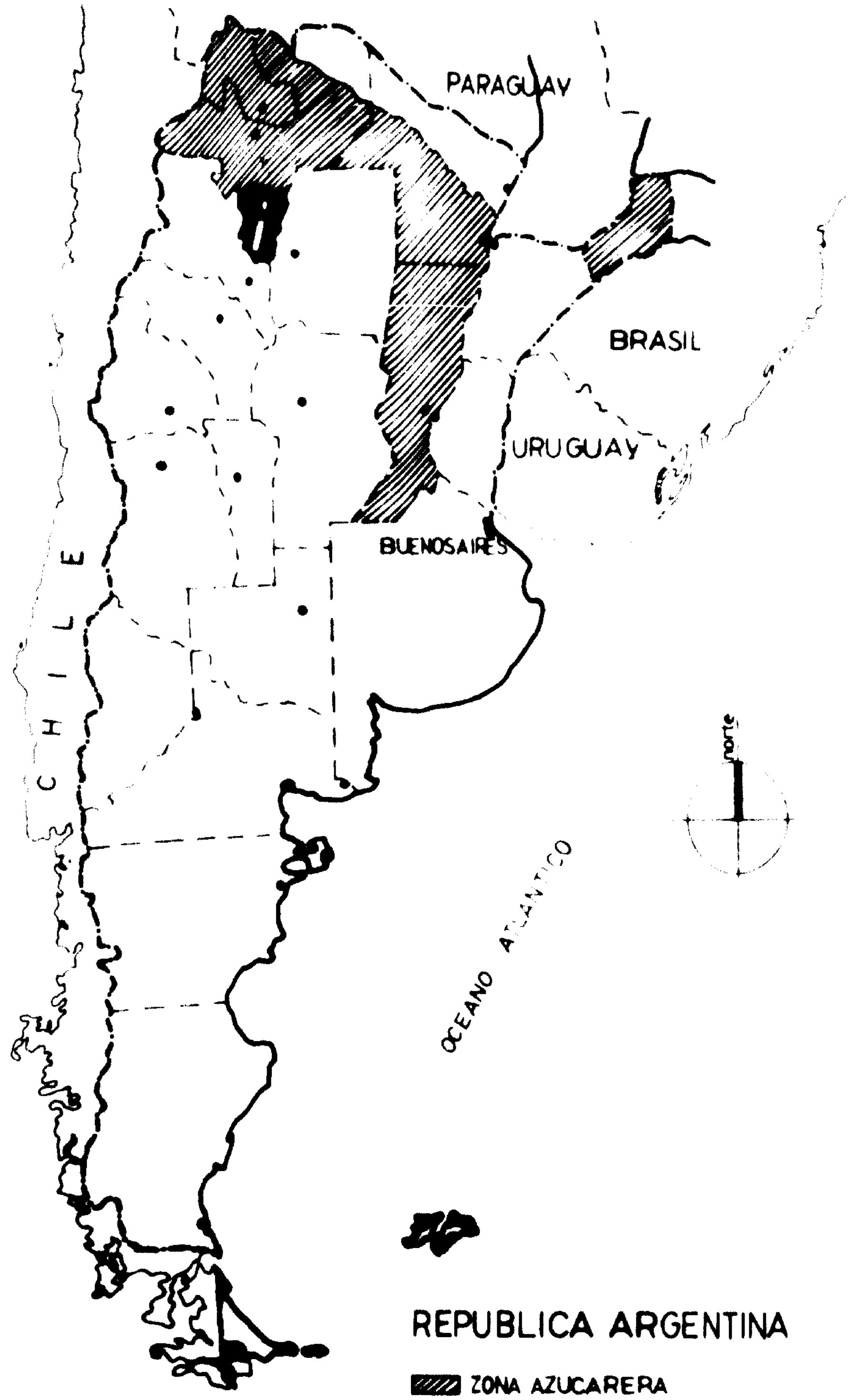
TABLE 4-D

MOIST BAGASSE (50%) PRODUCED IN THE PROVINCE OF TUCUMAN
(THOUSANDS OF TONS)

SUGAR MILLS	1965	1966	1967	1968	1969	1970	AVERAGES 10 YEARS (1961/70)	AVERAGES 3 YEARS (1968/70)
CONCEPCION	271.6	350.0	260.0	200.0	192.5	276.9	248.3	223.1
CRUZ ALTA	63.2	50.3	47.2	44.2	55.3	53.1	53.4	50.9
LA FLORIDA	78.8	15.0	48.9	54.0	74.6	41.2	56.5	56.6
SAN JUAN	70.7	70.8	64.1	74.5	70.9	53.7	70.5	66.4
DPT. CRUZ ALTA	484.3	486.1	420.2	372.7	393.3	424.9	428.8	397.0
LA CORONA	186.3	149.0	101.0	102.8	134.5	156.8	119.5	131.4
LA TRINIDAD	102.9	26.5	77.0	57.9	111.4	72.2	76.1	80.5
DPT. CHICLIGASTA	289.2	175.5	178.0	160.7	245.9	229.0	195.6	211.9
BELLA VISTA	141.3	51.0	100.1	104.6	103.6	91.8	102.4	100.0
LA FRONTERITA	148.0	111.4	135.5	120.0	113.7	161.5	117.0	131.7
SAN PABLO	140.1	119.6	128.4	163.1	129.9	121.6	129.9	138.2
DPT. FAMAILLA	429.4	282.0	364.0	387.7	347.2	374.9	349.3	369.9
LEALES	85.8	80.5	41.6	49.0	73.0	67.2	68.7	63.1
LA PROVIDENCIA	123.1	114.1	91.5	128.3	104.4	125.3	105.1	119.3
NUNORCO	102.4	63.6	52.4	67.2	74.0	74.7	71.1	72.0
SANTA ROSA	89.1	69.3	43.3	37.1	70.4	82.6	65.8	63.4
DPT. MONTEROS	314.6	247.0	187.2	232.6	248.8	282.6	242.0	254.7
AGUILARES	66.1	70.0	43.1	33.1	63.9	74.9	56.4	57.3
MARAPA	74.1	48.2	18.7	26.0	56.7	38.1	44.1	40.3
STA. BARBARA	114.5	93.5	65.5	78.9	81.3	87.7	77.3	82.6
DEPT. RIO CHICO	254.7	211.7	127.3	138.0	201.9	200.7	177.8	180.2
OPERATING MILLS	1,858.0	1,482.8	1,318.3	1,340.7	1,510.1	1,579.3	1,462.0	1,476.7

SOURCE: DIRECCION NACIONAL DE AZUCAR

FIG I-D



REPUBLICA ARGENTINA

ZONA AZUCARERA

PROVINCIA DE TUCUMAN

E. OTHER RAW MATERIALS - AVAILABILITY AND COSTS

E 1 Chemicals

(a) General

Of the chemicals which are important for the bagasse conversion industry, the following have been investigated:

- Lime (Calcium Oxide)
- Limestone
- Sodium carbonate
- Caustic soda
- Aluminum sulphate
- Chlorine
- Sulphuric acid
- Starch
- Resin size

and the availability and cost have been investigated.

Most chemicals are available in Argentina, some have to be imported.

Limited quantities of sulphuric acid (H_2SO_4) will be required for feedwater treatment and stock neutralization.

Small amounts of starch, resin, alum which are also needed in the process would be purchased from local suppliers to the pulp and paper industry.

Table 1-E shows the various chemicals with their availability and cost.

An electrolytic plant is not needed since the mills considered in the models produce unbleached pulp.

TABLE 1-E

OTHER RAW MATERIALS AVAILABILITY AND COST*

Name of Chemical	Lime	Limestone	Sodium Carbonate (Soda Ash)	Caustic Soda	Aluminum Sulphate (Alum)	Chlorine	Sulphuric Acid	Starch	Rosin Size
Formula	CaO	$CaCO_3$	Na_2CO_3	NaOH	$Al_2(SO_4)_3$	Cl_2	H_2SO_4		
Source	Local from Cordoba	Local from Cordoba	Imported thru Buenos Aires	Local from Cordoba	Local	Local from Cordoba	Local from Cordoba	Local in Tucuman	Imported
Current Production Tons/yr in 1970	1,880,000	16,000,000		96,700	91,140	83,300	195,500		
Method of Shipment	Bulk by road or rail	Bulk by road or rail	Carload lots from port of Buenos Aires	Bulk in tank truck or rail tank car	50 kg bags or liquid in tank trucks	Tubes & 800 kg cylinders	10 l bottles or bulk road or rail	Bulk or bag	Bags
Price Del at Tucuman $*	$184.00 MT	$33.75 MT	$585.00 MT	$900/T 100% + $81/T 100% freight	$575/MT as 16/17% Al_2O_3	$740/MT	$260.00 MT	$.82-$.86 kg.	$1,388 MT

* Further information can also be found in Appendix Section EE.2

E 2 Fuel

Bagasse, as a solid fuel, is a sub-product used in generating steam, in order to fulfill steam and electric power needs for the different processes in the sugar mills. As mentioned in Section D.1, any type of combustible may be used to replace the bagasse, when availability and technical characteristics make substitution possible.

As the result of preliminary study of documentation available, and field investigations in the province of Tucuman, wood has been discarded. Due to the lack of adequate legislation on the subject, wood sources near the sugar mills have disappeared, and transportation from places where it is available has become very costly. Same situation appears as regards coal.

From remaining fuels, i.e., fuel-oil and natural gas, the latter has to be considered for the sugar mills, due to its lower cost per calorific unit, and reliability of supply.

Furthermore, due to the agreement between Bolivia and Argentina governments on gas supply, Tucuman is crossed by a number of natural gas mains, and some sugar mills have already begun to use this fuel. (See Map Fig. I-E).

GAS DEL ESTADO furnishes the natural gas at specified pressures, which are never less than 45 kg/cm^2 on the main pipeline, and not less than 10 kg/cm^2 on secondary branches.

Pressure reducing plants, as well as facilities from them, must be paid by the consumer. Rates (Dec. 1971) as below:

FROM cu.mt/mo.	TO cu.mt/mo.	$/cu.mt.
-	6,000	0,1740
6,001	15,000	0,1071
15,001	30,000	0,0901
30,001	150,000	0,0841
150,001	900,000	0,0800
900,001	3,000,000	0,0761
3,000,001	6,000,000	0,0742
6,000,001	Or more	0,0721

Taxes on these rates are 0.003 $/cu.mt. on the first 6,000 cu. mt. and 0.001 $/cu.mt. for monthly consumption exceeding this figure. Calorific value of natural gas is 9,300 kg-cal/cu.mt., and boilers operate at 85-90% efficiency.

E.3 Long Fibre Pulp

Long fibre pulp is almost totally imported, and that from countries outside the LAFTA agreement is subject to duty ranging from 5 to 20%.

Price

Crude kraft long fibre pulp, CIF Buenos Aires:

(a) Extra-LAFTA zone

Prices obtained were averaged, and the average of taxes was added to this figure, thus resulting 171.00 US$/ADT.

(b) LAFTA zone

Prices obtained were averaged, thus resulting 170.00 US$/ADT.

Freight: By rail, carload lots, Buenos Aires-Tucuman:

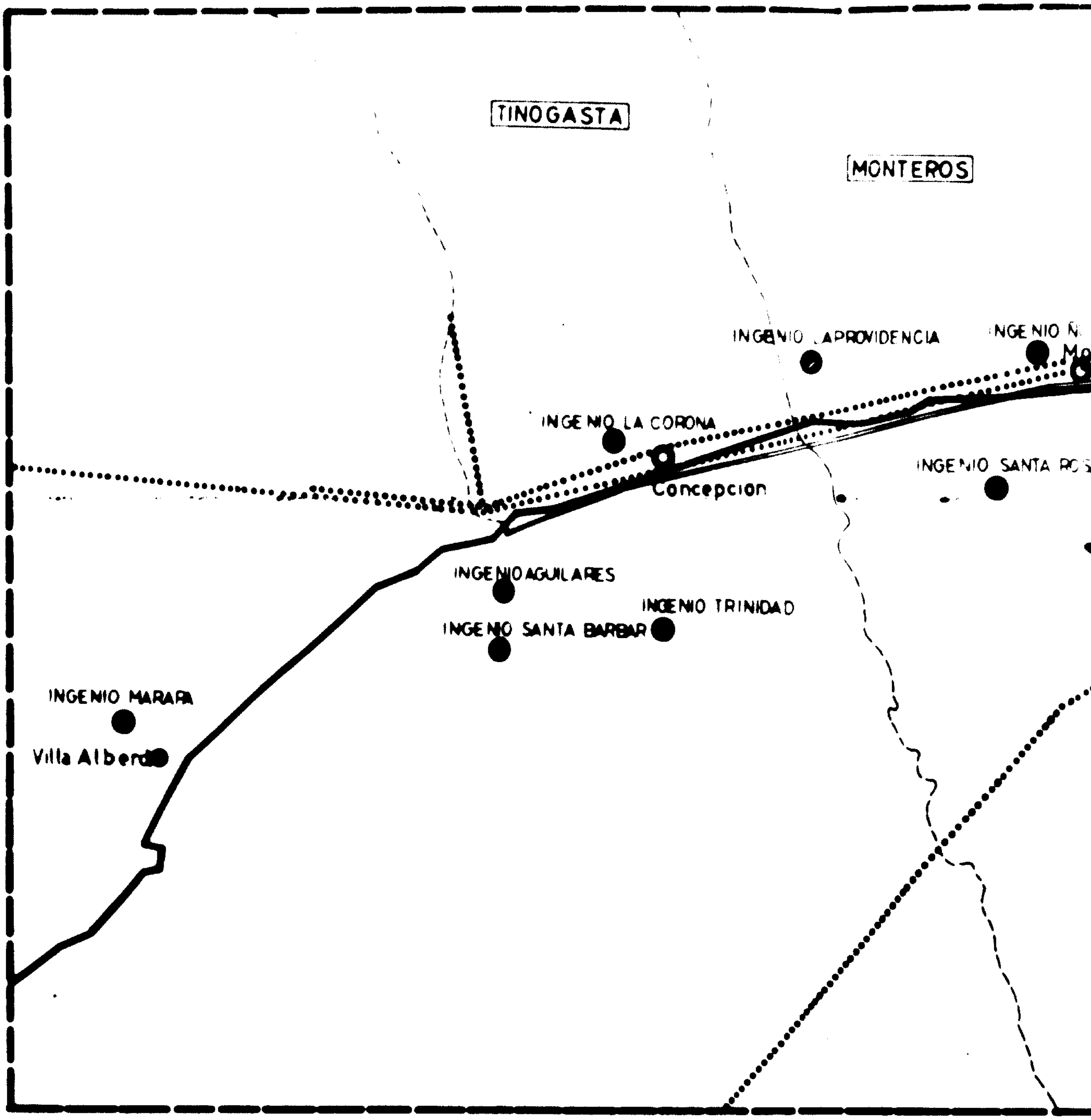
between 40 and 50 $ª/T (8-10 U$S).

Figures used for cost calculations were U$S 170.00 plus U$S 8.00 freight.

E.4 Waste Paper

Waste paper in sufficient quantities is readily available in Argentina, mostly from the populated areas because of the higher concentration of use.

Prices for second class newsprint including any freight landed in Tucuman is taken at $ª 310 per A.D. metric ton

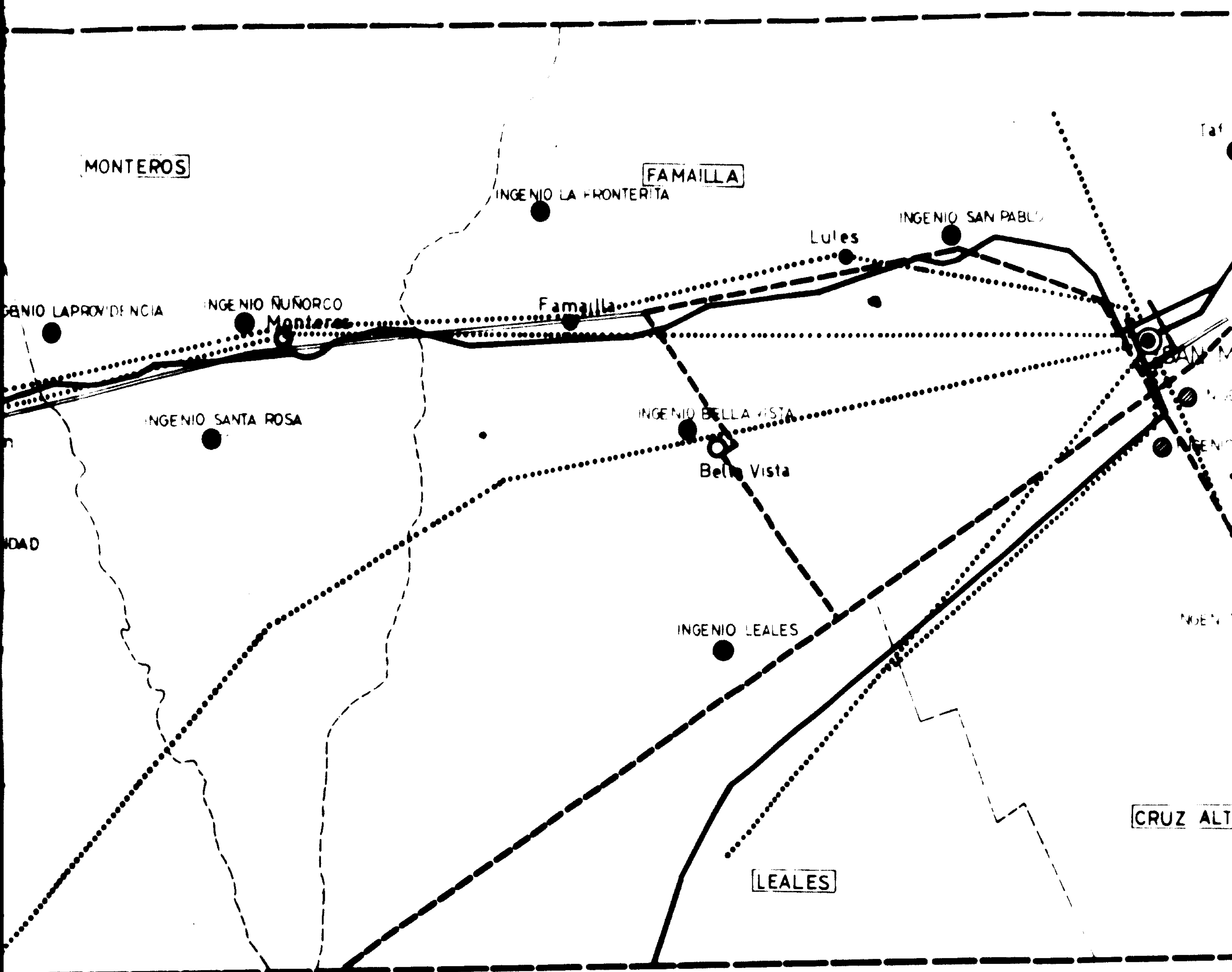


REFERENCIAS

LINEA DE TRANSMISION 132 KV

GASODUCTO EXISTENTE

" " EN EJECUCION


MONTEROS
FAMAILLA
INGENIO LA FRONTERITA
Lules
INGENIO ÑUÑORCO
Monteros
Famailla
INGENIO SANTA ROSA
INGENIO BELLA VISTA
Bella Vista
INGENIO LEALES
LEALES

SECTION 2

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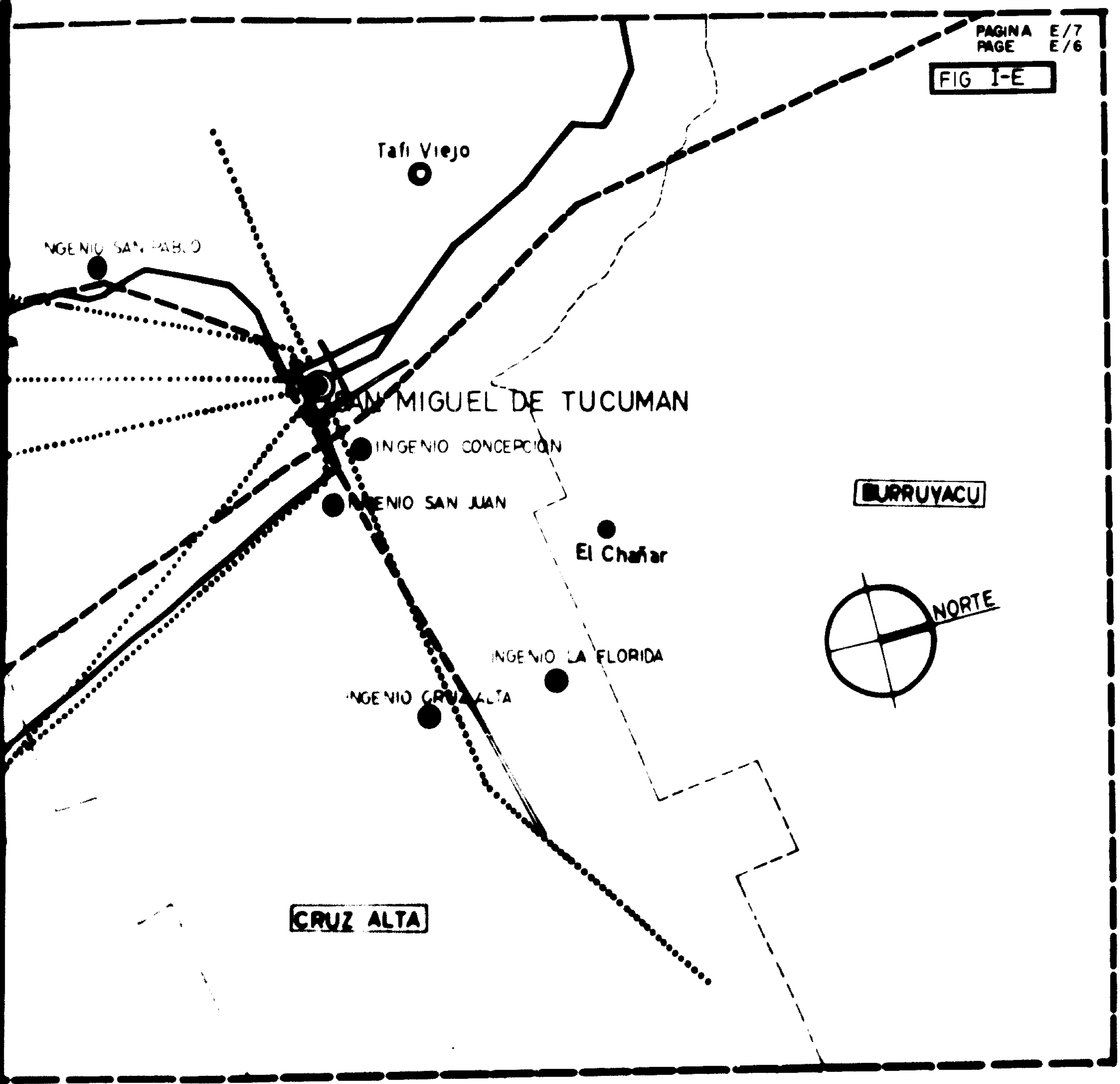
FIG I-E



ZONA DE INGENIOS AZUCAREROS
PROVINCIA DE TUCUMAN

ENERGIA Y COMBUSTIBLES

ESCALA 1 250 000

SECTION 3

F. SERVICES AVAILABILITY AND COSTS

F.1 Water

The availability of water has been incorporated into Subsection H.2 (b) in the discussion of alternative mill locations, and little supplementary information need be added here.

Specific information has been difficult (in fact impossible) to obtain but in interviews with Government officials and ingenio managements we have been assured that water in the quantities required for any of the three mill alternatives, i.e. up to 60,000 cubic meters/day for the largest mill, can be supplied on a year-round basis.

The cost of any special arrangements which might have to be made to supply water to the paper mill would not be excessive particularly if it is located adjacent to one of the larger ingenios.

F.2 Power

(a) General

There are two electrical power systems in Tucuman - one national and one provincial. The systems are, however, interconnected so that for most areas of the sugar belt, high tension transmission lines are within convenient range and, in general, the supply of power for any of the alternatives should present few problems (See map Figure I-E).

Power characteristics are 50 cycle, three phase. Because of the interconnections with other systems, interruptions in supply would be expected to be relatively infrequent. Except for emergency lighting provisions, therefore, the paper mill would not require to have stand-by generating capacity.

Power transmission is for the most part at 132 KV on the main lines thus, since voltages in the mill would be 3300 maximum ranging through the various standard voltages, depending on application, down to 220 V, two transformation stages might be required. Alternatively, it might be possible to connect to an existing 33 KV substation, in which case new transformers would be required only at the paper mill. In either case the cost would be chargeable to the project and the transmission line would be provided by Agua y Energia. The cost of a primary substation, should it be necessary, would be included in mill capital costs. Since, however, particularly in the North it is considered quite probable that 33 KV power would be available, funds have been allowed for the secondary substation only.

The costs of power have been based on the rates applicable to the last quarter of 1971, as follows:

Per Kw contracted	\$a	16.46 per month
Per Kwh consumed	\$a	0.029

Certain minor taxes may in some circumstances apply to these rates, but these have been ignored.

(b) Cost of generated power

In the calculation of manufacturing costs, it has been assumed that the power necessary for each of the paper mill alternatives would be purchased at the rates specified for the Tucuman area in "Regimen Tarifario No. 708/70".

At their respective consumption rates, power cost for all three mills has thus been computed to be \$ᵃ 0.0545 per KWH or, at 5 \$ᵃ/US \$, 10.9 mils.

For comparison the following calculations show the estimated costs of power which would result if generating equipment were to be installed in the different mills.

Factors common to all cases are:

Kilowatt hour	860.4 Kg. Cal.
Calorific Value - Natural Gas	9300 Kg. Cal./m^3
Generating Efficiency	85%

The gross return on investment for generating power in each of the three models is shown in Table 1-F.

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TABLE 1-F

GROSS INVESTMENT RETURN ON GENERATED VS. PURCHASED POWER

	Consumption KWH/Yr.	Annual Cost Purchased Power $ U.S. *	Annual Cost Generated Power $ U.S. **	Gross Return on Investment %	Gross Return on Investment Years
MODEL I	54,400,000	593,000	288,800	20.3	4.93
MODEL II	97,600,000	1,063,800	455,300	20.2	4.94
MODEL III	152,000,000	1,656,800	675,400	29.7	3.37

* Rates established from Regiment Tarifario No. 708/70 for Tucuman area.

** Amortization of capital cost at a conservative 15% interest to be repaid in 10 years plus straight line depreciation over 20 years plus cost of natural gas required to generate required power.

The figures developed above thus indicate that savings of at least 50% in power cost would be possible by providing for in-plant power generation. It should be noted also that loan interest at 15% and repayment in 10 years have been used intentionally to show a conservative estimate of the savings. If money is available at lower interest and for a longer term, the savings would be proportionately greater.

These are attractive figures and it is recommended that in a complete feasibility study for any of the three projects the inclusion of in-plant power generation should be fully investigated.

F.3 Transportation

Within the province of Tucuman transportation facilities are excellent. Two paved national highways (#9 and #38) pass through the area, there are many paved secondary roads to the larger municipalities, and these are fed by a complex network of consolidated and dirt roads. All roads remain in good condition even during the periods of heaviest precipitation. In the area of the sugar belt the terrain is almost uniformly level with a very slight slope generally to the East and somewhat towards the South, Conditions for road transport therefore leave little to be desired.

Several relatively large trucking companies have headquarters at San Miguel de Tucuman so that competitive bids on trucking contracts should be possible. This is particularly interesting from the point of view of bagasse transportation.

All ingenios, of course, are accessible by means of quite satiafactory roads since the major part of the cane is delivered by tractor-trailer trains.

Similarly rail facilities are more than adequate. Two railway systems operate in the province, Ferrocarril General Mitre (atandard gauge) and Ferrocarril General Belgrano (narrow gauge). The combination of the two different gauges might cause minor problems in respect to some locations but service to and from most areas can usually be aupplied without difficulty. Both rail aystems connect with moat of thelarger centers auch as Buenoa Aires, Rosario and Cordoba so that shipment of supplies to the mill and finished products to the consumera ahould be relatively simple to organize and arrange.

The map, Fig. II-F, gives a good general picture of road and rail distribution, although on such small acale it is not poesible to indicate the many minor sideroads and spurs which could be of intereet.

Costs of transportation are indicated for chemicala, kraft pulp etc. in the relevant sections of the report and in the Appendix.

The largest tonnages to be shipped out of the province would, of course, be the finished paper. Coata for such ahipment in box cars-carload lots of not less than 50% of rated car loading would be:

	CORDOBA		ROSARIO		BUENOS AIRES	
	Distance	Cost/Ton $a	Distance	Cost/Ton $a	Distance	Cost/Ton $a
F.C.G.M.	643 km	31.44	842 km	42.43	1143	48.87
F.C.G.M.	563 km	34.24	926 km	40.09	1221	51.21

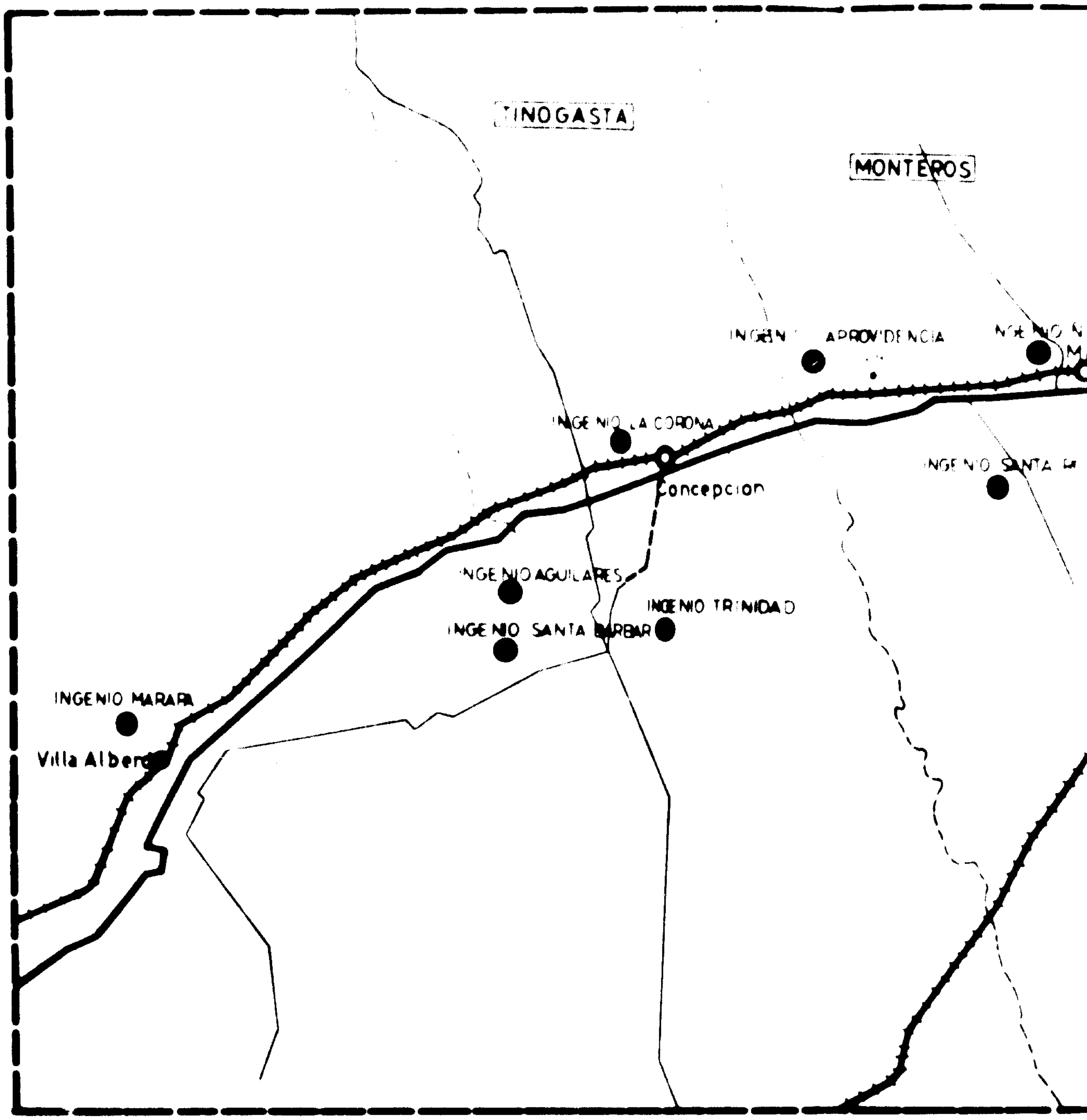
Transfer from one gauge to the other would have a surcharge of $a 2.90/ton.

Standard gauge load limit	50 tons
Narrow gauge load limit	35 tons

Rates for road transportation are more difficult to specify since truckera are inclined to adjust their charges according to circumstances prevailing at any given time. Alao, because of rapid inflation, they are reluctant to quote on a contingency basis. The rates which have been obtained, however, are more or less competitive with the rail shipment costs shown above.

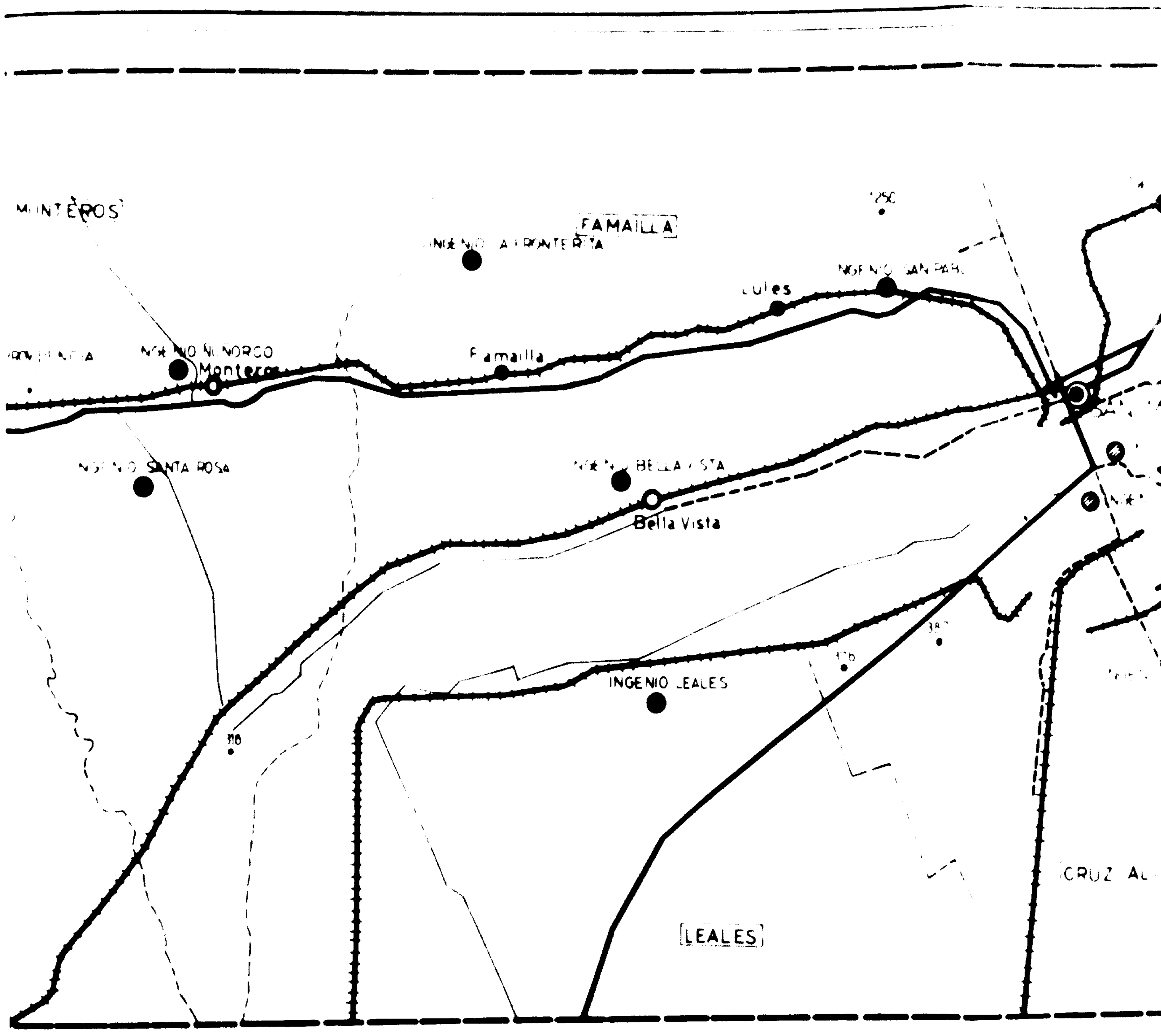
It is felt that the major part of product shipment would probably be by rail but in some cases road traneport might have advantages.

It is aleo considered quite likely that for the tonnages involved discounted rates could be negotiated. A realistic rate would possibly be about $a 40 per ton.



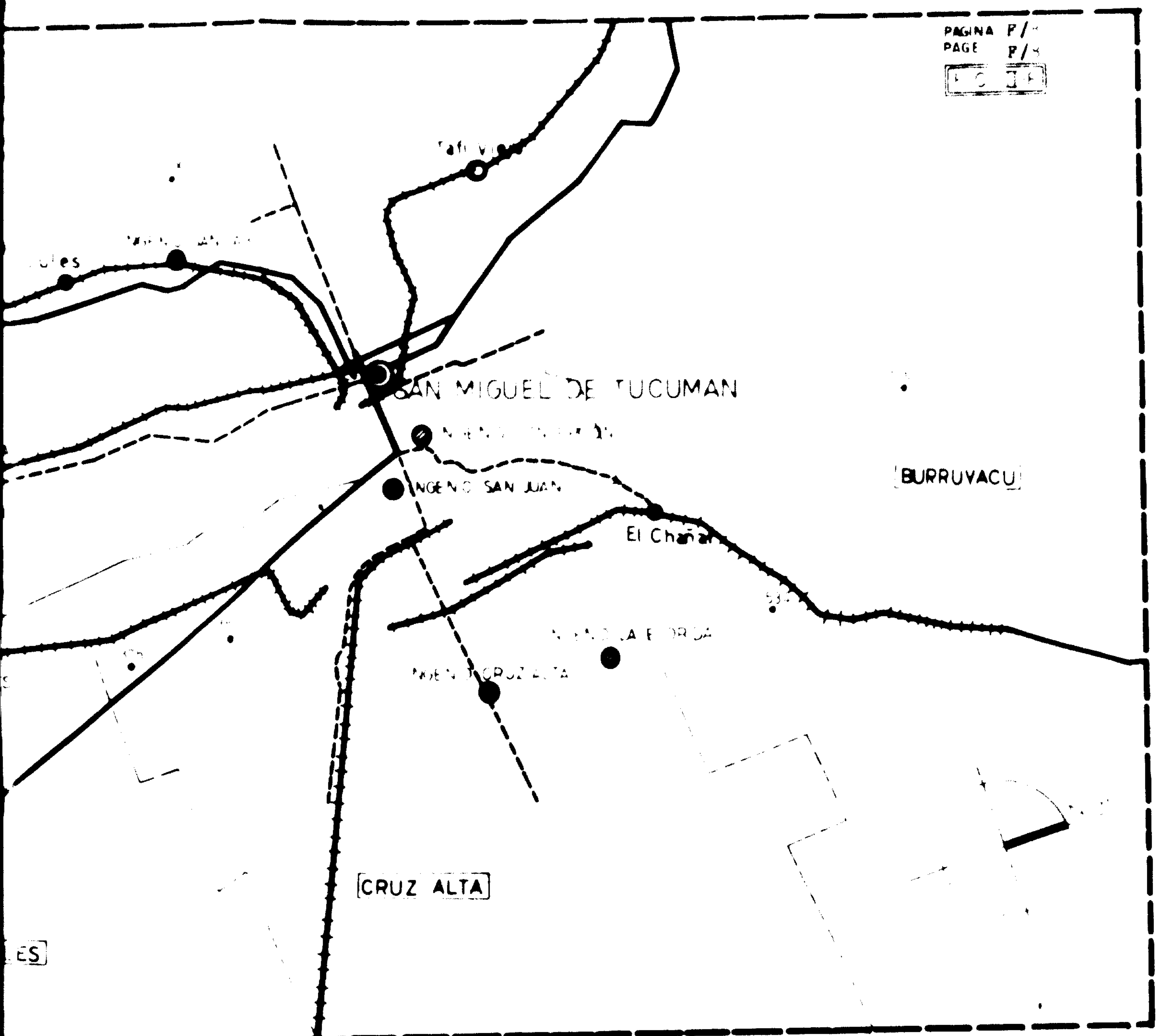
REFERENCIAS

CAMINO PAVIMENTADO
" " " SECUNDARIO
CAMINOS NO PAVIMENTADOS
FERROCARRIL (LINEA PRINCIPAL)
" (RAMAL)
PUNTOS ACOTADOS DEL TERRENO



MONTEROS
FAMAILLA
INGENIO LA FRONTERITA
250
INGENIO SAN PABLO
Lules
INGENIO ÑUÑORCO
Monteros
Famailla
NGENIO SANTA ROSA
BELLA VISTA
Bella Vista
387
376
INGENIO LEALES
318
CRUZ AL
LEALES

SECTION 2



ZONA DE INGENIOS AZUCAREROS
PROVINCIA DE TUCUMAN

CAMINOS Y FERROCARRILES

ESCALA 1 250000

SECTION 3

G. LABOUR AND MANAGEMENT

G.1 Organization

The Organization Chart - Fig. 1-G illustrates a typical arrangement and assignment of functions which would be suitable for each of the three sizes of mill under consideration. Administrative and supervisory positions down to the level of the various mill superintendents are shown and, below that level, the responsibilities of each superintendent are indicated in broad scope.

It may be seen that total personnel subdivides into four essentially distinct groups.

- Head Office
- Mill Administration
- Mill Operations
- Mill Repair and Maintenance

The functions of these individual groups are different in perspective and performance but all must cooperate and correlate well to achieve a smooth running, efficient and, above all, a profitable operation.

G.2 Personnel Requirements and Cost

(a) Foreign

It is considered very improbable that any of the proposed mills could be completely staffed right from the outset by Argentines possessing all of the skills and experience necessary for efficient start-up and operation. For certain mill management positions in particular, willingness to work and learn, and potential ability and enthusiasm cannot substitute for experience in the complex equipment, techniques, systems and procedures involved in paper manufacture. For the purpose of achieving a well organized and profitable operation as quickly as possible it has thus been deemed adviasble to provide for the temporary employment of foreign experienced personnel to administer some of the key functions until Argentine Nationals can be fully trained to assume the responsibilities of these most important management posts.

Table 1-G has therefore been prepared to show the extent and cost of foreign assistance considered necessary for the smallest mill, and Table 2-G shows similar information for the medium and largest capacity mills.

In the estimation of costs, it has been assumed that salary levels would conform to North American Standards and that usual concessions such as exemption from income tax, and free housing, medical care and local transportation would be granted. The first of these advantages would involve no extra cost to the project(s), but the remainder have been allowed for in the column headed "Annual Allowance". Return transportation expense for the men themselves, their families and a reasonable amount of household effects, has also been included.

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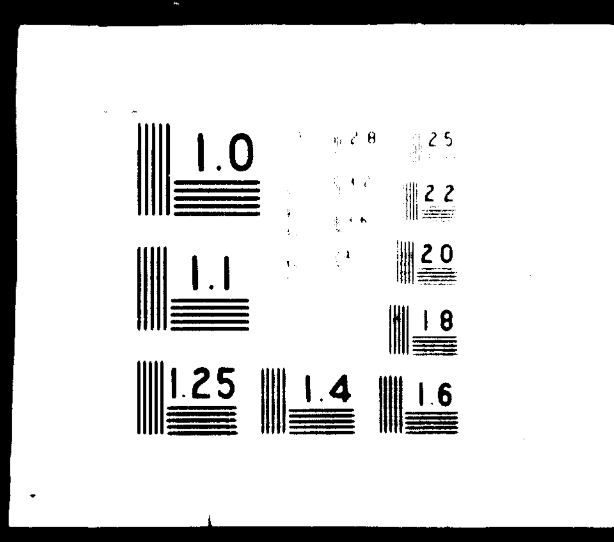

In reference to the item "Recruiting Expense and Fee" it has been assumed that the recruiting of expatriates would be arranged through Consultants qualified to evaluate the skills of the applicants. This is a conventional method of finding and selecting the most suitable candidates for the various positions and carries with it the advantage that provision may be, and usually is, included for handling all administrative matters in reference to expatriate personnel. Under such an arrangement the Consultant would continue to observe carefully the performance of the selected men in the positions to which they have been assigned and, should it prove necessary, would arrange to replace any who show themselves to be below the required standard. In addition, since expatriates are normally retained under two-year contracts, the Consultant would renegotiate the contracts of those men scheduled to stay three years, or would arrange for replacement of personnel who do not wish to remain after the original contract period. The sum allowed for this item has been estimated on the basis that the Consultants responsibilities in this respect would encompass the full scope which has been outlined.

The possibility cannot be ignored that some of the positions suggested for expatriates could be filled by Argentine, or at least Latin American, personnel at salaries and allowances substantially lower than those estimated in Tables 1-G and 2-G. A very significant advantage in the elimination of language difficulties would, no doubt, result from employment of such people if they can be found. However, since expatriate assistance is normally considered to be an indirect capital expense to be written off over a fairly lengthy period any variation from the totals shown would have relatively insignificant effect on the overall cost of production.

(b) Argentine

For estimating purposes it has been assumed that:

- As indicated above certain mill executive, operating, and maintenance management functions would be performed initially by expatriates possessing knowledge, skills and experience particular to the paper industry.
- Each position held by an expatriate would be understudied by an Argentine of adequate skills and ability to permit him eventually to take over the full duties and responsibilities of the function for which he is being trained.
- A suitable prestart-up training program would be implemented to ensure that other men in various key positions will possess adequate skills to permit them to work efficiently and to impart their knowledge to others being trained on the job.

- All Head Office personnel and, with the exception of the positions to be held initially by expatriates, all mill personnel would be Argentine. Accordingly average wage rates have been estimated with reference to the provisions of national labour agreements, and salary levels in accordance with current standards in Argentina

Based on these assumptions Tables 3-G, 4-G, 5-G and 6-G have been developed to show the approximate number of people and annual costs for each Cost Model and each of the principal sub-divisions of personnel. For convenient reference Table 7-G summarizes the four preceding tables in terms of the number and costs of personnel required for the three alternative mills.

It will be noted that, although the productive capacities of the three "Models" are in the general ratio of 1:2:3, the additional personnel and costs do not even approach these proportions thus illustrating one aspect of the advantage of scale.

G.3 Personnel Availability

(a) Foreign

In most of the positions suggested for expatriates experience in the manufacture of bagasse-based paper, though desirable, would not be a prerequisite. The principal require-ments would be sound basic knowledge of the duties and responsibilities of the positions which they have been selected to administer combined with willingness and ability to impart their knowledge to the Argentine trainees. The Paper Mill, Pulp Mill, and Control Superintendents, and to some extent the General Superintendent, however, should also have a record of proven competence in the processing of bagasse into paper.

There is no doubt that adequate incentive in addition to the challenge of contributing to the success of a new enterprise would interest well qualified men from most of the industrially advanced nations of the world. It is thus considered that the principal difficulty in this respect would occur in selecting the most suitable candidates.

(b) Argentine

As indicated in sub-section G.2, for any of the proposed projects, the intention is to staff the Head Office and the complete mill from the available manpower resources of Argentina. Even in the cases where foreign personnel have been recommended to assist during the early years provision has been made for the employment of Argentines who would eventually take over the various positions.

In common with many other large industries the preferred location for the Head Office would probably be Buenos Aires but, if desirable, it could also be in Tucuman province. At either location there should be no problem in attracting competent people to perform the various necessary administrative functions.

The Northern ingenios are more closely grouped thus, economically, this area would be a convenient site for the initial mill. At least five sugar mills and also the city of San Miguel de Tucuman would be within easy access. With such resources to draw upon, little difficulty should be encountered in finding suitable people to fill all administrative, operating and maintenance jobs not requiring specialized paper-making skills and knowledge. Similarly, professionals such as engineers, chemists and accountants, mature men with trades foreman qualities, machinists, electricians, pipefitters and other tradesmen, secretaries, typists and clerks, and all necessary common labour should also be available from the appreciable labour pool in the area, or certainly from within the province.

Recruiting of the supervisory and operating personnel who would be actively involved in the pulp and paper production processes is expected to present somewhat of a problem in finding the required number of suitably experienced men. Every effort, therefore, must be made to ensure that the maximum number of operating jobs will be handled by people with some background in paper manufacture and preferably, some working knowledge of the functions they will be expected to perform. Assuming that an appreciable nucleus of trained operetors will exist it is considered quite practical, for the remainder, to employ men who indicate potential to learn quickly.

Trainees to understudy expetriate counterparts constitute a select group and would have to be choeen from the best of the experienced Argentine applicants in accordance with most exacting standards end exercising the best possible judgment. It must be kept in mind that the expatriates only serve to assist in getting the project under way in minimum time end with optimum efficiency. The future and continued success of the totel venture will eventually depend totelly on the abilities of the trainee candidates to put into practice what they have learned and collectively, to form a strong management group.

G.4 <u>Training</u>

It is important for a smooth start-up and continued operation that, right from the beginning, the key positions on the operating staff should be managed by men who are familiar with their respective jobs and who, ideally, have spent some time performing similar functions under similar conditions. Since it is improbable that an adequate supply of such fully experienced men would be available for staffing the proposed mills, a well organized training program would form an essential part of the project planning.

At this point in time the total scope of the training which would be required is somewhat indeterminate because this is to a great extent dependent on the number of skilled, partially skilled, and unskilled men which can be found and employed. Generally, however, it is visualized that two different phases should be implemented:

- Periods of training in operating mills manufacturing products similar to those proposed,
- Pre-operational on-the-job training.

The first of these would apply principally to the key men on the operating staff such as the management trainees and the men who have been nominated as foremen in the various process departments. If a disproportionately large number of totally inexperienced men must be employed some of these also may have to be included.

To ensure experience in modern methods and technology such training should, if possible, take place in only the most advanced bagasse-based paper manufacturing plants available. To avoid language problems preference would be given to mills located in Latin American countries but it is recommended also that the more important personnel should spend a period of time in the best of North American mills engaged in this type of manufacture. It is estimated that an average period of two months would be the minimum for best results.

The finding of suitable mills which will accept trainees, specification of the type and amount of training required, and travel and accommodation arrangements for the men involved will require an appreciable amount of lead-time. Formulation of plans and selection and assignment of personnel for the various operating functions should therefore be done as early as possible during the construction phase.

The second aspect of training, as implied, would take place in the new mill itself and would include those who have spent periods in other mills together with all other members of the operating crews. These personnel would be assembled at the mill for varying periods of time before the initiation of production is attempted so that they can familiarize themselves with the system and equipment and can participate in training sessions, including dry runs, in all of the process departments. For the general run of operating personnel an average period of two months should be adequate for this phase of the training. The management trainees, however, should be engaged at the same time as their expatriate counterparts so that over and above the time spent in other mills and in the mill pre-operational training they would have additional time to become familiar with all aspects of the functions which they are understudying.

Based on the above training concept reasonable costs have been estimated for each of the proposed mills and included in Development Expense.

G.5 Accommodation and Transportation

As presently proposed, the location of the initial project will be almost adjacent to San Miguel de Tucuman thus it is not considered necessary to provide on-site housing or community facilities. Suitable accommodation for expatriate and local management personnel should be readily available in the city. The remainder of the working force, being in major part recruited from the immediate area, would likewise not require any special accommodation provision.

Similarly transportation to and from work would not be expected to present any particular problem since, if it does not already exist, it should be a simple matter for existing public transport facilities to arrange to provide adequate service at appropriate times.

No allowance, therefore, either capital or operational, has been made for either of these items.

G.6 Management Contract

Since implementation of any of the proposed projects would constitute the introduction of a relatively large industrial venture into a country where a comprehensive background in pulp and paper manufacture does not exist at present, it is recommended that a management contract should be negotiated to cover, in particular, recruiting of competent supervisory personnel (including expatriates) and actual management of the mill in its early years. These services can be supplied either by a firm operating similar mills or by a consulting engineering firm with experience in managing pulp and paper mills based on bagasse as the prime raw material.

The contract should be for a minimum period of about four years - approximately one year pre-operational, and three years after start-up. It should permit the management team to recruit suitable operating personnel and to institute all operating procedures and process techniques deemed necessary for the ultimate achievement of an efficient and economic operation. To avoid complications and promote coordination of effort, the best arrangement is normally to combine the management and engineering contracts.

TABLE 1-G

COSTS OF EXPATRIATE ASSISTANCE (MODEL I)

Position	Annual Salary	Annual Allowance	Return Air Fares	Pre-Startup 9 mo.	Pre-Startup 6 mo.	1st Year Production	2nd Year Production	3rd Year Production
Resident Mgr.	33,500	4,500	1,200	28,500		38,000	38,000	38,000
General Supt.	26,000	4,000	900	22,500		30,000	30,000	30,000
Paper Mill Supt.	24,500	3,500	900		14,000	28,000	28,000	28,000
Control Supt.	19,500	2,500	900		11,000	22,000	22,000	22,000
Pulping Supt.	21,000	3,000	900	18,000		24,000	24,000	
Plant Engineer	21,000	3,000	900	18,000		24,000	24,000	
Maintenance Supt.	19,500	2,500	900		11,000	22,000		
Instrument Eng.	13,500	2,500	900		8,000	16,000		
			7,500	87,000	44,000	204,000	166,000	118,000

Total for prestartup and production periods	619,000
Household & family moving expense	60,500
Recruiting expense and fee	60,000
Air fares	7,500
Total cost of expatriate assistance	US $747,000
at 5$[a] per US$	$[a]3,735,000

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TABLE 2-G

COSTS OF EXPATRIATE ASSISTANCE (MODELS II & III)

Position	Annual Salary	Annual Allowance	Return Air Fares	Pre-Startup 9 mo.	Pre-Startup 6 mo.	1st Year Production	2nd Year Production	3rd Year Production
Resident Mgr.	35,000	5,000	1,200	30,000		40,000	40,000	40,000
General Supt.	28,000	4,000	900	24,000		32,000	32,000	32,000
Paper Mill Supt.	24,500	3,500	900	21,000		28,000	28,000	28,000
Control Supt.	19,500	2,500	900		11,000	22,000	22,000	22,000
Pulping Supt.	22,500	3,500	900	19,500		26,000	26,000	
Plant Engineer	22,500	3,500	900	19,500		26,000	26,000	
Mechanical Supt.	17,500	2,500	900	15,000		20,000	20,000	
Instrument Eng.	13,500	2,500	900		8,000	16,000	16,000	
Electrical Supt.	15,500	2,500	900		9,000	18,000		
Steam Supt.	15,500	2,500	900		9,000	18,000		
Traffic Supt.	15,500	2,500	900		9,000	18,000		
Purchasing Agent	22,500	3,500	900		13,000	26,000		
			11,100	129,000	59,000	290,000	210,000	122,000

Total for prestartup & production periods	810,000
Household & family moving expense	90,000
Recruiting expense and fee	70,500
Air Fares	11,100
Total cost of expatriate assistance	US $981,600
at 5$[a] per US $	$[a]4,908,000

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TABLE 3-G

HEAD OFFICE EXPENSE

Title	Number	Annual Salary $[a]	Total Annual Salaries $[a]	Total Annual Salaries US $
Chief Executive Officer	1	120,000	120,000	24,000
Asst. to Chief Exec, Officer	1	90,000	90,000	18,000
Comptroller	1	90,000	90,000	18,000
Sales Manager	1	80,000	80,000	16,000
Sales Representatives	2	24,000	48,000	9,600
Accountants	2	30,000	60,000	12,000
Secretaries	3	14,400	43,200	8,640
Typists and Clerks	6	9,600	57,600	11,520
			588,800	117,760
Annual Salary Cost			588,800	117,760
60% Social Benefits			353,000	70,600
			941,800	188,360
Auditing Service			60,000	12,000
Legal Advice			30,000	6,000
Total Head Office			1,031,800	206,360

Note: Personnel required same for all mills

TABLE 4-G

COST OF MILL ADMINISTRATIVE PERSONNEL

Position	MODEL I No.	MODEL I $[a]/Year	MODEL I Total Annual Salaries-$[a]	MODEL II No.	MODEL II $[a]/Year	MODEL II Total Annual Salaries-$[a]	MODEL III No.	MODEL III $[a]/Year	MODEL III Total Annual Salaries-$[a]
Asst. to Res. Mgr.	1	45,600	45,600	1	48,000	48,000	1	48,000	48,000
Asst. to Gen. Supt.	1	38,400	38,400	1	40,800	40,800	1	40,800	40,800
Asst. to P.M. Supt.	1	36,000	36,000	1	38,400	38,400	1	38,400	38,400
Asst. to Cont. Supt.	1	26,400	26,400	1	28,800	28,800	1	28,800	28,800
Asst. to Pulp Supt.	1	31,200	31,200	1	33,600	33,600	1	33,600	33,600
Asst. to Pl. Eng.	1	36,000	36,000	1	38,400	38,400	1	38,400	38,400
Asst. to Instr. Eng.	1	19,200	19,200	1	21,600	21,600	1	21,600	21,600
Asst. to Mech. Supt.	1	26,400	26,400	1	28,800	28,800	1	28,800	28,800
*Asst. to Elec. Supt.	1	32,400	32,400	1	21,600	21,600	1	21,600	21,600
*Asst. to Steam Supt.	1	32,400	32,400	1	21,600	21,600	1	21,600	21,600
*Asst. to Traff. Supt.	1	32,400	32,400	1	21,600	21,600	1	21,600	21,600
*Asst. to Purch. Agent	1	36,000	36,000	1	33,600	33,600	1	33,600	33,600
Chief Chemist	1	30,000	30,000	1	30,000	30,000	1	30,000	30,000
Chemists	-	-	-	1	24,000	24,000	1	24,000	24,000
Technicians	2	18,000	36,000	3	18,000	54,000	4	18,000	72,000
Engineers	2	36,000	72,000	3	36,000	108,000	3	36,000	108,000
Draftsmen	2	18,000	36,000	3	18,000	54,000	4	18,000	72,000
Storekeeper	1	21,600	21,600	1	24,000	24,000	1	24,000	24,000
Buyers	2	18,000	36,000	3	18,000	54,000	3	18,000	54,000
Ch. Accountant	1	46,000	46,000	1	48,000	48,000	1	50,000	50,000
Accountants	2	18,000	36,000	3	18,000	54,000	3	18,000	54,000
Ind. Rel. Mgr.	1	40,000	40,000	1	42,000	42,000	1	44,000	44,000
Employment Superv.	-	-	-	1	24,000	24,000	1	30,000	30,000
Time Keepers	2	18,000	36,000	3	18,000	54,000	4	18,000	72,000
Doctor (Part-time)	1	36,000	36,000	1	36,000	36,000	1	36,000	36,000
Reg. Nurse	1	16,200	16,200	1	16,200	16,200	1	16,200	16,200

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TABLE 4-G

COST OF MILL ADMINISTRATIVE PERSONNEL (Cont'd)

Position	MODEL I No.	MODEL I $^a/Year	MODEL I Total Annual Salaries-$^a	MODEL II No.	MODEL II $^a/Year	MODEL II Total Annual Salaries-$^a	MODEL III No.	MODEL III $^a/Year	MODEL III Total Annual Salaries-$^a
Safety Superv.	-)	-	-	1	36,000	36,000	1	36,000	36,000
Security Officer	1)	36,000	36,000	1	36,000	36,000	1	36,000	36,000
Guards	8	18,000	144,000	8	18,000	144,000	8	18,000	144,000
Secretaries	4	12,000	48,000	5	12,000	60,000	6	12,000	72,000
Typists & Clerks	18	9,600	172,800	25	9,600	240,000	32	9,600	307,000
	61			78			89		
Total Direct Salaries			1,235,000			1,515,000			1,658,200
Social Benefits (60%)			740,000			909,000			995,000
Tot. Admin. Salary Expense			$^a1,975,000			$^a2,424,000			$^a2,653,200
at 5$^a per US $			US$ 395,000			US$ 484,800			US$ 530,640

NOTES:
a) All personnel Argentine Nationals
b) "Assistants to" are training to occupy positions held by expatriates. Salaries to increase 50% when full responsibility is assumed.
c) * - For Model I Argentines will fill these positions with full salary and title.

TABLE 5-G

COST OF OPERATING PERSONNEL

		MODEL I		MODEL II		MODEL III	
	Foremen	Skilled	Unskilled	Skilled	Unskilled	Skilled	Unskilled
Average Daily Rate	22.80	20.72	18.40	20.72	18.40	20.72	18.40
Number of Men	28	108	73	140	101	177	133
Total Direct Wages 6 Day/Week	3,830	13,420	8,060	17,400	11,150	22,000	14,680
Total Direct Wages/Year	199,200	698,200	419,100	904,800	579,800	1,144,000	763,400
60% Social Benefits	119,500	418,900	251,400	542,900	347,900	686,400	458,000
Annual Cost $[a]	318,700	1,117,100	670,500	1,447,700	927,700	1,830,400	1,221,400

Total Costs of Operating Labour

	$[a]	US $
MODEL I	2,106,300	421,300
MODEL II	2,694,100	538,800
MODEL III	3,370,500	674,100

NOTES:
a) Exchange Rate: $[a]5 per US $
b) Foreman requirement and cost same for each mill.
c) 6-day week - 8 hours per day.
d) Number of men inflated to compensate for required overtime Saturday and Sunday, shift differentials, etc.

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TABLE 6-G

COST OF REPAIR AND MAINTENANCE PERSONNEL

	MODEL I,II,III	MODEL I		MODEL II		MODEL III	
	Foremen	Skilled	Unskilled	Skilled	Unskilled	Skilled	Unskilled
Average Daily Rate $[a]	22.80	20.72	18.40	20.72	18.40	20.72	18.40
Number of Men	4	32	23	37	28	51	40
Total Direct Wages/Week	547	3,980	2,540	4,600	3,090	6,340	4,410
Total Direct Wages/Year	28,400	206,700	132,000	239,200	160,700	329,700	229,600
Overtime Allowance (15%)	4,250	31,000	19,800	35,900	24,100	49,400	34,400
	32,650	237,700	151,800	275,100	184,800	379,100	264,000
60% Social Benefits	19,59υ	142,600	91,100	165,100	110,900	227,500	158,400
Annual Cost $[a]	52,240	380,300	242,900	440,200	295,700	606,600	422,400

Total Costs of R&M Labour

	$[a]	US $
MODEL I	675,440	135,090
MODEL II	788,140	157,630
MODEL III	1,081,240	216,250

NOTES: a) Exchange Rate: 5$[a] per US $
b) Foreman requirement and cost same for each mill.
c) 6-day week - 8 hours per day.

TABLE 7-G

SUMMARY OF ARGENTINE PERSONNEL AND ANNUAL COSTS

	MODEL I		MODEL II		MODEL III	
Sub-Division	No.	Ann. Exp. $[a]	No.	Ann. Exp. $[a]	No.	Ann. Exp. $[a]
Head Office	17	1,031,800	17	1,031,800	17	1,031,800
Mill Administration	61	1,975,000	78	2,424,000	89	2,653,200
Mill Operation	180*	2,106,300	240*	2,694,100	300*	3,370,500
Mill Maint. & Repair	59	675,440	69	788,140	95	1,081,240
Totals	317	5,788,540	404	6,938,040	501	8,136,740
at 5$[a] per US $		1,157,710		1,387,610		1,627,350

NOTE: * - Figures scaled down from Table 5-G to show actual number of men.

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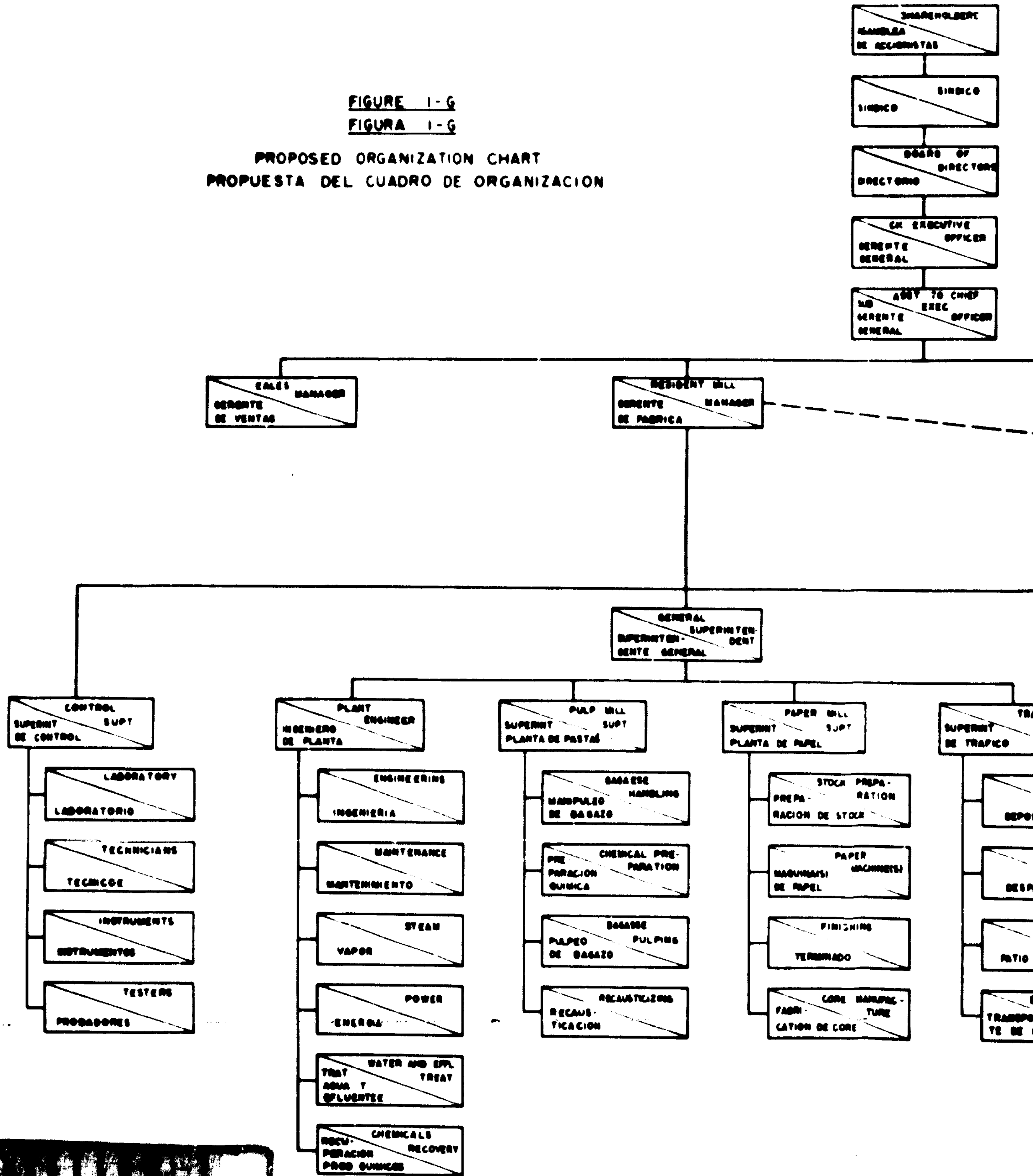
FIGURE 1-G
FIGURA 1-G

PROPOSED ORGANIZATION CHART
PROPUESTA DEL CUADRO DE ORGANIZACION



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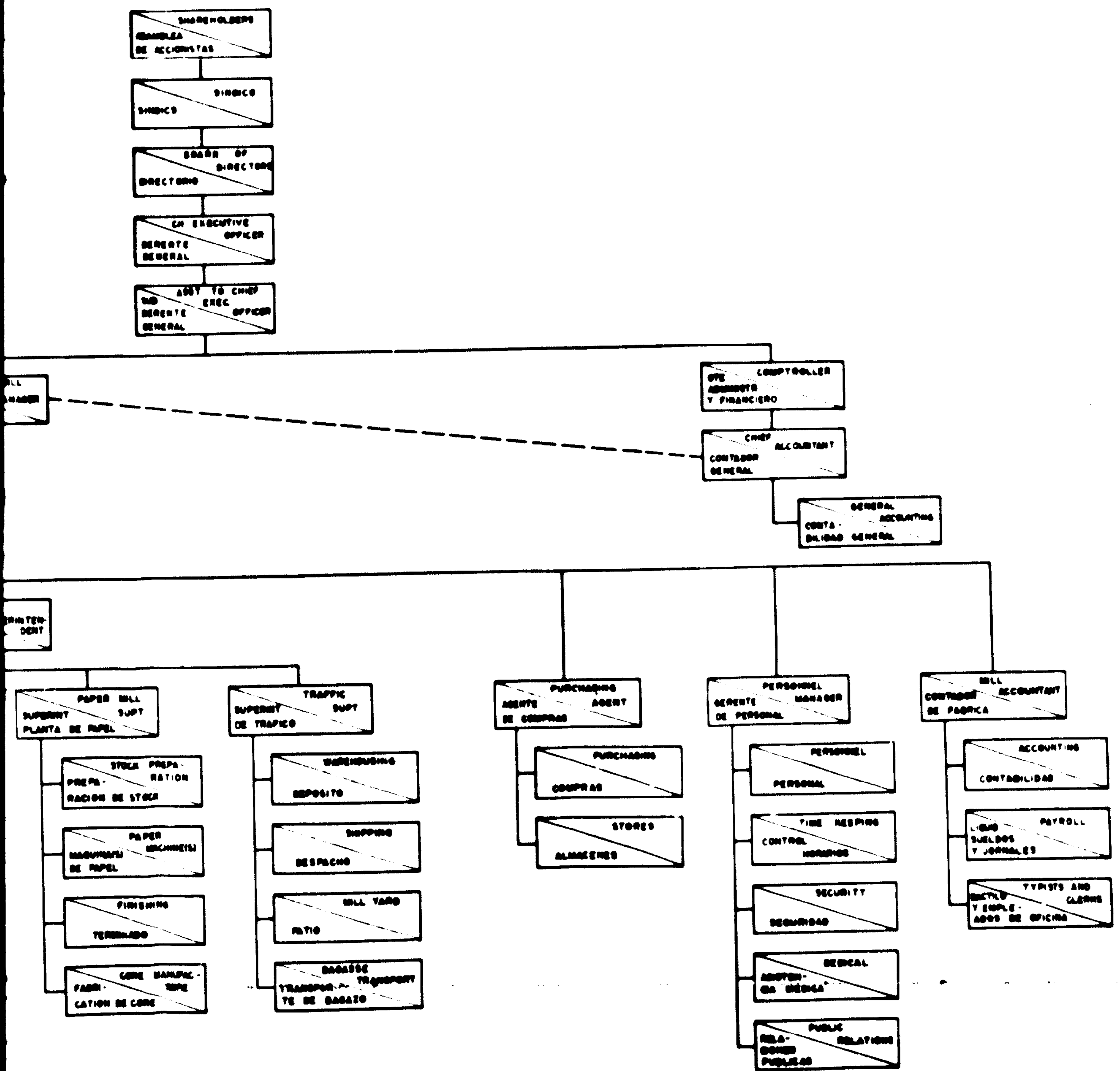


H. PAPER MILL LOCATION ALTERNATIVES

H 1 General

It is not the intention, nor is it within the scope of this report to pin-point the specific piece of land on which a paper mill would be built. Accordingly, this chapter will indicate only the general areas which comply best with the various aspects which must be considered in site selection for an industry of this type.

In the province of Tucuman most of these factors are approximately the same for many locations. Climatic conditions are relatively uniform over the area of the sugar belt, fuel and power are readily available, a good network of road and rail facilities serves all of the ingenios, and it is considered that from the point of view of the labour pool, any given area will differ only slightly from any other. Similarly, since the province is small in area, proximity to markets and availability and cost of construction materials would have little significance in the choice of tentative areas for a mill.

The determining factors, therefore, are reduced to bagasse availability and water availability for initial and future mill requirements and the economics of the supply of these essential elements.

It is recognized that political considerations may play some part in determining the degree of priority desirable for development of regional alternatives, but decisions of this nature must be left to the proper authorities. The Consultant can only evaluate factors affecting technological and economic suitability.

H.2 Discussion

(a) Bagasse

Examination of maps (Fig. I-H & II-H) shows that about 90% of the operating sugar mills of Tucuman can be enclosed in a rectangle roughly 80 km long x 15 km wide and that all can be included in 100 km x 25 km. It may also be seen that a concentration of ingenios exists in the North and another in the South. Three mills (La Fronterita, Bella Vista and Leales) are somewhat isolated from these groupings, but since distances are not great, these can be considered for inclusion in either group as required. The province, therefore, may be logically divided into two general zones, one at the North of the sugar belt and a second at the South. For purposes of discussion, it is assumed that Bella Vista would be in the Northern zone and La Fronterita in the Southern zone. Ingenio Leales, which is presently operating a small mill manufacturing corrugating medium, will be ignored for the present, although this, of course, does not preclude the possibility of inclusion in any proposed development program, should such prove desirable or necessary.

On the basis of average production 1961-1970, present annual metric tonnages of whole moist (50%) bagasse produced in the two zones are estimated to be:

TABLE 1-H

ANNUAL TONNAGES WHOLE MOIST (50%) BAGASSE PRODUCED

Northern Zone		Southern Zone	
Concepcion	248,300	La Fronterita	117,000
Cruz Alta	53,400	Nunorco	71,100
La Florida	56,500	Santa Rosa	65,800
San Juan	70,500	La Providencia	105,100
San Pablo	129,900	La Corona	119,500
Bella Vista	102,400	La Trinidad	76,100
		Aguilares	56,400
		Santa Barbara	77,300
		Marapa	44,100
	661,000		732,400

The estimated quantity required for manufacture of 168,640 metric tons per year of linerboard and corrugating medium (the largest mill proposed) amounts to 689,240 tons/year of whole moist bagasse.

It should be noted, however, that the above bagasse availability estimates apply to the year 1970, whereas the estimated bagasse requirements are for 1979. The predicted rate of increase in sugar production is 3% per year (30% total over a nine year period). Thus, theoretically, it would be expected that 30% additional bagasse will be available in 1979 which mean that the northern zone would be producing 860,000 tons of moist whole bagasse per year and the southern zone approximately 950,000 tons of whole moist bagasse. It would thus be possible to locate even the largest mill in either zone. For planning of bagasse procurement it will be assumed that expansion will take place in a uniformly distributed manner and at the predicted rate. The number of ingenios which must be involved will thus be reduced with consequent economies in capital and operating costs. If, on the other hand, actual expansion is at a reduced rate, or even if for some reason there is minimal expansion, the maximum size of mill proposed can be supplied simply by inclusion of other ingenios - at somewhat increased cost.

The remaining major factor to be considered relative to paper mill location and bagasse supply is the method of transportation which must be employed. For bulk handling, broadly speaking, this may be continuous by means of a conveyor system or in batches by road or rail.

The continuous system has a substantial cost advantage when compared to the batch method, so that for maximum economy, the largest possible quantity of the bagasse should be delivered through a conveyor system. Since conveyors by their nature are limited in range, it is therefore most advantageous to situate a paper mill adjacent to the largest ingenio in a given area, consistent with more or less central location relative to other ingenios from which bagasse will be supplied.

(b) Water

Water is not plentiful in the province of Tucuman hence careful management is necessary to ensure that it is used as efficiently and effectively as possible. The use of water is, therefore, subject to government control and approval.

By law, water for drinking purposes is given highest priority, secondary priority is given to industrial use and irrigation assumes the lowest priority. Actually, in the case of the sugar mills industrial and irrigation utilization are inter-related. During the crushing season (June to October) the ingenios use the water for manufacture of sugar and before and after the zafra the available water is diverted to irrigation. The major requirement for irrigation occurs during the period from November to March which fortunately coincides with the rainy season. In April and May water availability is at its lowest point.

The drinking water supply is for the most part independent of the water used for industrial and irrigation purposes and need not be of concern for this report.

Discussions with officials of a number of ingenios indicates that water supply to the paper mill should not be a problem either as to quantity or as to cost. The water requirement of any of the larger ingenios exceeds the quantity estimated for even the largest paper mill alternative thus during the crushing season more than enough water would be available to a paper mill built adjacent to a large mill (as recommended for economy of bagasse transportation). Similarly during the irrigation period, and even in the dry months of April and May, by appropriate diversion of water to the mill intake and arrangement to remove undesirable materials from the mill effluent, an adequate supply of water is assured.

It should be noted at this point that, generally speaking, a paper mill does not consume water but merely utilizes it as a means of diluting chemicals and suspending fibre as required in different parts of the process. The principal losses which do occur are in evaporation from the paper machines and moisture in the finished product. Since the bagasse received is at average 50% moisture such "losses" would not appear as water consumption. In other words, the amount of water discharged by the paper mill would be essentially identical to the quantity entering the system.

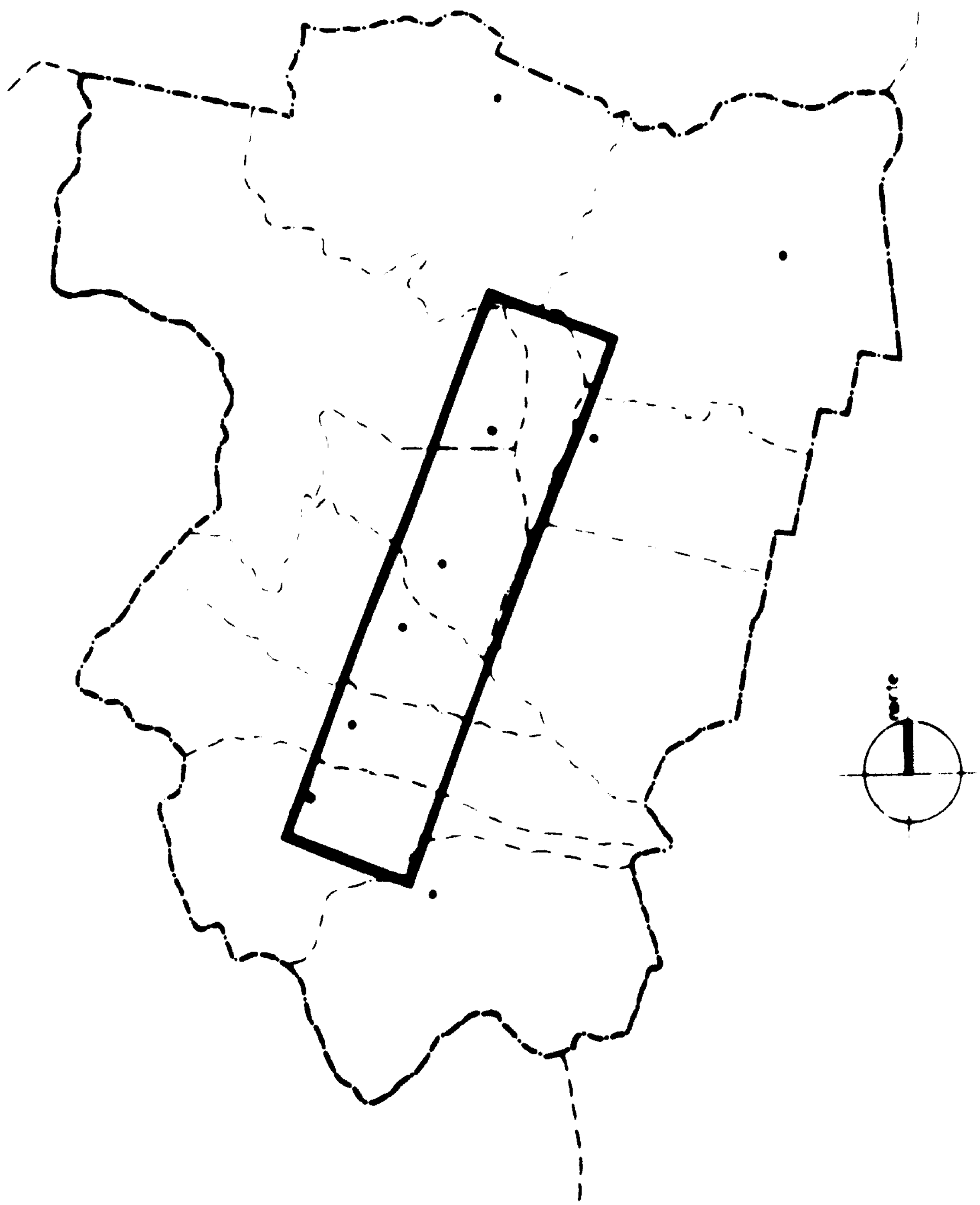
Understandably the ingenio management personnel expressed the opinion that a paper mill should be located downstream of the sugar mill so that any impurities in the paper mill effluent could not affect either their operation or their product. Since, with the possible exception of sulphuric acid, the materials introduced into the water in the sugar process can be readily removed or can be tolerated for the types of paper under consideration, such an arrangement would not be inconvenient. It is felt, however, that with provision of suitable effluent treatment the location of a paper mill upstream of a sugar mill would not be out of the question. Decision concerning this particular point would form part of a detailed and comprehensive feasibility study.

Generally, water is more plentiful and more economically available in the Northern area thus there could be some advantage to locating the paper mill in that region. In the South surface water is and has been in short supply but subterranean water sources exist in almost all parts of the area. Wells are not costly and water quality is, of course, superior to that of surface water. Possibly the expense of providing for the necessary quantities of mill process water would be somewhat higher than in the North but, from preliminary evaluation, would not be excessive

H.3 Conclusions

Bagasse and water are available in sufficient quantity to supply the largest mill contemplated whether it be located in the Northern zone or in the Southern zone. The cost of bagasse in the Northern zone would however be lower and it is probable that provision of the necessary water would also be more economical. It is therefore recommended that the initial implementation of any of the three alternative mills should be planned in accordance with all pertinent factors and conditions in the Northern zone.

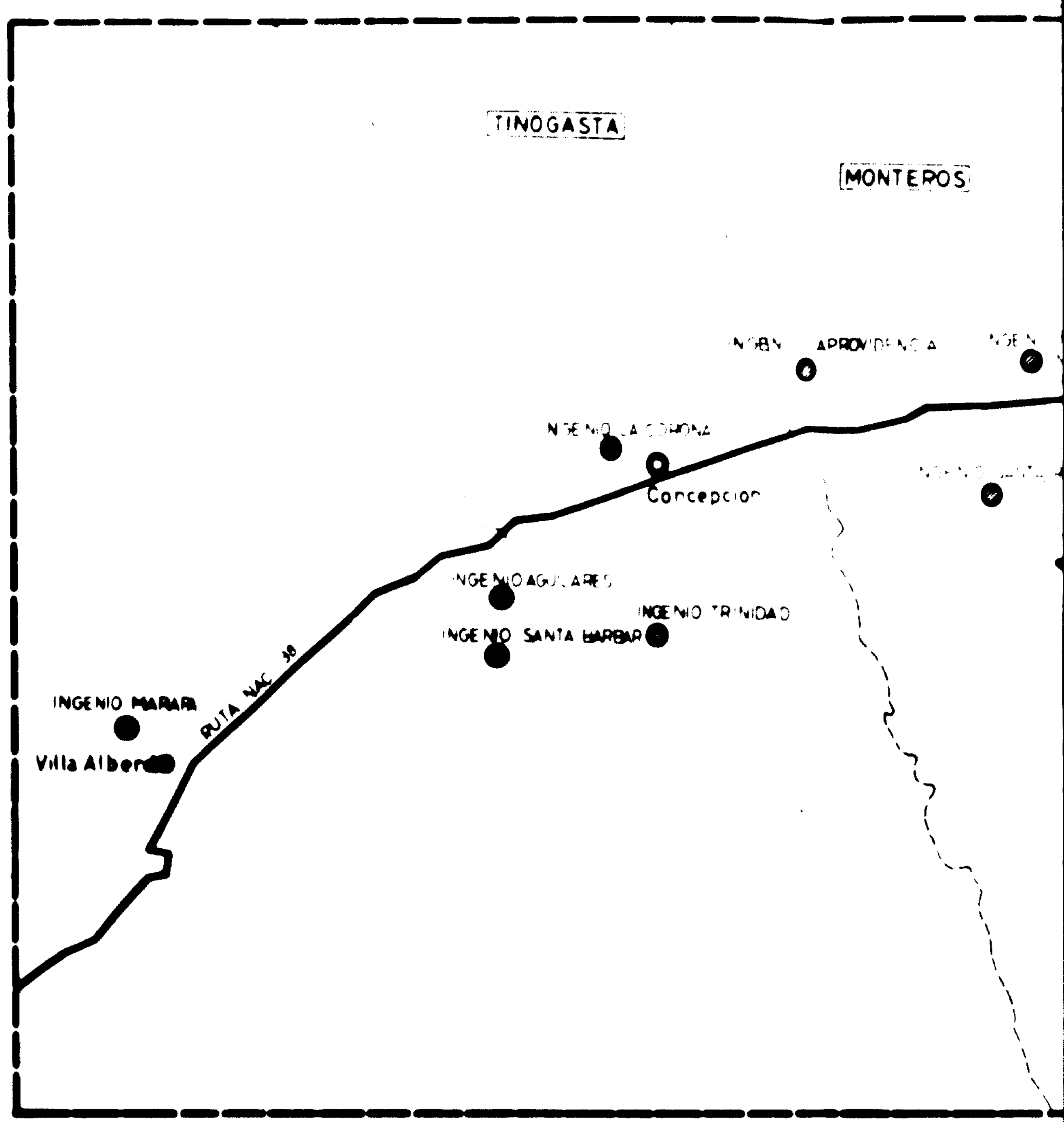
FIG I-H



PROVINCIA DE TUCUMAN

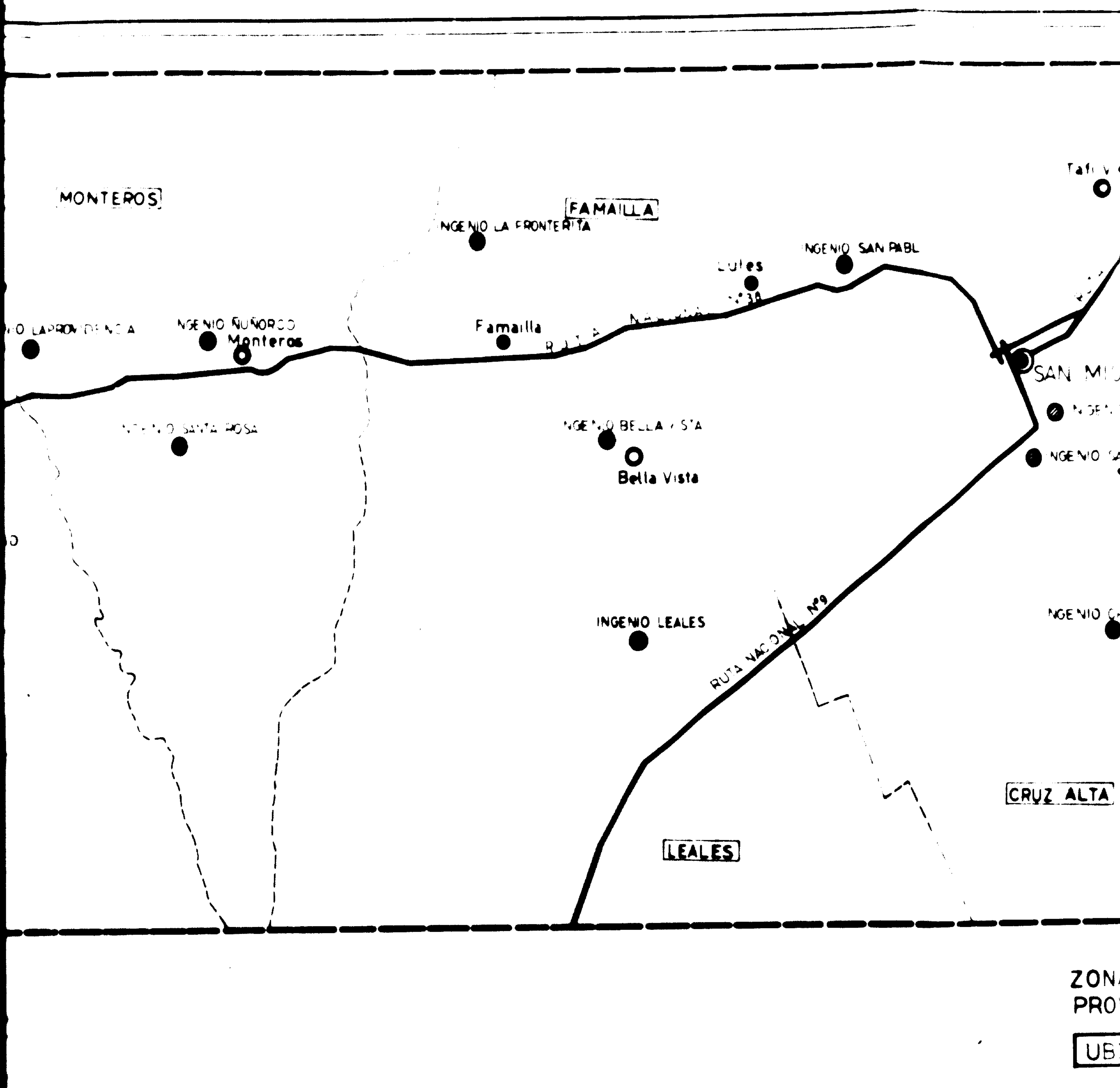
ZONA DE INGENIOS AZUCAREROS

ESCALA S/E



REFERENCIAS

- ○ INGENIOS
- ● CIUDAD DE MAS DE 25.000 HAB
- ◉ DE 10.000 a 25.000 HAB
- • DE 5.000 a 10.000 HAB
- ▭ DEPARTAMENTOS
- ---- LIMITE DEPARTAMENTAL


MONTEROS
FAMAILLA
INGENIO LA FRONTERITA
INGENIO SAN PABL
Lules
Famailla
INGENIO ÑUÑORCO
Monteros
INGENIO BELLA VISTA
Bella Vista
SAN MI
INGENIO LEALES
RUTA NACIONAL Nº9
CRUZ ALTA
LEALES
ZONA
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ESCAL

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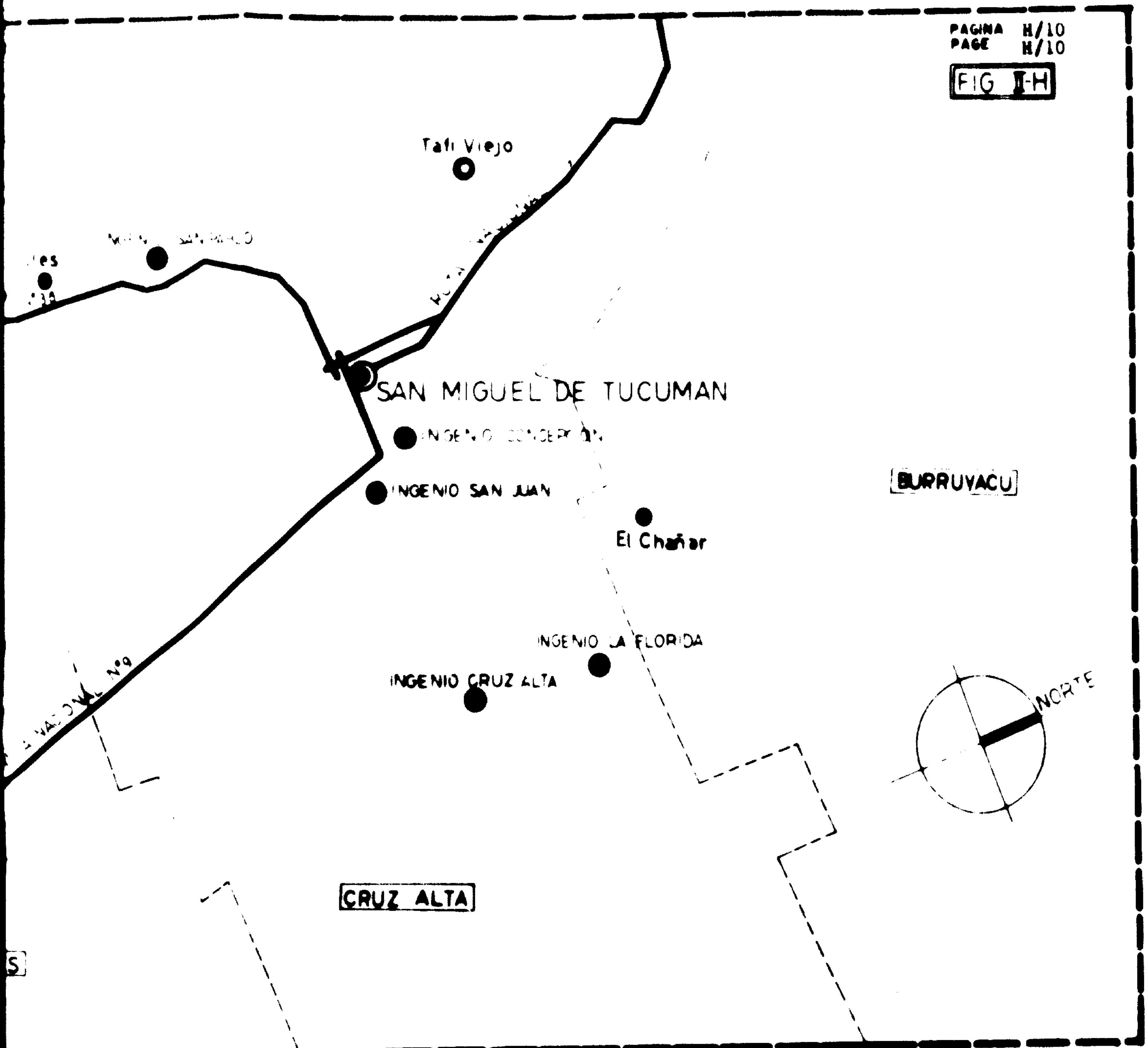
PAGINA H/10
PAGE H/10

FIG II-H



ZONA DE INGENIOS AZUCAREROS
PROVINCIA DE TUCUMAN

UBICACION DE LOS INGENIOS

ESCALA 1 250.000

I. SELECTION OF PROCESS

I 1 Introduction

The processes that are or have been used commercially for the production of bagasse pulp are:

- the acid sulphite process
- the mechano-chemical process
- the Pomilio process
- the Cusi process (Simon-Cusi)
- the Ayotla process
- the PEADCO process
- the conventional alkaline process

Some of these processes do not produce pulp of satisfactory quality for the types of papers to be produced, some are limited to small production levels, some are suited primarily to bleached or semi-bleached pulp production, and some are not well suited to the recovery of cooking chemicals.

In addition to these processes which have been used commercially, there are a number that have been tried on a laboratory and pilot plant scale. Those processes that have been tried on a laboratory or pilot plant scale that are different from those tried on a commercial scale, are the bisulphite and the neutral sulphite processes.

Since the pulp and paper mills proposed in this study are to have a capacity of 166 to 496 ton per day, are for unbleached products, and since the cooking chemicals must be recovered in at least two cases to make the projects viable, several processes may be eliminated almost immediately.

The acid sulphite process is not well suited to the production of pulp from bagasse and does not yield pulp of good quality. The bisulphite process (which has never been in commercial operation) is essentially the same as the acid sulphite process except that the pH of the cooking liquor is higher. The results are no better than with the acid sulphite process. The pulp is not of good quality and the chemical consumptions are high.

At still higher pH values, the neutral sulphite process produces pulps of good yield and brightness (brightness is of no importance for the products under consideration) but of low strength, and at the expense of high chemical consumptions. For this reason, the neutral sulphite process has never been used commercially and is unlikely to be used (except for special cases - newsprint) unless sulphur at very low prices is readily available.

In the mechano-chemical process bagasse is cooked at atmospheric pressure in a hydrapulper (a machine normally used for disintegrating pulp sheets and paper in water by intense hydraulic shear developed by an impeller at the bottom of the vat).

The violent agitation increases the rate of pulping the uniformity of pulping, and decreases the chemical consumption Pulp quality is good, but steam and power consumptions are high Recovery of chemicals is not feasible. Process equipment and economic considarations limit the mechano-chemical process to productions in the order of 50 tons per day.

The Pomilio process consists of a very mild cook in a tower at atmospheric pressure, followed by high density chlorination using massive quantities of chlorine to complete the dalignification The process was designed primarily for the production of bleached pulps based on the complete utilization of caustic and chlorine in the proportions obtained from an electrolytic plant.

Pulp quality is good, but recovery of chemicals is not feasible. Production costs are very high and the process is limited to production capacities of less than 150 tons per day. Though popular at one time, virtually all Pomilio plants have shut down because of uneconomically high production costs.

The balance of the processes are all alkaline pulping processes (soda or kraft) in which the cooking chemical is caustic soda (soda process) or caustic soda plus sodium sulphide (kraft process). In the case of the production of pulp from wood there is a very substantial difference in the strength of pulp produced by the kraft process as compared to the soda process.

Although the active pulping agent in both cases is caustic soda, the sodium sulphide in the kraft cooking liquor protects the cellulose fibre from attack with the result that such pulp produced by the kraft process is very much stronger than pulp produced by the soda process. However, in the case of bagasse because the rate of pulping is so rapid, there is virtually no difference in the strength properties of pulps produced by the kraft or soda process.

Chemical recovery is feasible for all of these processes where recovery of chemicals is economically justified. The equipment for the recovery of chemicals by either the kraft or soda process is almost identical. Because in the case of bagasse there is virtually no difference in the properties of pulp produced by the kraft or soda process, the choice of process depends only on the cost of the make-up chemicals. For the soda process the make-up chemicals are caustic soda or soda ash or a combination of both. For the kraft process the make-up chemical is salt cake, though a combination of caustic soda and elemental sulphur can also be used. Analysis of chemical costs in Tucuman has shown that the lower cost solution is the use of the soda process. (See Table 1-I).

Only the soda process, therefore, will be analyzed further in the following subsections.

Rev. November 10, 1972

TABLE 1-I

CHEMICAL COSTS

	SODA PROCESS		KRAFT PROCESS	
	Cooking or make-up chemical	Value per Ton Pulp Dollars	Cooking or make-up chemical	Value per Ton Pulp Dollars
No Recovery	NaOH	15.50	NaOH + S	16.20
	or Na_2CO_3 + CaO	16.80		
With recovery	NaOH	3.30	Na_2SO_4	3.10
	or Na_2CO_3 + $CaCO_3$	2.85	or NaOH + S	4.00

Regardless of which pulping process is used, "depithing" is an essential first step since for papermaking only the fibrous fraction of bagasse is of interest. The non-fibrous fraction of bagasse (which consists of dirt, water soluble material, epidermal material and pith) has no papermaking properties and the presence of pith cells is distinctly detrimental to pulping and papermaking operations.

The pith cells, being fine, thin-walled, and having a large surface, are highly reactive and consume a very large portion of any pulping chemicals used. Moreover, the presence of pith cells slows the pulp drainage rate and lowers the opacity of any pulp produced from bagasse. When pulp containing a large quantity of pith is made into paper, the paper is stiff, has poor opacity and poor strength properties, especially tear.

In order to produce pulp from bagasse economically at good yield with good properties and with minimum chemical consumption, and minimum wear on pulping equipment, the removal of pith is essential, as well as the removal of fines and sand, mud, solubles and other extraneous materials.

The lack of appreciation of the need for "depithing" and suitable depithing equipment retarded the development of bagasse pulping for many years. Because of the importance of bagasse depithing the matter is reviewed in some detail in the following subsection.

The waste liquors from the pulping operation contain the organic material dissolved during the pulping operation and the chemicals used for pulping. It is possible to recover 80 to 90% of the chemicals used for pulping, and this is normally done in mills producing pulp from wood. However, in the case of bagasse, because the quantity of chemicals required for pulping is relatively small and the pulp yield is high (especially in the case of pulps for corrugating medium and linerboard) the amount of organic material and chemicals in the waste liquor is relatively low. Also, the amount of wash water required for good washing is higher than in the case of woodpulp. Consequently, both the solids content of the spent liquor and the heat value are low. Because of the size of the proposed corrugating medium mill (Model I) and the relatively low chemical charge and low heat value of the waste liquor, a chemical recovery system would not be economical. In fact, there are no bagasse pulp and paper mills presently manufacturing corrugating which have a chemical recovery system. In general, a chemical recovery system for a bagasse pulp and paper mill producing the types of paper proposed is economical only for capacities in excess of 200 to 250 tons of pulp per day. Consequently, a chemical recovery system is considered only for the two larger mills.

Because there will be no chemical recovery system for the 166 tons per day corrugating medium mill, the effluent from the pulp mill will have a high pollution load and adequate provision must be made for effluent disposal.

I.2 Bagasse Depithing Handling, Transportation and Storage

(a) General

As mentioned previously, in order to produce pulp from bagasse economically at good yield with good properties and with minimum chemical consumption, and wear on equipment, "depithing" is essential. All of the mills producing pulp and paper from bagasse use some form of "pith" removal as the first step in the process. The so-called "pith" removed is actually a mixture of true pith, fibre fines, dirt, soil and foreign material. Any bagasse treated for removal of pith still contains appreciable quantities of true pith sinca complete separation is almost impossible. In addition, unless the bagasse has been subjected to wet depithing or a bagassa washing operation it will contain water solubles as well, (6-10% on an oven dry bagasse basis).

The dapithing methods used in commercial practice, ignoring mechanical differences, may be classified as follows:

(i) dry depithing

(ii) moist depithing

(iii) wet depithing

(iv) moist or dry depithing followed by wet depithing

(v) biological depithing

All of these systems, except to some extent biological depithing, use some form of mechanical or hydraulic beating or rubbing to loosen pith from the fibres, followed by a seperate or integral screening operation.

The amount of pith removed in commercial practice by these depithing methods may vary from 10% to 45%, of the original weight of bagasse fed to the system and in addition, if wet depithing or bagasse washing is used, part of the water solubles will be removed as well.

The method of depithing selected for a particular mill and the degree of pith removal depends on local conditions and the end product to be manufactured. Very complete depithing is not as essential for the production of corrugating medium as it is for papers requiring a high tear resistance. Moist or dry depithing may be preferable for some regions because of the cost of fuel and the problem of pith disposal. Depithing is also closely interrelated with storage, handling and transportation systems, and consideration of the system as a whole, that is, depithing, storage, handling and transportation may determine the method of depithing to be used to obtain the most effective overall system for local conditions.

Consequently, considering the products to be manufactured and local conditions in the province of Tucuman, the important factors which must be kept in mind with regard to depithing, handling, transportation and storage are:

- The ingenios crush cane for 3 to 4 months of the year. This is a rather short crushing period as compared to most sugar mill operations.
- Mechanical harvesting may be utilized.
- The total amount of bagasse available exceeds the pulp and paper mill requirements.
- Of the grades of paper and board to be produced, corrugating medium does not require a high tear characteristic and consequently does not necessarily require a high degree of pith removal; but linerboard must have a better tear characteristic, hence effective pith removal is essential.
- The site selected for the pulp and paper mill is 1/4 - 24 kilometers from the sugar mills which will supply the bagasse.
- There are good roads between the sugar mills and the selected pulp and paper mill site.

(b) Bagasse Depithing Systems

(i) Dry Depithing

Dry depithing is carried out at a bagasse moisture content of less than 35% and generally at a bagasse moisture content of approximately 25%. It is applied where, because of a short crushing season or long transportation distances the bagasse must be baled and allowed to dry in storage. This system therefore, cannot be considered for present purposes but some discussion might be of interest.

The usual dry depithing systems consist of bale breakers, primary screening, hammer milling in one or more stages, followed by screening for pith removal. Because the bagasse is dry and the sticky sugars have been removed by fermentation, dry bagasse screening operations are relatively free of the "blinding" that can occur if moist bagasse still containing sugars is screened. Therefore, dry bagasse screening for pith removal is quite effective and simple from an operating point of view. However, because of the large volume to weight ratio of bagasse, many screens and hammer mills are required and many conveyors. This means high capital and maintenance costs and large building volumes.

This has led to tha development of high capacity hammer mills of spacial design for bagasse with rotors and flails or hammers of spacial profile to reduce fibra breakage.

Thesa ere fittad with integral screens to reduce or eliminete screening after hemmer milling.

The more recent bagaese hammer mills such as the Novarotor, Horkel, and Ayotla machinas do not use any subsequant screening system, which means a considerable saving in space and capitel and maintenance costs. Some of the newer bagesse hammer mills such as the Gruendler and the Rietz-Rivenco still uss aftar-screening but much reduced in size.

Many of thsse dry depithing systems that use pneumatic transport of bagasss also have some form of sand and stone ssperation of varying degrees of effectiveness.

Serious disadvantages of the dry depithing systems ere: high mechenical damage to the fibras and high health hasard caused by the airborne pith particles causing e lung disease called begessosis.

(ii) Moist Depithing

Moist depithing is carried out at a moisture content of between 40 to 55 percent, in other words, in the range of moisture usual for bagasse taken directly from the crushing train. The former is the lowest limit at which the bagasse fibres are still pliable enough to avoid the breakage that occurs in dry depithing. Because of the lesser breakage and damage to the bagasse fibres, moist depithing is preferable to dry depithing.

Moist depithing is normally carried out at the sugar mills during the crushing season and the pith is returned directly to the bagasse burning boilers. Only in unusual circumstances, where the bagasse is supplied in small proportions from many sugar mills, is moist depithing carried out at the pulp mill, where provision must then be made for burning the pith.

The milling equipment used for moist depithing is essentially the same as that used for dry depithing. This usually comprises single or double rotor hammer mills of conventional or special design with or without integral screens and attrition mills. However, because the moist bagasse fibres are pliable and tough, the damage and breakage caused even by conventional hammer mills are very much less and when mills of special design for bagasse are used both the losses of fibre with the "pith" removed due to fibre breakage and fibre damage are relatively small.

In the case of moist depithing, mills which have an integral screening system that does not require subsequent screening for pith removal have even a greater advantage since moist bagasse still contains sticky sugars and separate screens for moist depithing tend to "blind". Most moist depithing systems that use pneumatic transport of bagasse have some form of sand and stone separation of varying degree of effectiveness.

The prime advantages of moist depithing at the sugar mill are:

- The "pith" that is removed can be returned directly to the sugar mill bagasse boilers and burned: pith disposal is therefore no problem.
- The "bagasse" purchased by the pulp and paper mill has a much higher proportion of fibre suitable for papermaking than the whole or prescreened bagasse used in the case of dry or wet depithing systems. This is due to the fact that most of the pith and fines have been removed at the sugar mill, consequently

the raw material cost is lower.

Since moist bagasse fibres are pliable the fibre damage due to depithing is much less than in the case of dry depithing.

- Little or no water is required.

The prime disadvantages of moist depithing are:

- Where external screening is used for pith removal operating difficulties may be expected.
- Pith removal is not quite as effective as with dry or wet depithing.

The better known moist depithing systems in commercial operation are:

- PEADCO (W.R. Grace)
- Gruendler (Gruendler Mfg. Co.)
- Horkel (Parsons & Whittemore)
- Ayotla (Beloit-Jones)
- Novarotor or SPM (Swiss Puerto Rican Metallurgical Corp.)
- Rietz-Rivenco

In addition, both Sprout Waldron and Bauer Bros. have experimented with depithing systems based on single disc refiners (attrition mills). To date, no such systems have been installed in a commercial application.

Any one of the moist depithers or depithing systems mentioned will give comparatively satisfactory performance and will remove about two thirds of the "pith" (defined as true pith, dirt, epidermal material and bagasse fines), but none of the moist depithers will remove very much more than half of the true pith and, of course, do not remove any of the water solubles. Also, although all of the systems that use pneumatic transport will remove some of the dirt and sand, those that do not, are not very effective for the removal of stones and larger foreign material that may occur in the bagasse if it is mechanically harvested.

(iii) Wet Depithing

In wet depithing, intense agitation or hydraulic shear is used to separate the pith from the fibre. Any mechanical impact on the bagasse is reduced greatly and, consequently, fibre damage is held to an absolute minimum.

Wet depithing may be used with moist or dry bagasse; when used to depith moist bagasse, wet depithing removes not only the pith and fines, but also the residual sugars and other solubles as well as mud and dirt, and in some systems stones as well, thus yielding a very clean depithed bagasse. With dry bagasse, the fibre damage that occurs with dry depithing is avoided Solubles and fine dirt are also removed together with the pith, and the fibre is conditioned for subsequent pulping, which compensatee for some of the damage due to fermentation and drying. If wet depithing is performed prior to storage, the storage losses are substantially reduced becsuse removal of sugars and other solubles reduces the extent of chemical reactions and makes conditions in pilee less suitable for the growth of bacteria.

Wet depithing is usually carried out at the pulp mills where the waste effluent from the mill can be used as the water supply and where provieion for effluent disposal must be made in any case. At the sugar mill, it ie better to uee moiet depithing since the pith can be burned as fuel. This reduces the pith dispoeal problem with a gain in the economy of the operation. Although other systems exist, wet depithing can be accomplished moet effectively by:

- Two hydrapulpers in series to loosen the pith followed by rotary cylindrical screens in which the pith is washed out of the bagasse.

- Single hydrapulper followed by a sand settling flume and removal of the pith and fine dirt in specially designed hammer mills with or without integral screens.

  (Note: Method 2 is usually preceded by moist depithing or dry depithing).

The first method is a modification of the wet cleaning system for rice straw developed by Youssef Fouad, Kraues Maffei and Stadler Hurter at the RAKTA mill in Alexandria. The system consists of two stages of hydra-pulpers in series followed by rotary cylindrical screens of Stadler Hurter design. Bulk moist or dry bagasse is fed into the first pulper together with water to bring the consistency to about 2-1/2 %. If the first pulper is provided with sufficient power, entire bales can be fed to the pulper. From the first pulper, the bagasse slurry flows into the second pulper. Stones and coarse foreign materials are removed by the junk trap of the pulper. Some pith is extracted through strainer plates in the pulpers, the balance of the pith and the sand is removed by large axial flow rotary screens fitted with internal showers into which the bagasse slurry from the second pulper is discharged. In these screens, pith, water and dirt, drain from the bagasse and the bagasse is also washed free of pith by the showers.

The system is simple, effective and maintenance costs are very low. The system can be used to depith whole bagasse without prior moist depithing and the equipment is particularly effective in removing stones, mud and sand which can cause considerable wear on pulp mill equipment. Fibre breakage and damage are minimal, but the initial costs and power requirements are rather high.

In the second method a single stage hydrapulper is used to break up and/or to thoroughly wet and condition the bagasse, and to remove stones and large foreign material, as in the case of the first method. From the pulper, the bagasse slurry then flows to a sand settling flume and then passes on to the flooded hammer mill wet depithing machines. (These machines are similar in design to the moist depithing machines).

In many cases a pulper and settling flume for bagasse washing to remove stones and sand is not used and bagasse is fed directly into the flooded hammer mill wet depithers. This can be done if the bagasse is relatively free of stones, sand and large foreign material; if otherwise, wear on pulp mill equipment will be excessive, as the flooded hammer mill wet depithers will remove but little of the sand and none of the stones and coarse foreign material.

Since the bagasse fibres have been moistened and conditioned and since the action of these machines when operated wet is not as drastic, fibre damage is much less than for moist or dry operation and pith and dirt removal is more complete.

Wet depithing is more effective and produces a cleaner bagasse with a lower pith content than moist or dry depithing. There are, however, a number of problems associated with wet depithing. These are:

- the large amount of water required
- disposal of the wet pith
- the higher moisture content of accepted bagasse

In almost all cases where wet depithing is used, it becomes necessary to recirculate at least part of the water used. This means the installation of a pith filter to separate the pith from the water in circulation.

The pith can be pumped to disposal fields or de-watered and trucked to disposal beds or it can be used as a soil conditioner on the cane fields if they are not too far away. Pith disposal is the principal problem.

The bagasse from wet depithing systems (80-86% moisture), may be so wet that it will introduce substantial quantities of water into the pulp mill liquor cycle, which means added costs for liquor evaporation. Presses can be used to remove much of the excess water, but these add to the capital, maintenance, and operating costs.

(iv) Moist or Dry Depithing Followed by Wet Depithing

Moist or dry depithing followed by wet depithing involves the use of the depithing systems described previously in a two-stage operation to produce the cleanest and most pith-free bagasse possible using present day technology in the most economical manner.

In the previous section (iii) it was mentioned that the prime problem of wet depithing is the disposal of the wet pith. If a portion of the pith is first removed by moist or dry depithing and burned as fuel, the wet pith disposal problem is reduced. Such a two-stage depithing is most effective in the case of moist depithing at the sugar mill followed by wet depithing at the pulp and paper mill. Since the moist bagasse fibres are pliable, two-thirds or more of the pith may be removed and burned at the sugar mill without serious damage to the bagasse fibres, thus leaving only a third or less of the pith to be removed by wet depithing. Two-stage depithing is less attractive in the case of dry depithing followed by wet depithing as the dry depithing operation cannot be carried too far before fibre damage and fibre losses become prohibitive.

For the project under study moist depithing at the sugar mills followed by wet depithing at the pulp mill would give the best raw material for the linerboard. For corrugating grade pulp moist depithing would be sufficient, but we believe a bagasse washing stage at the pulp mill would be justified by savings in maintenance costs on the pulp mill equipment. The capital cost is high, but it is our opinion that the reduction of wear rates of the continuous digester feeders and refiner plates will more than compensate the higher cost of the two-stage depithing system for linerboard and the bagasse washing stage for corrugating medium.

(v) Biological Depithing

In some storage systems, notably the Ritter process, biological action is reported to aid in loosening the pith from the fibre making it easier to remove. Since, however, a two stage depithing arrangement suits the requirements of this study, there appears to be little to be gained by introducing depithing considerations into the storage system to be selected.

Biological depithing, therefore, will not be discussed in detail.

(c) Bagasse Handling and Transportation

There are quite a number of variations in methods by which bagasse can be handled and transported from the sugar mills to the pulp mill.

These differ principally in the form in which the bagasse is transported (in bulk or in bales) and the means of transportation (continuous by conveyors, pneumatic systems, flumes or pipelines, or in batches, by road or rail.

The selection of the most economical system to be used for handling and transporting the bagasse depends on the following factors:

- the length of the cane crush season
- the distance between the sugar mills and the pulp mill
- the configuration of the terrain between the sugar mills and the pulp mill
- the availability and condition of roads and/or railways between the sugar mills and the pulp mill
- fuel and power costs
- the availability of suitable water
- the quantities of bagasse to be transported

In general, for distances over 2 km between the sugar mills and the pulp mill a continuous transportation system using conveyors or pneumatic systems is not economical, and for distances over 90 km transportation of bagasse in bulk is uneconomical. Continuous systems may only be considered in reference to bulk transportation.

The following comments apply to the different types mentioned.

Studies and large scale trials have demonstrated that pipeline transport of fibrous solids in fluid suspension over considerable distances is efficient and economical, but it has not yet been proven in commercial operation, at least not for bagasse and the distances involved. Also, large quantities of water are required, and the water becomes contaminated by fines and soluble material which makes pipeline transport impractical in this particular case.

Flumes have been used for transportation of bagasse mainly in conjunction with the Ritter storage systems. They are relatively inexpensive in themselves but the auxiliary equipment such as pumps, screens and water recycling systems are costly which makes such installation uneconomical for most applications. Furthermore, water requirements are very high even in the "closed" systems because substantial quantities must be sewered to prevent build-up of excessive sugar concentration. Hence, for Tucuman, flume transportation is also considered impractical.

Pneumatic conveyors can be used to transport bagasse up to 1 km, but power requirements are very high. Such conveyors are usually advantageous in applications where several changes in direction are necessary and where distances exceed 150-200 meters.

Of the many types of mechanical conveyors which are available, the ones normally used for bagasse transport are the scraper and the belt.

Scraper-type conveyors have been in operation in sugar and pulp mills for many years. They are best applied for relatively short conveying, for feeders, and multiple point distribution. The major disadvantage of these conveyors is the relatively high maintenance cost.

Belt conveyors have also been utilized extensively and may be used with advantage for both short and medium distance conveying. They have high capacity, low power and maintenance requirements, and, if properly designed and maintained, can have a very long operating life.

Each of the mechanical alternatives has advantages in specific applications but, overall, the belt type has proven to be more economical for general use over short to medium distances. Over longer distances (up to 1 km), or for directional flexibility, the pneumatic system may be necessary in some cases. Assuming that any of the paper mills proposed could be located within practical range, it has been assumed for estimating purposes that belt conveyors would be used

For distances beyond the range of conveyors a batch transportation system of one type or another must be considered, and a choice must be made between baled or bulk form.

Transportation in baled form has some distinct advantage where distances exceed 90 km as reduced volume means lower shipping costs, and savings very directly in proportion to distance. In Tucuman, however, distances are very short so that the additional expenses of baled transport such as the costs of baling, bale handling to and from carriers, very large storage areas, and breaking the bales for supply to process would be more than offset any savings in shipping costs. Thus, following the trend of most modern installations, the bagasse from even the most distant ingenios can be more advantageously transported in bulk.

Although there is a good rail network in the sugar belt this form of transport is too inflexible to adapt well to the operating conditions of either the ingenio or the paper mill and, for this reason would be both difficult to regulate and uneconomical. Since the province also has a good road system, by process of elimination, the most suitable type of vehicle is considered to be the truck or the trailer. Self dumping semi-trailer rigs of about 80 m^3 capacity are prasently operating successfully in such nations as Peru, Colombia and the U.S.A. The topography of the sugar-producing area of Tucuman is almoet uniformly flat so that capacities up to 100 m^3 would probably be feasible.

In contrast to continuous handling by conveyor, bulk traneportetion in batches inherently involves higher coste. The flow of bagasse from the sugar mill "trapiches" is continuous thus additional equipment and labour are required in order to accumulate the loads to avoid delaying tha trailers and parmit optimum cycling. Similerly, labour and special equipment must be used for rapid unloading at tha paper mill.

Also, since bagaasa is very bulky, any batch transportation syatem will raquire e relativaly large number of units to transport e givan tonnage and, therefore, the cost of such traneport is correspondingly high relativa to that of conveyore. The greeter the dietance between the sugar mills and the pulp mill, the longer is the time cycle per unit, the more units are required, and the higher the cost. However, the increase in costs is not in direct proportion to the increase in the distances, because the major part of batch transportation cost is incurred in loading and unloading, which will remain practically the same per unit weight regardless of the transportation distance.

Substantial savings in transportation costs can be achieved by locating the pulp mill next to a large sugar mill nearest to the weighted ton-distance center of the sugar mills selected to supply the bagasse, thus permitting maximum use of conveyors. Transportation cost of bulk bagasse by trucks from sugar mills 10 to 25 km distant, will be higher by US $ 1.00 to 2.50 per oven dry ton than that of bagasse delivered by belt conveyors (about 200 m long) from the adjacent sugar mill.

This report assumes that any of the mills proposed could be located within 200 meters of one of the larger ingenios hence transportation costs are based on maximum use of belt conveyors.

(d) Bagasse Storage Systems

In the province of Tucuman, the crushing season for sugar cane is usually three to four months. Since the operation of a pulp and paper mill cannot be considered economical on a seasonal basis and it must operate continuously the whole year round, bagasse must be stored for the entire period when the sugar mills are not crushing cane and producing bagasse.

During the storage period bagasse is attacked by micro-organisms such as yeasts, bacteria, moulds and fungi. Two types of biochemical attack may be involved, aerobic and anaerobic. In the case of aerobic biochemical attack the principal reaction is the fermentation of the residual sugar into alcohol by yeasts and the subsequent oxidation of the alcohol to acetic acid. The reactions involved are, however, complex and other organic acids such as lactic acid are also formed, as well as many enzymes which will attack the cellular walls of the pith and fibre. However, the most damaging attack on bagasse "fibre" is usually by moulds and fungi which are aerobic.

For baled storage, the extent of the reaction or attack is a function of time, temperature and moisture content. Fermentation of the residual sugars generates considerable heat and, if the bagasse is stored in a dry place with good air circulation allowing good release of moisture, the heat generated will drive off the moisture in the bagasse quite rapidly and will reduce the moisture content from 45 to 50 percent to 20 to 25 percent, at which point yeasts, bacteria and fungi cannot multiply and attack ceases almost completely. Bagasse at a moisture content of 20 to 25 percent can be stored for several years.

If air circulation is hindered preventing the baled bagasse from drying rapidly, or if the bagasse is stored under very humid conditions, the biochemical and fungus attacks can be severe and it cannot be stored for long periods before fibre losses become serious. Losses through aerobic biochemical and fungus attacks may range from 8 percent of the weight of the insoluble portion of the whole bagasse to as much as 30 percent or more, depending on the rate at which moisture is dissipated, the final moisture content of the bagasse, and the length of the storage period.

As a comparable alternative to the storage of baled bagasse with good air circulation, it is possible to store moist bagasse in large bulk piles which have only a limited surface exposed to the air. The bagasse can be densely piled and thoroughly saturated with water to prevent air from coming in contact with the bagasse except at the surface of the pile. Black liquor can also be used to saturate the pile in cases where chemical recovery is not used by the pulp mill.

Under these conditions any fermentation of the sugars and other biochemical reactions are forced to proceed under anaerobic conditions and the rate of attack is much slower. Since it is aerobic fungi which cause the most damage, this attack is thus limited. Aerobic attack by yeasts, bacteria and moulds does proceed on the surface very rapidly to a depth of a few inches and fibre losses in these surface layers can amount to as much as 50 percent in eight to ten months. However, this thin outer layer constitutes only a very small fraction of the total pile, the interior of which is almost unaffected.

"Fibre" losses for moist bagasse in bulk piles or bagasse in saturated wet piles are reported to be relatively very low - in the order of 5% or less.

Bulk storage of bagasse can be highly mechanized. Space requirements are far smaller and handling losses are lower than for bale storage. Also, losses through biochemical attack are lower if the pile is large.

Since pith and fines are more readily attacked than the denser, larger fibre bundles, the losses through storage are greater for the whole bagasse than for depithed bagasse. Therefore, since the paper mill must pay for the bagasse on a replacement fuel basis, it is evidently preferable to store depithed bagasse.

In one of the most commonly used wet storage techniques, known as the Ritter system, bagasse is suspended as a slurry in water and flumed or piped to a concrete slab, fitted with drainage channels, where the thoroughly saturated bagasse is accumulated in a pile. Excess water is collected in the drainage channels and reused for sluicing more bagasse onto the pile. Bagasse is reclaimed from the pile hydraulically in slurry form through the same system of channels either manually or mechanically. A lactic acid solution is added to the water used for sluicing the bagasse onto the piles in storage. The fermentation of the residual sugars is primarily by lactic acid bacteria which lowers the pH and the damaging aerobic attack on the "fibre" by fungi is suppressed. Changes in bagasse quality and losses of fibre in storage, even over a very extensive period, are reported to be small.

The Ritter storage system has the advantages that, space requirements are relatively small (even less than for bulk storage of moist bagasse) and that, although capital costs are appreciable, the overall expenses for storage and handling are less than one half the costs of storage in bales. Also, the material can be stored over lengthy periods, reportedly with minimal deterioration. It is well suited to applications where the sugar mill is close enough to the pulp mill to permit continuous delivery and lends itself well to combination with secondary wet depithing or washing.

In the province of Tucuman the crushing season is only 3-4 months so that a large storage capacity (245 days supply approximately) would be essential at the paper mill. Also, as mentioned in I.2 (c), conditions favour bulk transportation and, by extension, indicate bulk storage. For reasons of overall economy and suitability, bulk storage of wet bagasse, either by Ritter or other wet system, is therefore the obvious recommendation. To further minimize storage losses and also to ensure reasonable uniformity in the characteristics of bagasse from storage to process, the system should be organized on the "first-in-first-out" principle.

I.3 Pulping Process

Conventional alkaline processes as well as patented systems such as Cusi, Ayotla and PEADCO, which are also alkaline, can be used with either soda or kraft pulping. As mentioned previously, in the case under study the soda pulping is more economical. All of these alkaline processes are basically similar, all will produce satisfactory pulp and all are suitable for the size of pulp and paper mills under consideration.

The Cusi process differs from the others in that cooking takes place in two stages with fractional screening after the first stage to remove material that has already received sufficient treatment. In the early stages of bagasse pulping technology, when depithing was not the best and cooking conditions tended to be more severe, there was perhaps considerable merit in fractional screening, as this not only removed pulp already sufficiently cooked but removed considerable pith as well.

The result was two pulps: one, a top grade bagasse pulp, the other a slow-draining low grade pulp suitable only for the production of low grade cardboards. Today, with improvements in depithing and less severe cooking conditions, it has become possible to recombine the two pulp fractions to obtain a good grade of bagasse pulp. However, on the basis of results obtained with modern depithing and single stage cooking techniques, (as in all other processes), the Cusi process has no particular advantage for the production of bagasse pulp of the types under consideration in this study. The two-stage cook and fractional intermediate screening add costs and complications and result in a dilute black liquor which means higher costs for chemical recovery.

The Ayotla and Peadco processes are virtually identical and differ but little from the conventional alkaline pulping process.

The main feature of both processes is the patented depithing machine, and it is only in the mechanical features of the depithing machines that there is a distinguishable difference between the Ayotla and Peadco processes (and, of course, it is quite possible to use Ayotla or Peadco depithing equipment with any bagasse pulping process).

A feature of both the Ayotla and the Peadco process is the location of a fiberizing refiner in the blowline of the continuous digester between the digester and the blow tank. Most conventional alkaline process mills have the fiberizing refiner after the blow tank. The use of blowline fiberizers is, however, by no means unique or specific to the Ayotla and Peadco processes. Blowline fiberizers are used in a number of wood pulping processes.

We can see no basic reason to favour one "process" over the other. Since the conventional alkaline process does not involve proprietory or patent considerations, this study is based on using the conventional alkaline process with a soda cook or, in other words, the conventional soda process.

Although, as mentioned previously, chemical recovery systems can be readily applied to the Ayotla or the Peadco process (and to the Cusi process as well but at greater cost), to date no mill using any of these processes had been equipped with a chemical recovery system.

However, a number of conventional alkaline pulp mills have been built with full chemical recovery systems and Stadler Hurter have been consultants on several.

I.4 Preparation and Recovery of Chemicals

For the soda process without recovery the make-up chemicals may be caustic soda or soda ash causticized by means of burnt lime. As can be seen from Table 1-I, if no chemical recovery is involved, caustic sode (NaOH) is the more economical solution. Moreover, caustic soda has the advantage that a stronger cooking liquor may be prepared which will offset to some extent the water introduced in the digester because of the high moisture content of bagasse after bagasse washing or wet depithing.

The waste liquors from the pulping operation contain the organic materials dissolved during the cook and the chemicals used for pulping. It is possible to recover 80 to 90% of the soda used for pulping through the use of a chemical recovery system. There are several recovery systems that could be applied. All of them involve evaporation of the waste liquor to bring it to a concentration at which it can be burned, followed by burning of the liquor in a furnace or reactor of some type. In the course of combustion heat is generated from the organic material in the waste liquors and this heat can be used for the production of steam. As a result of combustion of the waste liquors, the sodium salts are converted to sodium carbonate, which can then be causticized by burnt lime to form fresh cooking liquor.

Since, depending on the efficiency of recovery, it may be expected that from 10 to 20% of the chemicals will not be recovered some make-up must be supplied to maintain the chemical balance. This can be in the form of sodium carbonate added before recausticizing or sodium hydroxide after recausticizing. The former would be used in this case for reasons of economy.

For the primary recovery cycle, several systems are available:

- the conventional recovery boiler system in which the black liquor must be concentrated to more than 45% solids in a multiple effect evaporator and still further concentrated by means of flue gases before being burnt in the furnace. The molten smelt of sodium carbonate formed is then dissolved in water and recausticized.
- the fluid bed reactor system, in which the black liquor must be concentrated in a multiple effect evaporator to over 30% solids before being added to the fluid bed reactor where the liquor is burnt resulting in the formation of sodium carbonate pellets. These pellets are subsequently dissolved and causticized.
- the Torras-Xucla process, in which the black liquor must be concentrated to 40% solids in a multiple effect evaporator followed by carbonation with the furnace flue gases to

precipitate the lignin which is filtered out of the liquor. The recovered lignin is then burnt in a special gasifier retort furnace and the filtrate is further concentrated by flue gases from the gasifier furnace and burned in a boiler. The smelt of sodium carbonate formed is then dissolved and recausticized.

Of the three systems the first has the highest thermal efficiency and is the system most commonly used. It is also, however, the most expensive system, as can be seen from Table 2-I. The second system is less efficient thermally and usually can provide only sufficient steam for the required concentration of the spent liquor. It, however, has the advantage of being much lower in capital cost.

The Torras-Xucla process is the least used and least known. It is primarily suited to small mills (60 to 80 tons per day). The capital cost is low for small mills, but increases rapidly with increased capacity and even for medium-sized mills exceeds the cost of conventional equipment. An advantage of the process is that by a minor modification of the system, it is possible to eliminate much of the silica from the waste liquor, which is of considerable interest in the case of the recovery of spent liquors from the pulping of agricultural residues which often contain appreciable quantities of silica.

Although 80 to 90% of chemicals can be recovered, the cost of a conventional chemical recovery system is high and disproportionately so in the case of small mills. Because of high chemical consumption and high eolids content in the spent liquor it can usually be justified in wood pulping.

In the pulping of bagaese, however, particularly at higher yields, the amount of chemicals used is greatly reduced. Also the organic content of the waste liquor is much lower with consequent decreased fuel value. Thus, chemical recovery for emaller bagasse mills is usually uneconomical.

In general, a chemical recovery system for a bagasse pulp and paper mill producing the types of pulps proposed is economical only for production capacities in excese of 200 to 250 tons per day. Consequently, in this study chemical recovery is considered only for the two larger modele.

Because of the low solids and heat value of the spent liquor, any gain through high thermal efficiency is marginal and consequently, the fluid bed reactor type of recovery system has been selected for primary chemical recovery in this study, as it is much lower in capital cost, as can be seen from Table 2-I. An analysis of the coste is shown in Table 1-I, and shows that reburning of lime would be economical, and again a fluid bed reactor has been chosen for thie purpose because of its lower capital cost.

TABLE 2-I

CAPITAL COSTS OF COMPLETE RECOVERY SYSTEMS

Model No.	Pulp Mill Size BDMTD	Cost (Millions U.S. Dollars) Conventional	Fluidized Bed	Torras-Xucla
I	136	-	-	2.9
II	200	4.0	3.0	-
III	336	6.3	4.8	-

The Torras-Xucla process was not selected despite the advantages of silica removal because the system, even for the smelleet mill studied, would cost more than the reactor type of recovery system and is more complicated to operate.

Reference has been made in several instances to the "primary" re.overy cycle. This is beceuse, if suitable economy is indicated e secondary cycle mey also be used for the recovery of the lime consumed in receusticizing the spent liquor.

Ueually in this type of system the sludge (lime mud) resulting from the receusticization process is dewatered end oxidized by burning in a rotary kiln to form quick-lime which can then be used again. The mud may elso be burnt in a fluid bed reactor.

Compensation for losses (make-up) may be limestone added before burning or burnt lime edded efterwards. In this case limestone would be used.

A point to be noted with regard to chemicel recovery is that silica in the bagesse introduced through mud end sand will be dissolved in the cooking process and appear in the cooking liquor, where it will cause problems in the chemical recovery system. It is, therefore, essential to remove sand and mud before the bagasse enters the digestere, not only to protect the pulp mill equipment, but aleo to eliminate recovery cycle problems. This is another reason for providing bagasse washing and wet depithing.

Because, regardless of precautions taken, some silica will enter the system, it will be necessary, when chemical recovery is used, to use more lime than normally required for causticizing and the white liquor clarifier will have to be larger because of lower settling rate. All of the lime mud should not be reburnt, a bleed-off will be required to control silica levels in the recovery system.

I.5 Pulping Yields

Using the soda process the yield of pulp when cooking pulp for corrugating medium will be approximately 67% and 58.5% in the case of linerboard on the weight of depithed bagasse. Bagasse requirements are given in more detail in Section K.

I.6 Chemical Requirements

The consumption of caustic soda may be taken as 8% on the oven dry weight of depithed bagasse in the case of corrugating medium and 10% in the case of linerboard. On this basis and using the yields given in Section I.5, the caustic soda consumptions per ton bagasse pulp are 120 kg. for corrugating medium and 170 kg. for linerboard.

In the case of Model I there would be no chemical recovery. In the case of Model II and III, there would be chemical recovery (80%) and sodium carbonate would be the basic make-up chemical together with limestone or lime.

The chemical consumptions per ton of pulp can thus be calculated to be as per Table 3-I.

TABLE 3-I

CHEMICAL CONSUMPTIONS PER OD TON PULP

Type of Pulp	Chemical Consumption per Ton Pulp
Model I	
Corrugating	120 Kg NaOH
Model II	
Linerboard	45 Kg Na_2CO_3 + 90 Kg limestone
Model III	
Corrugating	30 Kg Na_2CO_3 + 60 Kg limestone
Linerboard	45 Kg Na_2CO_3 + 90 Kg limestone

I.7 Recommendations

Based on the foregoing, the processes selected for the production of pulp in this study are:

1) Moist depithing at the sugar mills
2) Bulk transport of bagasse to the pulp mill
3) Bulk storage of the bagasse
4) Two-stage (moist-wet) depithing for linerboard grade pulp and moist depithing and bagasse washing for corrugating medium grade pulp
5) Bagasse pulping by the soda process
6) Cooking liquor preparation from caustic soda for the smallest mill with no chemical recovery
7) Chemical recovery for the larger mills using fluid bed reactors and soda ash and limestone make-up.

J. PAPER MACHINES

J.1 General

In Section C it has been determined that the most logical papers to be investigated for utilization of the bagasse from the ingenios of Tucuman would be linerboard and corrugating medium, i.e., the component elements of containerboard. Taking into account the widths of fluting machines presently installed in various converting plants it was further determined that the optimum paper machine widths to be considered would trim 3.2 meters and 5 meters. The rated productive capacities of such machines, on average standard weights and average practical speeds, would be 166 ADTD of corrugating medium from the 3.2 meter, and 330 ADTD of linerboard from the 5 meter unit.

The possibility exists that paper machines of these widths could be manufactured, at least in part, in Argentina by an existing licensee of Escher Wyss GmbH. It has been stated that the Argentine plant can manufacture to a maximum wire width of 5 meters but this could probably be increased slightly if necessary. It is, however, reported that costs and delivery time for Argentine equipment might be somewhat greater than for machines of foreign manufacture. Foreign exchange consideration would have to be evaluated in final selection of a supplier.

The actual weights and speeds which were averaged to derive these rated capacities were as shown in Table 1-J.

TABLE 1-J

STANDARD WEIGHTS AND SPEEDS FOR PRODUCTION OF CORRUGATING MEDIUM AND LINERBOARD

Product	Basis Weight Gm/m²	Basis Weight Lbs.	Machine Speed M/Min.	Machine Speed FPM
Corrugating Medium	125	26	360	1180
	150	31	300	980
	170	35	265	870
Linerboard	125	26	410	1350
	175	36	300	980
	225	46	230	760
	300	61	175	570

Note: Speeds adjusted for bagasse furnish

It will be noted that within each product category the speeds are in inverse ratio to the weights. This relationship is quite accurate in practice so that for any product-weight mix the estimated production rates may be expected to remain constant.

The estimated speeds and also the paper machine efficiencies used in the calculation of rated capacities have intentionally been maintained towards the conservative side because the behaviour of bagasse-based furnishes varies over a considerable range from one application to another. The possibility, therefore, exists that actual productions could, to some extent, exceed those estimated.

J.2 Proposed Paper Machinee

In racent times numeroue variatione of "formers" for paper machine wet ends have baen daveloped and some of them have been proven in production applications of bagaeae furnish. It has also been reported that the inclusion of a eize-prees hae some advantage in the manufacture of linerboard. Whether theee and other technological modifications could advantageously be applied would, however, form part of a detailed feasibility study for the specific project selected for implementation.

For purposes of thie report, it hae been assumed that the paper machines to be installed would have the headbox-fourdrinier type wet end configuration which hae eucceeefully served the paper industry for many yeare and aleo that, in other respects, the machinee would conform generally to the arrangament which has come to be regarded as standard. The capital cost astimates derived on this basie are coneidered to be reasonably accurate, particularly since any departure from atandard would have to be justified, at least in part, by capital savings.

The euggested paper machines are therefore quite similar as to the principal componente, although the linerboard machina is somewhat more elaborate. It ehould be noted at thie point that, if desirable, corrugating medium, or even bag, sack and wrapping papers, can be produced on a machine designed for linerboard. A machine designed for production of corrugating medium is, however, restricted to manufacture of only that type of paper.

For comparison the proposed principal features of each machine are outlined in Table 2-J.

In addition to the items listed in the table, both paper machines would have closed dryer hoods and appropriate ventilating equipment, suitable vacuum systems, lubrication systems, all controls required for efficient operation and all other miscellaneous essential auxiliaries.

Paper machine wires are made in Argentina up to 5.5 m width and press and dryer felts are readily available from at least two different national manufacturers. There should, therefore, be no difficulty in clothing machines of the proposed widths.

J.3 Proposed Paper Furnishes

Based on experience developed in Peru while corrugating medium can be produced from 100% bagasse pulp, the corrugating medium will run better on the corrugator if it contains 10% waste paper.

Also based on Peruvian experience, a satisfactory linerboard can be made using 70% bagasse pulp and 30% long fibred kraft pulp.

In both cases the furnish will also contain small quantities of alum and size and in the case of linerboard, starch as well.

Stadler Hurter
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TABLE 2-J

PAPER MACHINE MAJOR COMPONENTS

Section	Machine to Trim 3.2 Meters for Corrugating Medium	Machine to Trim 5 Meters for Linerboard
Headbox	Primary only - pressure type	One primary and one secondary - pressure type
Fourdrinier	Level wire 3.4 M wide x 39.5 M long	Level wire 5.5 M wide x 44.2 M long
Couch	Gear driven, double suction box - bronze shell	Gear driven - double suction box - bronze shell
Press Part	Straight-through suction 1st press, Straight-through grooved 2nd press	Straight-through suction 1st press, Straight-through grooved 2nd press
Dryer Part	46 cast iron dryers 1524 mm dia. - pressure rating 8.8 kg/cm^2 - 4 drive sections	58 cast iron dryers 1524 mm dia. - pressure rating 8.8 kg/cm^2 - 5 drive sections
Breaker Stack	Not required	Two roll stack
Calender Stack	One two-roll, open side stack	One six-roll, open side stack
Reel	Constant tension type - 8 reel bars	Constant tension type - 8 reel bars
Winder	Shaftless type with lowering table	Shaftless type with lowering table
Drive Speed Range	250 - 400 m/min.	150 - 450 m/min.

TABLE 2-J (Continued)

PAPER MACHINE MAJOR COMPONENTS

Section	Machine to Trim 3.2 Meters for Corrugating Medium	Machine to Trim 5 Meters for Linerboard
Balanced for	500 m/min.	500 m/min.
Length - Overall	102 meters	122 meters
Approximate Weight	1820 metric tons	2500 metric tons

Assuming average consumption figures for alum resin, starch and a 0.5 white water losses and a paper moisture of 6%, the composition of the furnish to the paper machines would be (on an O.D. basis) as follows:

TABLE 3-J

O.D. PAPER FURNISH REQUIREMENTS
PER A.D. TON PAPER (6% MOISTURE)

Corrugating Medium	
Slush bagasse pulp	830 Kg.
Waste paper	90 Kg.
Alum	15 Kg.
Size	10 Kg.
Linerboard	
Slush bagasse pulp	620 Kg.
Imported long fibre pulp	265 Kg.
Alum	35 Kg.
Size	20 Kg.
Starch	5 Kg.

J.4 Pulp Requirements

Based on the furnishes given in Table 3-J the annual pulp requirements are as shown in Table 4-J.

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TABLE 4-J

ANNUAL O.D. PULP REQUIREMENTS

Product	Annual Production A.D. Tons	Waste Paper O.D. Tons	Imported Pulp O.D. Tons	Slush Bagasse Pulp O.D. Tons
Model I Corrugating Medium	56,440	5,080	-	46,850
Model II Linerboard	112,200	-	29,730	69,560
Model III Linerboard and Corrugating Medium	168,640	5,080	29,730	116,410

J.5 Papermaking Chemical Requirements

Based on the quantities developed in Table 3-J the annual papermaking chemical requirements will be as follows:

TABLE 5-J

ANNUAL PAPERMAKING CHEMICAL REQUIREMENTS - METRIC TONS

Product	Annual Board Production A.D. Tons	Chemical Requirements (Metric Tons)		
		Alum	Size	Starch
Model I Corrugating Medium	56,440	850	560	-
Model II Linerboard	112,200	3,930	2,250	560
Model III Linerboard and Corrugating Medium	168,640	4,780	2,810	560

K. BAGASSE REQUIREMENTS

K.1 Introduction

In order to determine the quantities of bagasse which must be purchased from the sugar mills it is necessary to consider the various losses which will occur from the time the bagasse leaves the crushing train until it is manufactured into pulp. For simplicity such calculations are made on an oven dry basis.

The losses to be taken into account are:

- moist depithing loss,
- wet depithing and washing loss,
- handling and storage losses,
- pulping loss

A typical analysis of whole bagasse on an oven dry basis would be:

Water solubles	8.0%
Dirt (mud, sand, stones, leaves)	5.0%
Fibre fines	4.5%
Pith and epidermal cells	28.0%
Fibre (suitable for pulp)	54.5%
	100.0%

K.2 Depithing Losses

If it is assumed that on moist depithing, one half the dirt, all of the fines and slightly more than one half of the pith and epidermal cells are removed, as well as a small fraction of the clean fibre, and that the water solubles are distributed more or less equally between the pith and fibre fractions, then for 100 kg. whole bagasse entering a moist depither, the discharge would be in the following approximate proportions:

Material	Whole Bagasse kg.	Accepted as "Fibre" kg.	Rejected as "Pith" kg.
Water solubles	8.0	5.5	2.5
Dirt	5.0	2.5	2.5
Fibre fines	4.5	.0	4.5
Pith and epidermal cells	28.0	13.5	14.5
Clean fibre	54.5	48.5	6.0
	100.0	70.0	30.0

i.e. the loss in moist depithing is 30% of the whole bagasse and the analysis of the accepted fibre fraction is:

Water solubles	7.8%
Dirt	3.6%
Pith	19.3%
Fibre	69.3%
	100.0%

Two different types of treatment are proposed for the secondary stage in the processing of the bagasse:

- washing and wet depithing for bagasse to be used for manufacture of linerboard grade pulp,
- washing without wet depithing for bagasse to be used for making pulp for corrugating medium

In combined washing and wet depithing half of the water solubles, about 95% of dirt, and about 50% of the pith, as well as a small fraction of the clean fibre are removed, thus for 100 kg. moist depithed bagasse entering the wet washing and depithing stage, material of the following composition would emerge:

Material	Moist Depithed Bagasse kg.	Accepted as "Fibre" kg.	Rejected as "Pith" kg.
Water solubles	7.8	3.9	3.9
Dirt	3.6	0.2	3.4
Pith	19.3	9.6	9.7
Fibre	69.3	68.3	1.0
	100.0	82.0	18.0

i.e. loss in the washing and wet depithing stage is 18% of the weight of the moist depithed bagasse and the approximate composition of the material entering the digester is:

Pith, dirt and solubles	16.7%
Clean fibre	83.3%

In the second case where only bagasse washing is required after moist depithing, about half of the water solubles and 90% of the dirt are removed with only minor losses of pith and fibre, thus for 100 kg. of moist depithed bagasse entering, the composition of the discharge would be:

Material	Moist Depithed Bagasse kg.	Accepted as "Fibre" kg.	Rejected as "Pith" kg.
Water solubles	7.8	3.9	3.9
Dirt	3.6	0.5	3.1
Pith	19.3	17.3	2.0
Fibre	69.3	68.3	1.0
	100.0	90.0	10.0

Hence loss in the bagasse washing stage is 10% of weight of moist depithed bagasse and the proportion of the material entering the digesters is:

Pith, dirt and solubles	19.2%
Fibre suitable for pulp	80.8%

The total loss of material during storage has been assumed to be about 7-1/2% (Since, during the crushing season the bagasse would be stored for only short periods, if at all, this figure represents approximately 10% loss in the portion of the bagasse which must be stored for a longer time).

K.3 Pulping Loss

The final loss of material takes place in the process of cooking, washing, screening, etc., which is used to manufacture the bagasse pulp. In order to develop higher strength properties in the resulting pulp a more thorough processing is given to pulp for linerboard than to pulp for corrugating medium. From previous experience therefore, the yield of pulp based on the bagasse fibre entering the digester has been assumed at 58.5% for liner-board grade pulp, and 67% for corrugating medium pulp, i.e., additional losses of 41.5% and 33% respectively.

K.4 Summary of Losses and Bagasse Requirements for Pulp Production

Incorporation of all of these losses thus shows the amounts of bagasse required at the different stages of the process as follows (Figures in O.D. tons):

	Linerboard		Corrugating Medium	
	Quantity	Loss	Quantity	Loss
O.D. fully processed pulp	1.0		1.0	
Pulping loss (41.5 & 33%)		0.71		0.49
To digester	1.71		1.49	
Washing & Wet Depithing Loss (18%)		0.38		
Washing Loss (10%)				0.17
From Storage	2.09		1.66	
Handling & Storage Loss (7.5%)		0.17		0.13
From Ingenios	2.26		1.79	
Primary Depithing Loss (30%)		0.97		0.77
Whole Bagasse required	3.23		2.56	

Hence the amounts of bagasse which the ingenios must produce to make one ton of either type of pulp would be 3.23 and 2.56 tons respectively (Since bagasse from the crushing trains averages 50% moisture these amounts represent 6.46 and 5.12 tons of whole bagasse, wet basis).

Since primary depithing would be done at the sugar mills the quantities for which compensation would be required would be 2.26 OD tons/ton pulp and 1.79 OD tons/ton pulp. The remaining portion would be pith returned to the ingenio boilers and would amount to 0.97 OD tons/ton pulp and 0.77 OD tons/ton pulp for each case.

From Section J.3 830 Kg. bagasse pulp are required for the production of one AD ton corrugating medium and 620 kg. bagasse pulp for one AD ton of linerboard. Consequently, the annual bagasse requirement for the three models are as shown in Table 1-K.

TABLE 1-K

ANNUAL BAGASSE REQUIREMENTS

Production	Annual Board Production A.D. Tons	Bagasse Pulp Required O.D. Tons	Moist Depithed Bagasse Required to be Purchased O.D. Tons	Whole Bagasse Required O.D. Tons	Whole Moist Bagasse Tons
Model I Corrugating Medium	56,440	46,850	83,960	119,940	239,880
Model II Linerboard	112,200	69,560	157,280	224,680	449,360
Model III Linerboard and Corrugati Medium	168,640	116,410	241,240	344,620	689,240

L. COST OF BAGASSE

L.1 General

Cost of begasse is sometimes understood to mean only the fuel velue replacement costs but in the pulp and paper industry this term usually means total cost of begasse moist depithed at the suger mills and delivered to the pulp mill. At times the term "cost of bagasse" may also be applied to bagasse fibre fed to the digesters. For this study the term is applied to the cost of moist depithed bagasse delivered to the paper mill.

There are many factors which influence the cost of bagasse delivered to the mill of which the most important are:

- cost of replacement fuel,
- length of cane crushing season,
- size of the sugar mill,
- power costs,
- labour costs,
- transportetion distance - sugar mill to pulp mill,
- state of bagasse handled - bulk or baled,
- means and type of transport selected - transportation costs,
- primary depithing system selected - operating costs,
- amount of incentive payments demanded by sugar mills (if any)

Where cost of bagasse refers to bagasse fed into the digesters the above costs would be increased by the capital charges applicable to equipment for bagasse receiving, moist and wet depithing, handling and transportation to and from storage, pavement of the storage area, and handling and transportation to the digesters. Also included would be the fibre losses in wet depithing and storage, and bagasse preparation equipment up to the digester, and labour, power and maintenance costs for all machinery utilized.

L.2 Discussion

Fuel replacement value is normally the largest single item effecting the cost of bagasse. In most areas where bagasse has been diverted for other purposes fuel oil has been substituted. This has been done to such an extent that a generally accepted standard for equivalent fuel value has been developed in the ratio of 1 ton of oil = 3 tons OD bagasse and this relationship is considered quite accurate for estimating purposes.

Any type of combustible, of course, may be used to replace the bagasse and at times even coal or wood have been utilized. These fuels, however, are only economical under very special circumstances and consideration of their use is complicated by the fact that necessary boiler conversion is usually difficult and exceedingly costly.

Very competitive with oil and, in the province of Tucuman, much more economical, is natural gas. This fuel is rarely available in cane growing areas but Tucuman is most fortunate in the fact that the natural gas main from the Northern provinces and Bolivia crosses the province very near to the sugar producing region. Branch-mains, in fact, have been or are being constructed to pass conveniently near to all operating ingenios.

In the past the supply of gas has been severely limited but recent connection to the new main from Bolivia makes it feasible to consider this type of fuel. Assurances have been received that even for the large quantities required the gas will be available by the time it is required.

At the time of writing the price of oil in Tucuman is depressed and dealers are willing to sell for the best price they can get. This, however, is considered to be a temporary condition which cannot persist in the face of rising international prices. Considering all aspects therefore, there is little doubt that the most logical and economical fuel on which to base bagasse costs in this area is natural gas.

The duration of the cane crushing season has also an appreciable effect on the cost of bagasse, particularly in Tucuman. The crushing season is relatively short thus large quantities of bagasse must be depithed and transported over a short period necessitating more and larger equipment than would normally be required and inflated power, operating, and maintenance costs. The length of the cane crushing season also determines the size of bagasse storage at the pulp mill and, indirectly, also the extent of fibre loss in storage. Fibre losses in storage range from 5% to 15% and even more, depending on the type and length of storage, but in general the longer the storage the greater are the losses. The additional capital expense attributable to the short season are charged against the paper mill and do not appear in the cost of bagasse.

Power costs influence cost of bagasse mainly because the depithing machines consume, as a rule, substantial quantities of power, cost of which is then added to the cost of bagasse.

Labour costs usually do not constitute a very large portion of the bagasse costs in a bulk bagasse system but in the bale handling systems labour costs are usually very high.

Transportation distance plays a very important role in the cost of bagasse. If the distance is very small, up to about 800 m., belt or pneumatic conveyors can be used. These conveyors have much longer useful life (15 years or longer) than trucks, require little maintenance and supervision and can be designed for very high capacities. Increase in the transportation distance by only a few hundred meters makes conveyors impractical so that trucks must be used with substantial increase in costs per ton handled.

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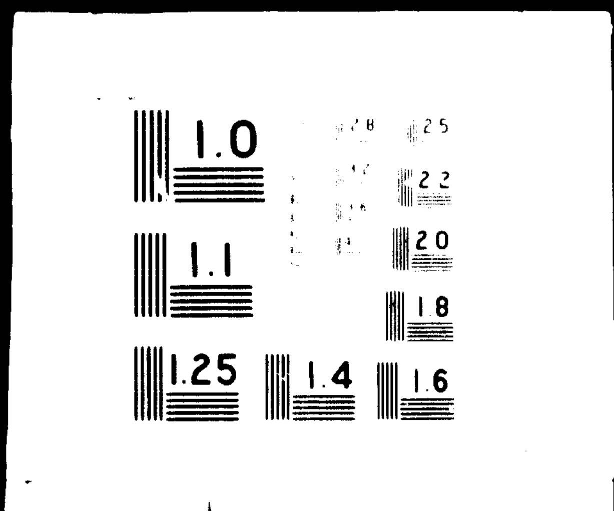


Bagasse can be handled, transported and stored in bulk or in bales. Baled bagasse is considerably less bulky but the costs involved in baling, storage, and bale handling equipment are substantial and unless transport over long distances is involved, the resulting total costs of bagasse may become prohibitively high for its use in pulp and paper.

Bagasse is discharged from the crushing trains in bulk and has to be fed ultimately into the digesters, also in bulk form. Therefore, if bagasse is handled, transported and stored in bulk all the unnecessary work involved in baling and bale breaking may be eliminated with corresponding reduction in costs. Since distances are short in Tucuman, baling would have no advantage and costs are based on bulk handling.

Means of transport selected such as conveyors, trucks, barges, flumes, influence the cost of bagasse by their own operating costs per ton of bagasse handled for the given distance. Conveyor and truck transportation have been assumed for cost purposes.

Operating costs of primary depithing systems per ton of bagasse processed vary greatly with the systems selected. Unfortunately, a direct selection strictly on the basis of costs is not always possible because the quality of pith removal and efficiencies of clean fibre recovery also vary greatly.

Sugar mills that have experienced consistent bagasse surpluses will usually sell bagasse without incentive payments because otherwise they must spend money to dispose of these surpluses. In Tucuman however almost all sugar produced is fully refined so that all of the fuel value of the bagasse produced is required and, in addition, auxiliary fuel is used. Because of this, the sugar mills may request so-called "incentive" payments, that is, payments in excess of the fuel value plus costs, before they agree to sell their bagasse on long term contracts.

Such payments, if they are made, must be reasonably low otherwise the cost of bagasse might become too high for pulp and paper making. Since conversion to natural gas fuel will indirectly cause some benefits and savings to the ingenios involved, e.g. over-compensation for fuel value of the bagasse and more efficient and responsive boiler operation, allowance for incentive payment has not been made, although it is convenient not to forget that it could be necessary to consider incentive payments when the operation is confirmed.

Table 1-L shows the estimate costs of bagasse from various sugar mills delivered to a paper mill located adjacent to Ingenio Concepcion. In this table, capital costs and the installations at the sugar mill (moist depithing, truck loading and conveyor to the paper mill as well as boiler conversion) are not included

in the costs because they are already included in the paper mill costs. Transportation by trucks is assumed to be done by contractors thus contractors' costs and profit have been allowed for.

Further details may be found in Appendix Sections as follows:

BX.3 Power Consumed and Power Contract

BX.4 Bagasse Requirements and Costs

BX.5 Fuel Cost

TABLE 1-L

ESTIMATED COSTS OF MOIST DEPITHED BAGASSE FOR VARIOUS MILLS

ADJACENT TO INGENIO CONCEPCION

Source of Bagasse	OD Tons Whole* Bagasse Available 1979	OD Tons Moist** Depithed Bagasse Available 1979	Quantity Required by Pulp & Paper Mill	Percent of Total Available	Transport System and Distance	Cost of Transport	Total Annual Cost $^a	Bagasse Cost/OD Ton $^a	Bagasse Cost/OD Ton US$
Model I									
Ingenio Concepcion	161,400	113,000	83,960	74	Belt - 250 m	Incl.	2,619,687	31,199	6.24
Model II									
Ingenio Concepcion	161,400	113,000	157,280	100	Belt - 250 m	Incl.	3,471,365	30,721	6.14
Ingenio San Juan	45,800	32,100		100	Road - 12 km	299,390	1,364,216	42,497	8.50
Ingenio Cruz Alta	34,700	24,300		50	Road - 20 km	273,860	731,686	60,080	12.02
							5,567,267	35,397	7.08
Weighted Average Cost of Bagasse $^a 35,397 = US$ 7.08									
Model III									
Ingenio Concepcion	161,400	113,000	241,240	100	Belt - 250 m	Incl.	3,471,365	30,721	6.14
Ingenio San Juan	45,800	32,100		100	Road - 12 km	299,390	1,364,216	42,497	8.50
Ingenio San Pablo	84,400	59,100		100	Road - 24 km	830,310	2,676,545	45,288	9.06
Ingenio Cruz Alta	34,700	24,300		100	Road - 20 km	317,480	1,156,003	47,572	9.51
Ingenio La Florida	36,700	25,700		50	Road - 20 km	275,865	749,855	58,858	11.77
							9,417,984	39,040	7.81
Weighted Average Cost of Bagasse $^a 39,040 = US$ 7.81									

* Assuming 30% increase over figures given in Table 1-H
** Assuming 30% losses in moist depithing

Notes:

(a) Rate of Exchange 5^a per US$
(b) Only capital costs included are for truck transportation

M. DESCRIPTION OF PROPOSED MILLS

M.1 General

Drawings No. 19L6-301, 302 and 303 show typical layouts for the three sizes of papermill proposed. It would be possible to construct and supply any of these mills in either the Northern or the Southern part of Tucuman province, but for purposes of discussion, it has been assumed that:

- the location for any of the three alternative paper mills would be adjacent to the largest mill in the northern zone
- the total bagasse from this mill would be utilized before drawing upon other ingenios
- where bagasse required exceeds that produced by the adjacent mill, the additional quantities would be drawn from other ingenios according to their size and proximity to the paper mill site
- transportation of bagasse to the paper mill would be by belt conveyor from the adjacent ingenio and from other sugar mills by semi-trailer
- by 1979, the amount of bagasse available from any given ingenio will have increased 30% over 1961-70 average.
- primary depithing installations would be at the sugar mills, an installation being required for each ingenio involved in the supply of bagasse

M.2 Depithing Installations at Sugar Mills

a) Mode.. I

The bagasse produced by the principal ingenio will be more than adequate to supply the needs of the 166 TPD corrugating mill and, consequently, no truck transportation will be necessary. For depithing at the sugar mill, the bagasse would be taken from the existing boiler feed conveyor ahead of the first boiler and transferred to a distributing conveyor, it would be metered at the required rate into individual depithers by means of twin drum feeders. The material in excess of the depithing capacity would by-pass the depithers to overflow and pith return conveyors and be returned to the existing boiler feed conveyor downstream of the depither take-off point. The pith and fines rejected by the depithing machines would be collected and returned to boilers by means of the same overflow and pith return conveyor arrangement.

The cleaned accepted bagasse would be collected by a belt conveyor, weighed by a belt scale, elevated and transferred onto the main conveyor to the paper mill. It is estimated that only one operator and a part-time helper would be required on each shift for this operation. Arrangement would be made to have the sugar mill supervise and administer the moist depithing operation.

b) Model II

Bagasse requirements for a 330 TPD linerboard mill exceed the total quantity which will be produced by the adjacent ingenio, thus some additional bagasse (about 56,400 tons O.D.) will have to be transported by road from two other sugar mills. The depithing installation at the main ingenio would be similar to that described for the corrugating mill, but bagasse overflow and pith return would be by separate conveyors so that only the pith would go to the boilers. The overflow bagasse would either be re-cycled immediately or, if necessary, would be stored until an interruption in cane crushing would permit it to be fed back into the depithing system. Such an arrangement will ensure maximum utilization of the least expensive and most readily available bagasse.

The depithing equipment at the other ingenios would differ not only in size, but also in the incorporation of truck loading bins. The much smaller quantities of bagasse to be handled would also make it practical to utilize pneumatic conveyors for transportation of the whole bagasse to moist depithing and from depithing to the loading bins. Pneumatic conveyors because of superior flexibility, would permit location of the truck loading bins immediately adjacent to the depithing machine so that only the minimum of operating labour would be necessary.

The accumulation of depithed bagasse in loading hoppers will reduce loading of trailers to a matter of minutes, and permit optimum cycling of the transportation equipment. In addition, settling of the bagasse, even in very temporary storage in the hoppers, combined with the further compaction caused by the method of loading the trailers will reduce volume to some extent so that somewhat larger tonnages can be loaded per unit volume of the transport vehicles.

c) Model III

Bagasse requirement of this large mill can be satisfied only by taking all the bagasse available from Ingenios: Concepcion, San Juan, Cruz Alta, and San Pablo, augmented by the remaining quantity from Ing. La Florida.

The handling and depithing installed at Ing. Concepcion, San Juan and Cruz Alta would be as described for the linerboard mill (Model II). The moist depithing installation at Ingenio San Pablo would be similar to that at Concepcion with the exception that facilities for truck loading would be provided. Because the total bagasse available will have to be taken from these sugar mills, all bagasse would be taken off the existing boiler feed conveyor and fed into the depithers. Overflow conveyors would be provided to take bagasse in excess of the depithing capacity to temporary storage in a surge pile for future depithing. After depithing, as for linerboard mill, the accepted bagasse would be accumulated in loading bins for rapid truck loading. Two bins, each of capacity equal to that of one bagasse trailer, would be provided to ensure optimum flexibility.

Equipment at Ingenio La Florida would be similar to that installed at Cruz Alta, but the overflow return for excess bagasse would not be necessary because only about 50% of the available bagasse would require depithing.

M.3 Depithing Installations at Paper Mill

a) Model I

The bagasse delivered by belt conveyor from Ingenio Concepcion would be fed directly into the bagasse washing system consisting of a hydrapulper, a washing chest, sand and "junk" removal conveyors and a water re-cycling system. From the washing system bagasse will be sluiced onto a drainer type elevating conveyor with three discharge points. The first two discharge openings would be equipped with metering feeders, while the last one would be permanently open in order to permit transfer of excess bagasse to a surge pile. The first feeder would deposit bagasse onto the digester feed conveyor for immediate processing and the second feeder would meter the bagasse into a preservative mixer discharging into truck loading conveyor system for subsequent transportation to the main storage, where it would be piled up to 15 m high by means of front-end loaders. The bagasse-preservant mixer would operate only on fresh bagasse from the sugar mill. When no fresh bagasse is being delivered, the feeder to the mixer would be stopped so that the bagasse on the drainer-elevating conveyor in excess of that required at the digester would be transferred to the surge pile.

From the main storage pile, bagasse would be reclaimed by a mobile crane equipped with an "orange peel" type grab and high reach front end loader, loaded onto dump trucks, transported to a well drained surge pile or intermediate storage area, dumped there and fed onto a reclaim conveyor as and when required. Front-end loaders would be used to transfer bagasse from the surge or intermediate storage pile directly onto the reclaim conveyor from which it would be transferred to the drainer-elevating conveyor described above.

Sugar mills usually shut down one to two days every 7 to 14 days during the crushing season for evaporator clean-out causing intermittent interruptions in production of bagasse.

The paper mill, however, must operate continuously. During the sugar mill shut-downs, bagasse would be reclaimed either from the surge or intermediate storage pile or from the main storage piles.

In order to reduce re-handling of bagasse during the sugar mill shut-downs sufficient washed bagasse would be accumulated in the surge pile to provide uninterrupted supply to the paper mill without having to reclaim from the main storage piles.

b) Model II

The wet depithing, storage and handling installation would be similar to that described for Model I, but wet depithers and wet pith handling system would be added and the capacities of the washing, handling and storage systems would be increased because of the larger production. Operation of this installation will be very similar to that described for Model I with the exception that during the crushing season about 36% of bagasse will be delivered by trucks, dumped alongside the bagasse receiving conveyor and fed into the bagasse washing system and wet depithers simultaneously with bagasse delivered by the belt conveyor from Ingenio Concepcion.

c) Model III

The wet depithing, storage and handling system for this

496 TPD mill would be identical in design to that described for the 330 TPD linerboard mill with the exception that the capacities would be increased and about 53% of bagasse would be delivered by trucks.

Two digesters would be required thus provision of two receiving conveyors and metering feeders would be necessary.

M.4 Sequence of Operation

Basically the processes for the proposed plants are as shown on flow sheet 39F6-201/1 for Model I, on 39F6-202/1 for Model II and on 39F6-203/1 for Model III. The operation of the plant is described hereunder.

a) Model I

Moist depithed and washed bagasse is fed to a wilting screw conveyor where black liquor is added. The bagasse then drops from the wilting screw to the presteamer and then into the rotary feeder of a continuous digester. The type of continuous digester preferred is the double tube horizontal digester because retention times may be varied over a considerable range.

Cooking liquor is delivered to the mill as sodium hydroxide at a 50% concentration, then diluted at the mill to the required strength and added to the continuous digester immediately after the rotary feeder. The digester is operated at pressures of 7 to 7.5 atmospheres by direct steaming. Retention times are in the order of 15 to 20 minutes to reduce the fibrous material to a suitable pulp. After passing through the continuous digester, the pulp is discharged under pressure through a pressurized fiberizing refiner to a blow tank from which it is pumped to a washer in which the cooking liquor is separated from the fiber. A portion of the waste liquor is reused for the preparation of cooking liquor and in the wilting operation as well as for wet depithing. The balance of the waste liquor is sewered. From the pulp washers the pulp is discharged at high consistency and pumped to storage in a high density tower. From here the bagasse pulp is diluted and pumped to the bagasse pulp chest from which it is fed at regulated consistency to a battery of disk refiners, where the pulp is subjected to additional fiberization. From the refiners the pulp goes to the refined bagasse pulp chest where it is stored under controlled consistency and agitated to prevent flocculation and to ensure uniformity of the fibre and water mixture.

The waste paper, which is the other fibrous component of the corrugating medium, is pulped in a conventional batch pulper after which it is screened, thickened, refined and stored in a low density refined storage chest.

Broke from the wet end of the paper machine (wet broke) is collected in the couch pit, diluted, then passed over a save-all to bring it to the required consistency after which it is stored in the refined waste and broke stock chest. Wet broke under normal operating conditions is produced at a uniform rate, but may present problems in starting up if passing of the sheet to the dryer section takes excessive time. Broke from the dry end of the paper machine (dry broke) is transported to the waste paper batch pulper where it passes through the same system as waste paper. Dry broke will be produced at a variable rate during threading operations and dry end breaks. The winder trim, together with cut-up unacceptable rolls of paper, are collected into the dry broke pulper and then pass to the waste paper system.

From the refined stock chests, the waste paper pulp, which would normally also contain small proportions of paper mill broke, and bagasse pulp are pumped to a proportioner where the desired ratios of bagasse and waste paper pulp are metered, mixed, and controlled. Resin size and alum are added at this point to give fibre set, water impermeability, and for pH control. The pulp mixture (furnish) is pumped through a battery of conical brushing refiners and, after further dilution passes through the machine screens to the headbox of the paper machine.

The paper machine is a standard fourdrinier machine as described in detail in Table 2-J. The board is formed on the wet end of the paper machine, dried in the dryer section and wound into rolls on the reel. The reels of paper (or board) are slit and trimmed to desired widths on the machine slitter-winder and after being strapped and weighed the rolls from the winder are transferred to roll storage to await shipment. Ideally scheduling of production should avoid storage but this is not always possible.

After the winder the rolls of paper are inspected and may either be rewound or cut up for recycling depending on whether it is the quality of the winding or the quality of the paper which is at fault. Rewound rolls are eventually included with other paper ready for shipment.

The operation of stock preparation and the paper machine is controlled by centralized instrumentation systems located strategically, permitting observation and control of the operating variables from panel group indicators, recorders and controllers, including remote push-button stations for all motors.

Satisfactory working conditions for the personnel are ensured by proper ventilation of the paper machine room through adequate machine hood exhaust and room fresh air supply systems.

In addition to the main production facilities deecribed above, the mill would have complete steam generating facilitiee, electricel power distribution system,water supply and water treatment eystem, fire protection fecilities, shops and stores for maintenance and repaire, firet eid station, cafeteria, and mill offices for management, accounting, engineering, purchasing and eales.

Inasmuch as the corrugating medium mill is not planned to hava a chemical recovery eyetem, the effluent from the mill would hava a higher pollution load than the other two alternativa milla. Effluant treatment would coneiet, principally of primary clarification to reduce the pollution load of diecharged water to acceptable levels.

Watar from the affluent plant would be re-cycled as much as possible tharaby reducing the amount of freeh weter usad. For reduction of B.O.D. (Biological Oxygen Demand) the claar, axcess effluent would be aerated by meana of a serias of channele and waira befora it entere the axiating watar-table or watar way ayatem. Solid water from the clarifiera would be dumped on waste land away from habitetion.

b) Model II

The procesa for the proposed plant is as shown on flowsheet 39F6-202/1. The operation of the plant would be as described hereunder.

Washed and wet depithed bagasse is fed to a wilting screw conveyor, where black liquor is added. The bagasse then drops from the wilting screw to the presteamer and then into the rotary feeder of a continuous digester. A continuous horizontal digester of the tube and screw type is preferred because retention time may be varied over a considerable range.

Cooking liquor, prepared by causticizing sodium carbonate with burnt lime, is added to the continuous digester immediately after the rotary feeder. The digester is operated at pressures of 7 to 7.5 atmospheres by direct steaming. Retention times required are in the order of 15 to 20 minutes, to process the fibrous material into pulp of suitable characteristics after passing through a pressurized fiberizing refiner to a blow tank.

From the blow tank the pulp is pumped to Jonsson screens, and then flows to the washers in which it is washed free from cooking liquor. A portion of the liquor is re-used for the preparation of cooking liquor and in the wilting operation. The balance of the liquor is sent to the recovery plant.

From the pulp washers, the pulp is discharged at high consistency and pumped to a high density storage, the principal purpose of which is to compensate for surges or fluctuations between the pulp mill production and paper machine demand. Pulp from the high density storage tower is diluted and pumped to the bagasse pulp chest.

Imported unbleached kraft, the second fibrous component of linerboard, is pulped in a conventional batch pulper and then pumped to a storage chest.

The paper machine will produce wet broke from the wire trim and from the press section at a more or less constant rate during normal operation and at a variable rate during threading procedures and wet end breaks. This material will be collected in the couch pit.

Dry broke will be produced at a variable rate during threading operations and dry end breaks. The winder trim together with dry broke will be collected in a dry broke pulper.

Wet and dry broke are returned to the paper machine circuit through the broke handling and proportioning system and are pumped to the broke storage chest.

When producing linerboard, bagasse pulp, imported pulp, and broke are refined separately in a battery of pressurized disk refiners and go to their respective refined stock chests where the consistency is constantly controlled and the stock is adequately agitated to prevent flocculation and to ensure uniformity. From the refined stock chests the three types of pulp are pumped to a proportioner where the relative ratios of bagasse pulp, imported kraft pulp, and broke pulp are metered and controlled. The pulp mixture flows into the primary machine chest. From the primary machine chest the pulp is pumped through conical refiners and screens through a basis weight valve and into the primary headbox fan pump circuit.

Portions of the bagasse pulp, and the imported kraft pulp (without broke) are pumped to a secondary proportioner and thence to a secondary machine chest. This furnish forms the supply for the top liner. From the secondary machine chest, where rosin size and alum have been added, the pulp is pumped through conical refiners and screens to the paper machine secondary headbox.

Here again, the paper machine is a standard fourdrinier machine which is discussed in detail in Table 2-J. The board is formed on the wet end of the paper machine, dried in the dryer section and wound into rolls on the reel. The reels of paper or board are slit and trimmed to the desired width on the machine slitter winder and then weighed on a platform scale and transferred to roll storage for shipment as required.

Defective rolls are either temporarily stored and later rewound, or cut up and returned to the dry broke system. The rolls from the rewinder are then weighed, strapped, and sent to storage for shipment.

The operation of stock preparation and the paper machine is controlled by centralized instrumentation systems located strategically, permitting observation and control of the operating variables from panel grouped indicators, recorders and controllers, including remote push-button stations for all motors.

Satisfactory working conditions for the personnel are ensured by proper ventilation of the paper machine room through adequate machine hood exhaust and room fresh air supply systems.

The chemical recovery system is relatively simple. The weak black liquor from the washers flows into filtrate tanks from which it is then pumped to a black liquor filter where any entrained fibres are removed. The filtered black liquor then goes to the weak black liquor storage tank. From this storage it is pumped to multiple effect evaporators where it is concentrated to approximately 30%. The evaporated black liquor is stored in a thick black liquor storage tank, from which is is fed to a fluidized bed reactor for burning.

During oxidation, the volatile organic matter, which consists of complex compounds of soda and organic non-cellulose portions of the bagasse, is converted to harmless gases and water vapour which pass through a cyclone and scrubber system and emerge as innocuous gases, devoid of the original pollutive character of the waste effluent of which it was a part.

The residual inorganic chemicals, previously existing in various stages of complexity in combination with inorganic and organic process wastes, are oxidized and converted to a stable state and deposited in the fluidized bed as pelleted or agglomerated granules. These pellets or granules of residual inorganic chemical form the matter of the oxidized bed and, as the chemicals accumulate, a portion is continually discharged as a solid, granular product. These chemicals are recovered as sodium carbonate which is dissolved in a tank using weak liquor from the recausticizing system to form green liquor. Make-up sodium carbonate is added to the dissolving tank.

The green liquor is pumped to a conventional recausticizing system where, by treatment with lime, the sodium carbonate in the green liquor is converted to sodium hydroxide. The white liquor thus formed is then ready to be used for cooking.

The lime mud formed in the recausticizing process is washed, filtered and then burned in a lime kiln to produce fresh lime. Make-up limestone would be added as required and burned together with the lime mud.

In addition to the main production facilities described above, the mill would have complete steam generating facilities, electrical power distribution system, water supply and water treatment system, fire protection facilities, shops and stores for maintenance and repairs, laboratories for testing and control, locker rooms, wash rooms, first aid station, cafeteria, and mill offices for management, accounting, engineering, purchasing and sales.

The effluent from the mill would not be very difficult to treat since the fluid bed reactor and recausticizing area will remove most of the contaminants. The effluent will, however, contain some biological oxygen demand (B.O.D.) and some suspended solids which will consist of fine solids removed from the pulp and some chemical which is washed out of the paper during manufacture.

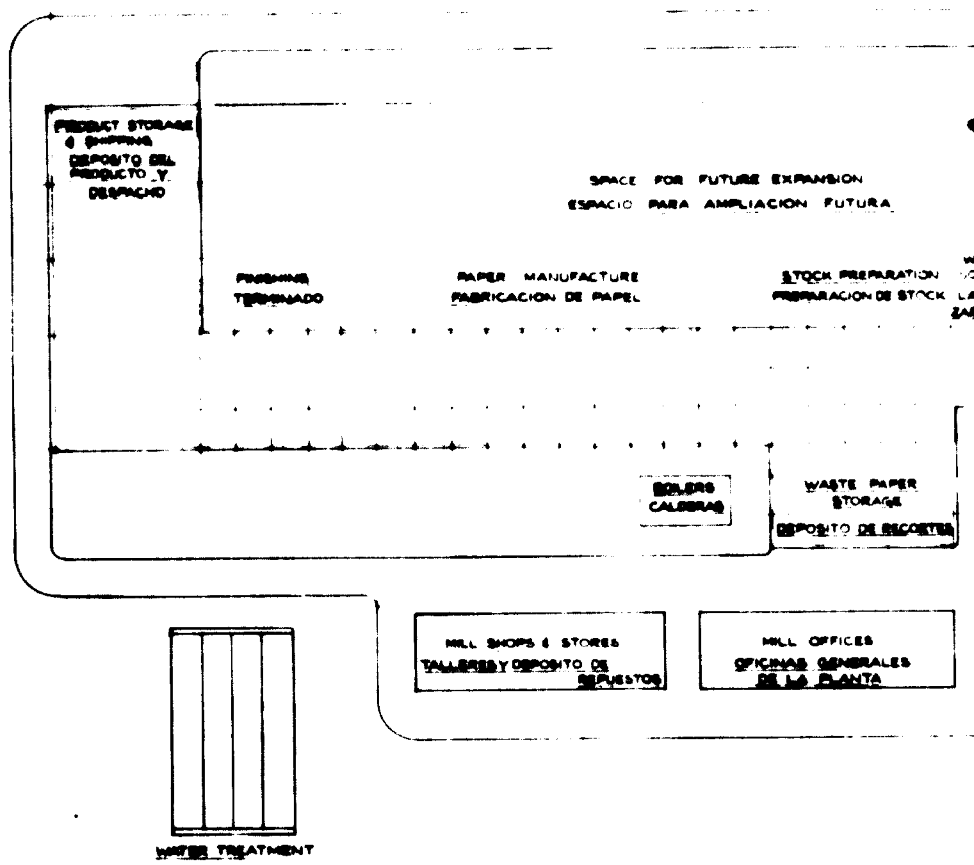
The best treatment for effluent under these conditions would be by means of primary clarifiers from which the sludge would be gathered and disposed of on waste land away from habitation. As much water as possible from the effluent plant would be re-cycled thereby reducing the amount of fresh water used. For further B.O.D. reduction, the clear, excess effluent water would be aerated in a series of channels and weirs before it is returned to the existing water-table or water-way system.

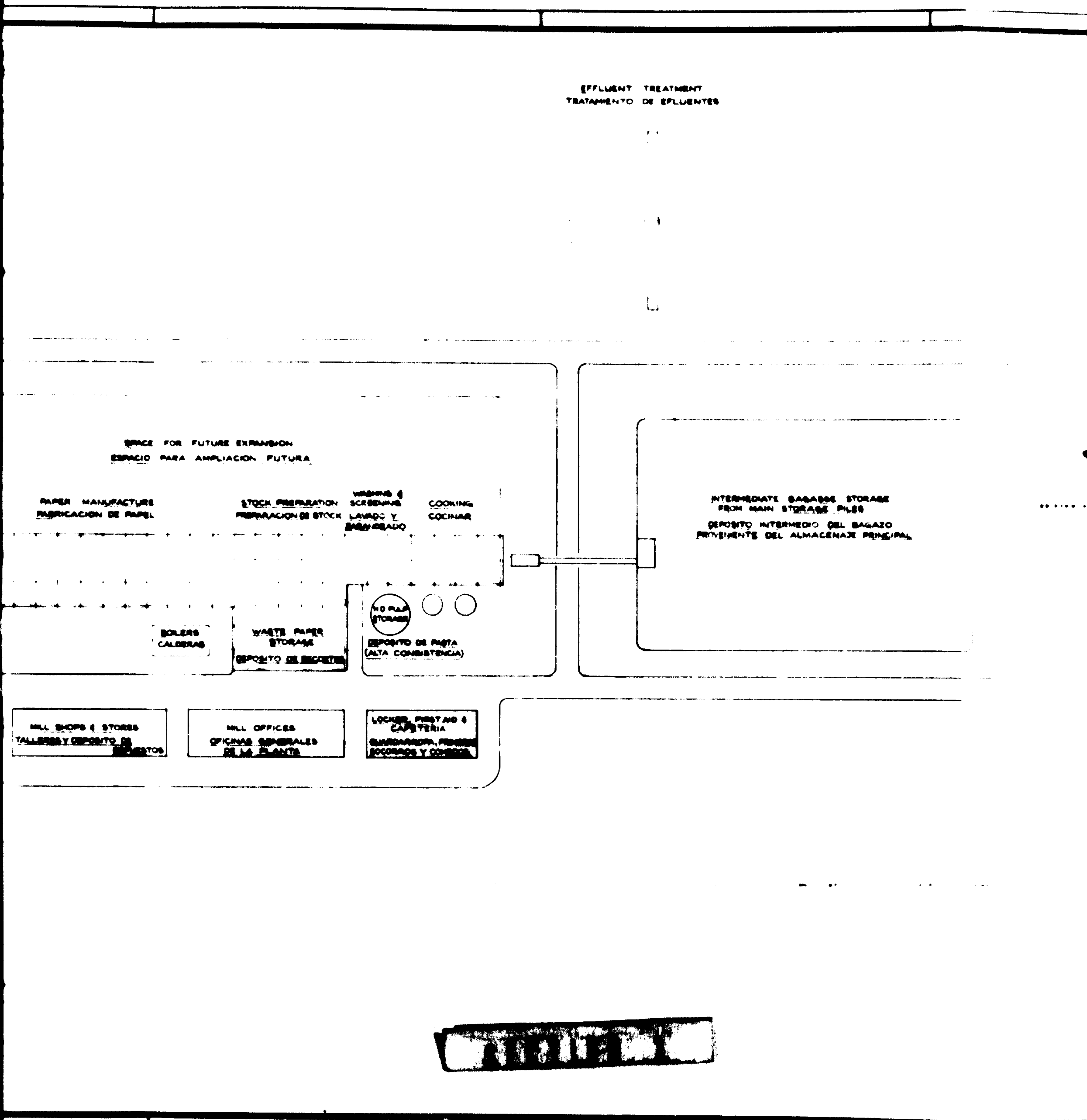
c) <u>Model III</u>

The process for the proposed plant is as shown on flowsheet 39F6-203/1. The proposed plant would have two pulping lines, one for production of 330 T/D linerboard, as described previously under M.4 (b) - Model II, and one for production of 166 T/D corrugating medium, as described under M.4 (a) with the exception that through minor additions to the recovery system the chemicals used in production of corrugating grade pulp may also be economically recovered.

In addition to the main production facilities described above, the mill would have complete steam generating facilities, electrical power distribution system, water supply and water treatment, fire protection facilities, shops and stores for maintanance and repairs, laboratories for testing and control, locker rooms, wash rooms, first aid station, cafeteria, and mill offices for management, accounting, engineering, purchasing and sales.

The effluent treatment system would be a larger model of the already described in section M.4 (b) - Model II.


PRODUCT STORAGE & SHIPPING
DEPOSITO DEL PRODUCTO Y DESPACHO
SPACE FOR FUTURE EXPANSION
ESPACIO PARA AMPLIACION FUTURA
FINISHING
TERMINADO
PAPER MANUFACTURE
FABRICACION DE PAPEL
STOCK PREPARATION
PREPARACION DE STOCK
BOILERS
CALDERAS
WASTE PAPER STORAGE
DEPOSITO DE RECORTES
MILL SHOPS & STORES
TALLERES Y DEPOSITO DE REPUESTOS
MILL OFFICES
OFICINAS GENERALES DE LA PLANTA
WATER TREATMENT
TRATAMIENTO DE AGUA


EFFLUENT TREATMENT
TRATAMIENTO DE EFLUENTES
SPACE FOR FUTURE EXPANSION
ESPACIO PARA AMPLIACION FUTURA
PAPER MANUFACTURE
FABRICACION DE PAPEL
STOCK PREPARATION
PREPARACION DE STOCK
WASHING & SCREENING
LAVADO Y
COOKING
COCINAR
BOILERS
CALDERAS
WASTE PAPER STORAGE
H D PULP STORAGE
DEPOSITO DE PASTA
(ALTA CONSISTENCIA)
INTERMEDIATE BAGASSE STORAGE
FROM MAIN STORAGE PILES
DEPOSITO INTERMEDIO DEL BAGAZO
PROVENIENTE DEL ALMACENAJE PRINCIPAL
MILL SHOPS & STORES
MILL OFFICES
OFICINAS GENERALES
DE LA PLANTA
CAFETERIA

MEDIATE BAGASSE STORAGE
MAIN STORAGE PILES

T INTERMEDI DEL BAGAZO
TE DEL ALMACENAJE PRINCIPAL

PROYECTO MODELO I TUCUMAN	PROJECT MODEL I TUCUMAN
PLANTA DE PAPEL CORRUGADO-166 T/D PLANO DE MASA TIPICO	CORRUGATING MEDIUM MILL-166 T/D TYPICAL LAYOUT

Sadler Hurter
ENGINEERS . CONSULTANTS
MONTREAL

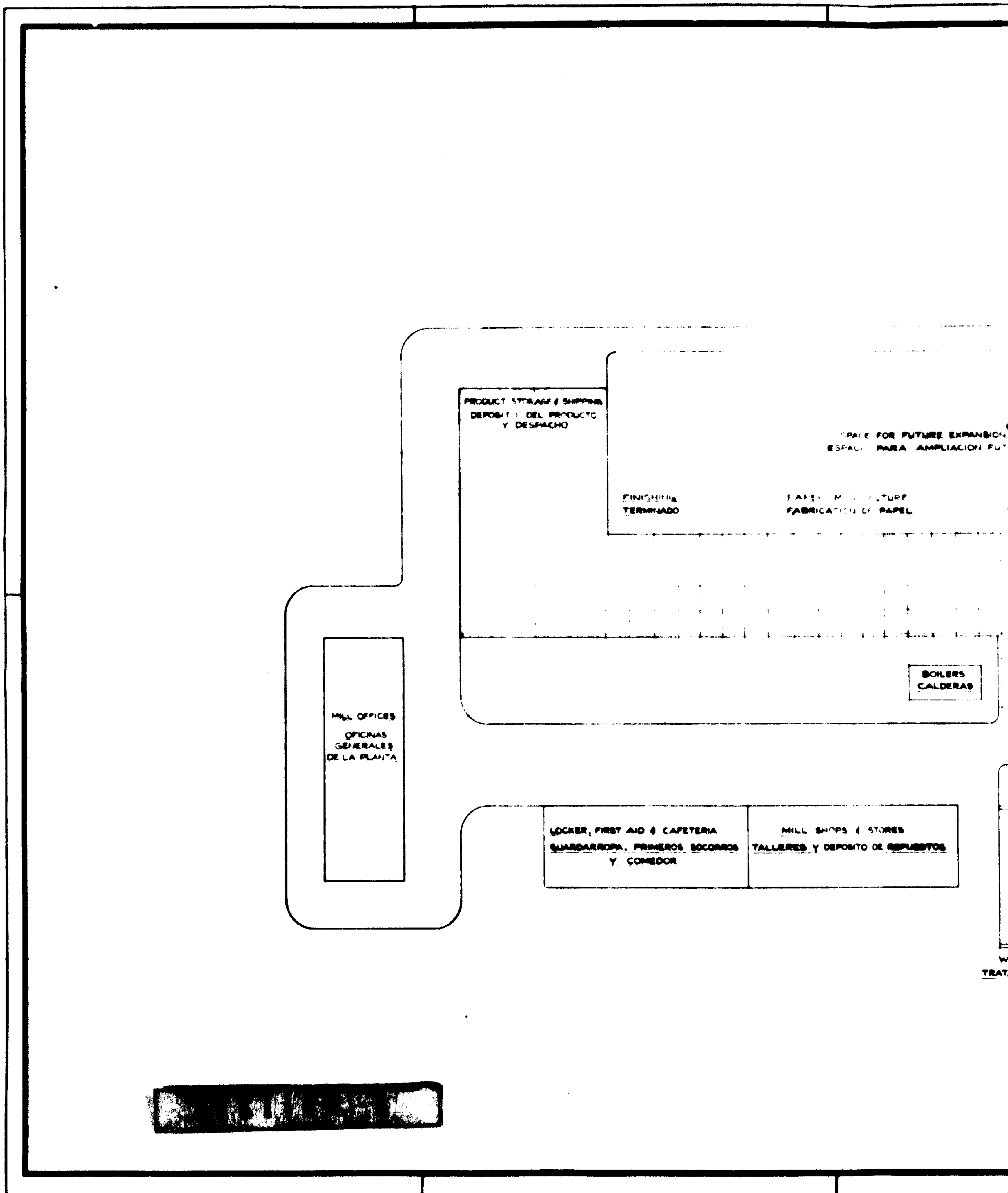
SCALE 1:500

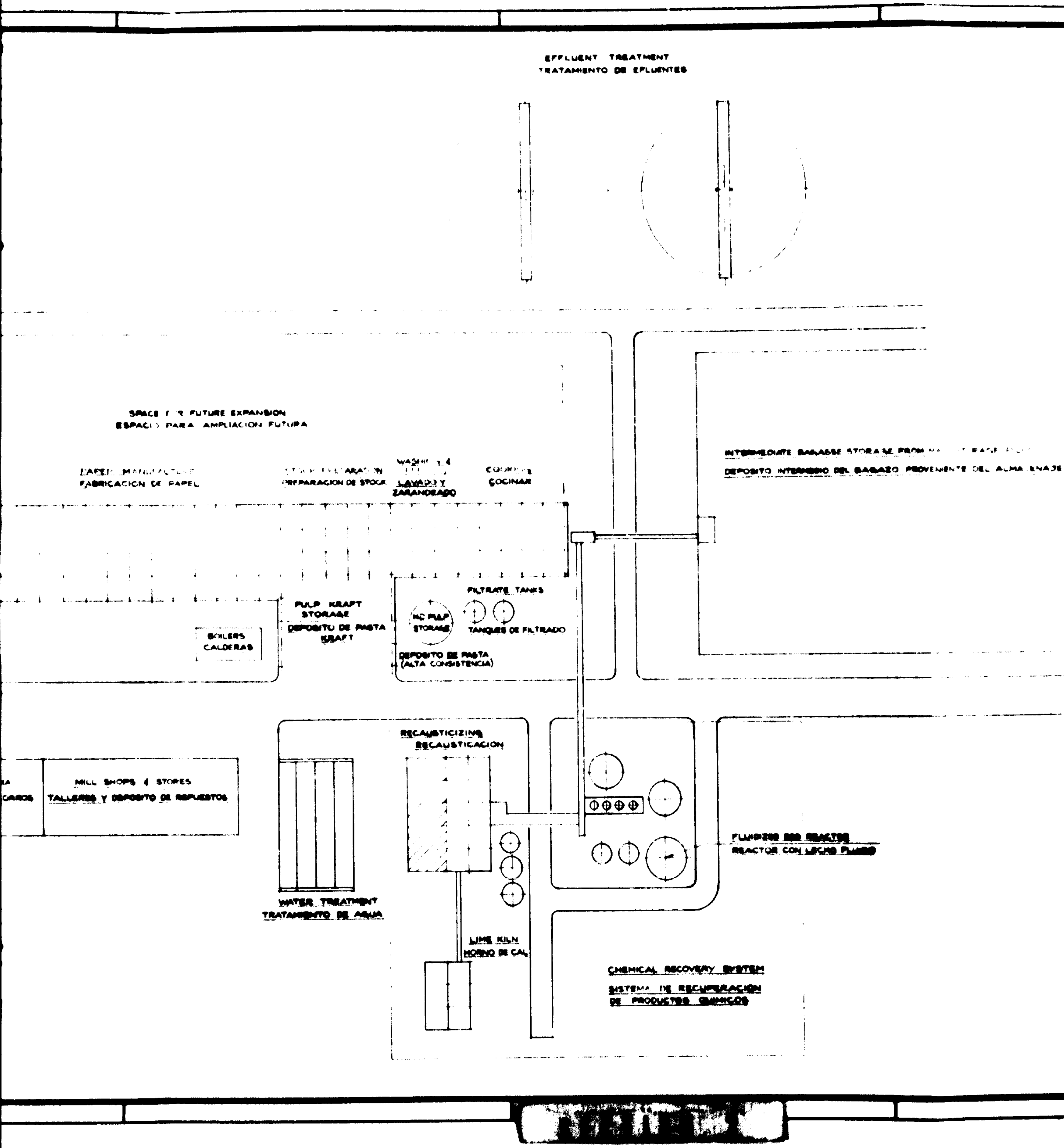
DATE MAY 1972

UNIDO CONTRACT
71/83

193-A

19L6-301


PRODUCT STORAGE & SHIPPING
DEPOSITO DEL PRODUCTO
Y DESPACHO
SPACE FOR FUTURE EXPANSION
PARA AMPLIACION
FINISHING
TERMINADO
FABRICACION DE PAPEL
BOILERS
CALDERAS
MILL OFFICES
OFICINAS
GENERALES
DE LA PLANTA
LOCKER, FIRST AID & CAFETERIA
GUARDARROPA, PRIMEROS SOCORROS
Y COMEDOR
MILL SHOPS & STORES
TALLERES Y DEPOSITO DE REPUESTOS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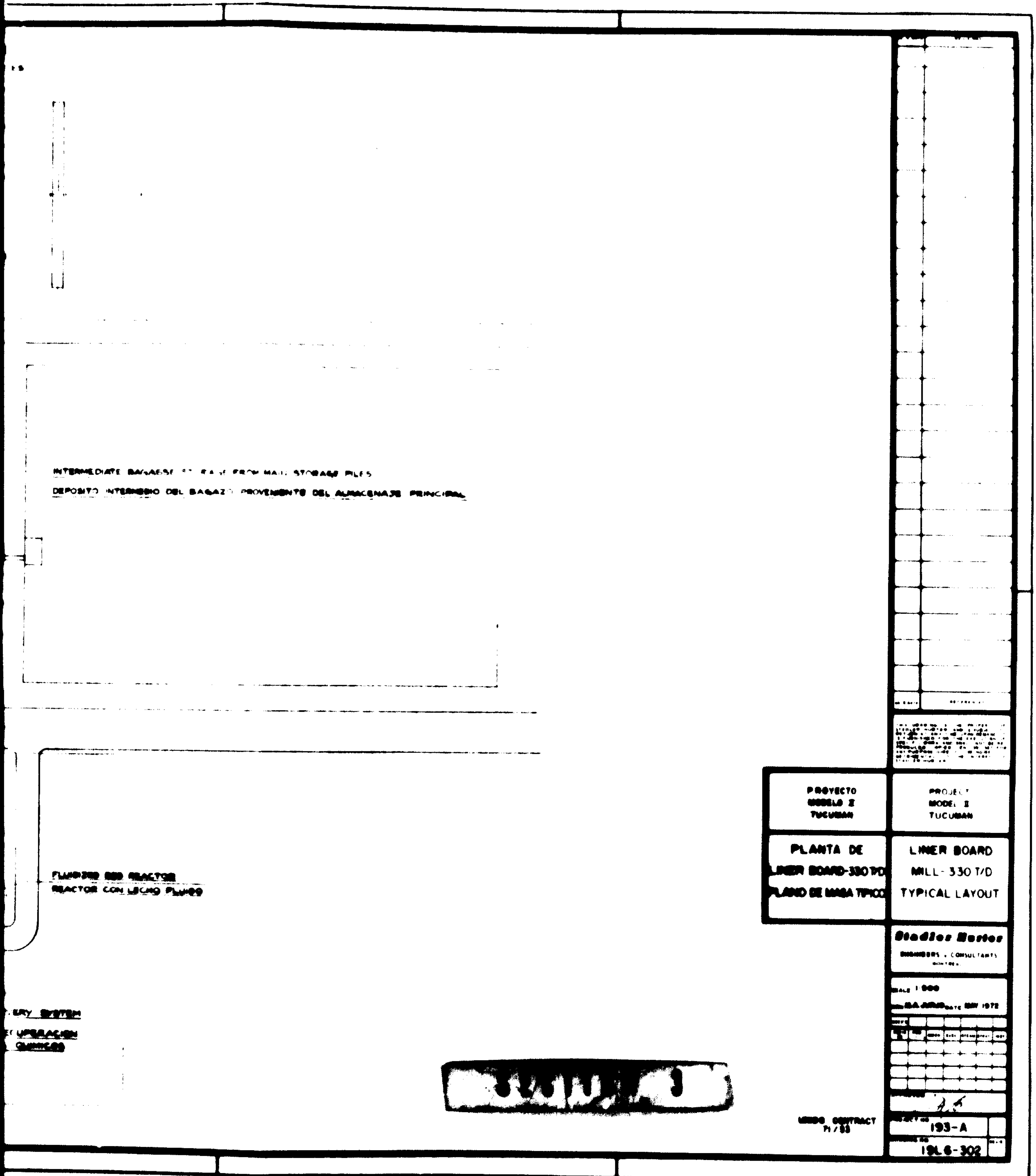
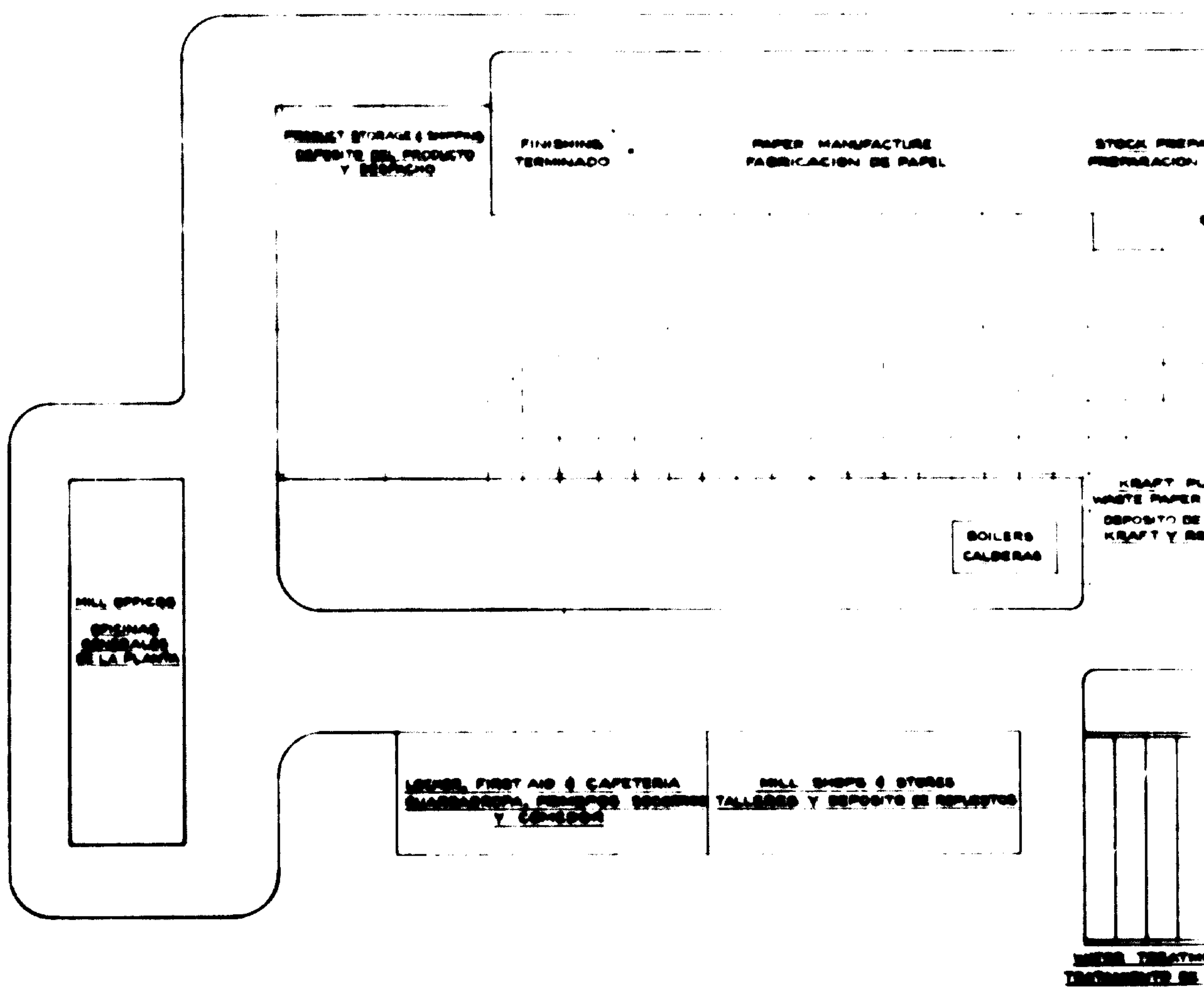
TRATAMIENTO DE EFLUENTES
ESPACIO PARA AMPLIACION FUTURA
FABRICACION DE PAPEL
PREPARACION DE STOCK
LAVADO Y ZARANDEADO
COCINAR
DEPOSITO INTERMEDIO DEL BAGAZO PROVENIENTE DEL ALMACENAJE
PULP KRAFT STORAGE
DEPOSITO DE PASTA KRAFT
BOILERS
CALDERAS
FILTRATE TANKS
TANQUES DE FILTRADO
DEPOSITO DE PASTA (ALTA CONSISTENCIA)
RECAUSTICIZING
RECAUSTICACION
MILL SHOPS & STORES
TALLERES Y DEPOSITO DE REPUESTOS
WATER TREATMENT
TRATAMIENTO DE AGUA
REACTOR CON LECHO FLUIDO
LIME KILN
HORNO DE CAL
CHEMICAL RECOVERY SYSTEM
SISTEMA DE RECUPERACION DE PRODUCTOS QUIMICOS


INTERMEDIATE BAGASSE STORAGE FROM MAIN STORAGE PILES
DEPOSITO INTERMEDIO DEL BAGAZO PROVENIENTE DEL ALMACENAJE PRINCIPAL
FLUIDIZED BED REACTOR
REACTOR CON LECHO FLUIDO
PROYECTO
MODELO II
TUCUMAN
PROJECT
MODEL II
TUCUMAN
PLANTA DE
LINER BOARD-330 T/D
PLANO DE MASA TIPICO
LINER BOARD
MILL - 330 T/D
TYPICAL LAYOUT
Stadler Hurter
ENGINEERS & CONSULTANTS
SCALE 1:800
DATE MAY 1972
CONTRACT
71/33
193-A
19L6-302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PAPER MANUFACTURE
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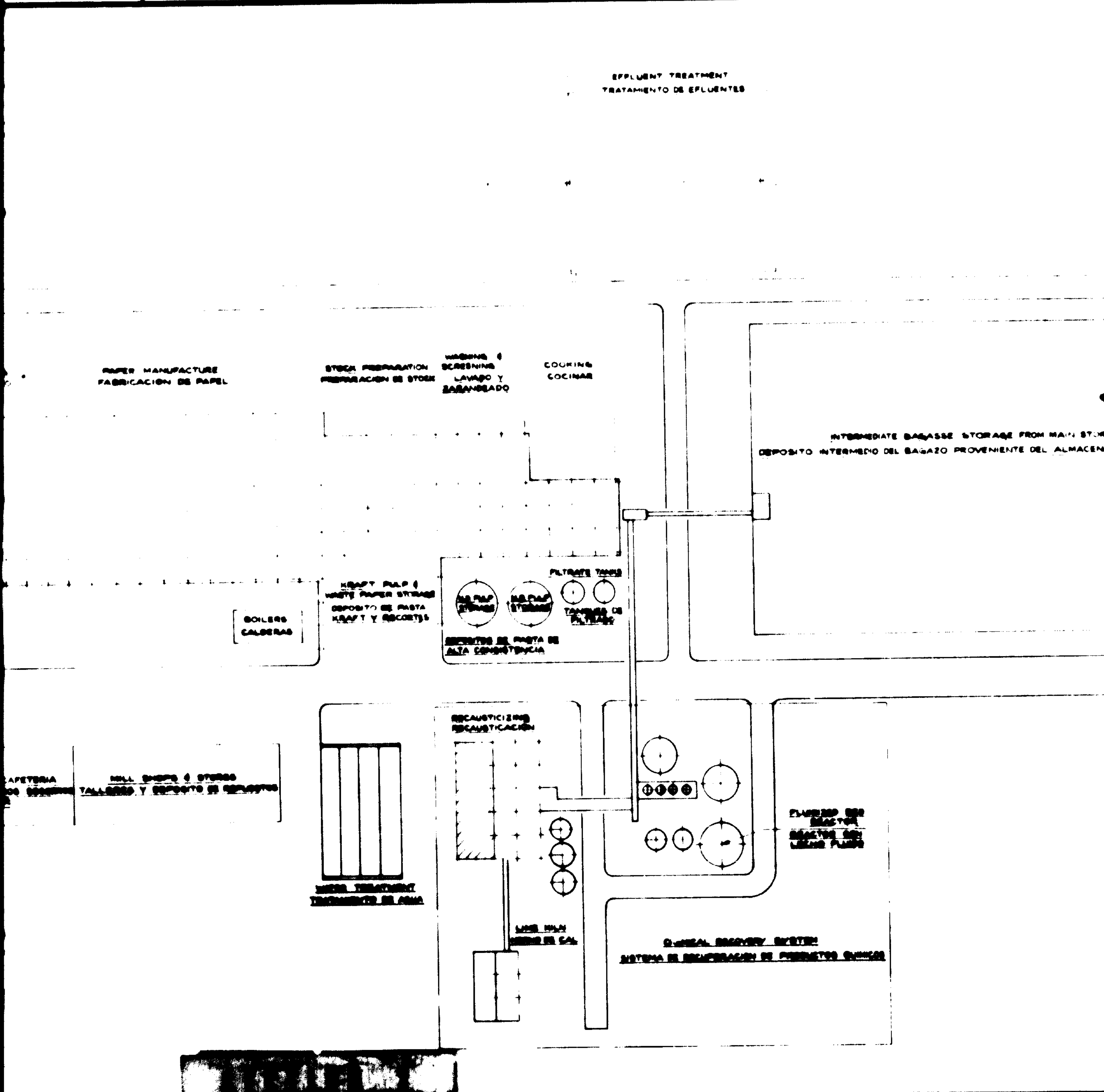
BOILERS
CALDERAS
MILL OFFICES
MILL SHOPS & STORES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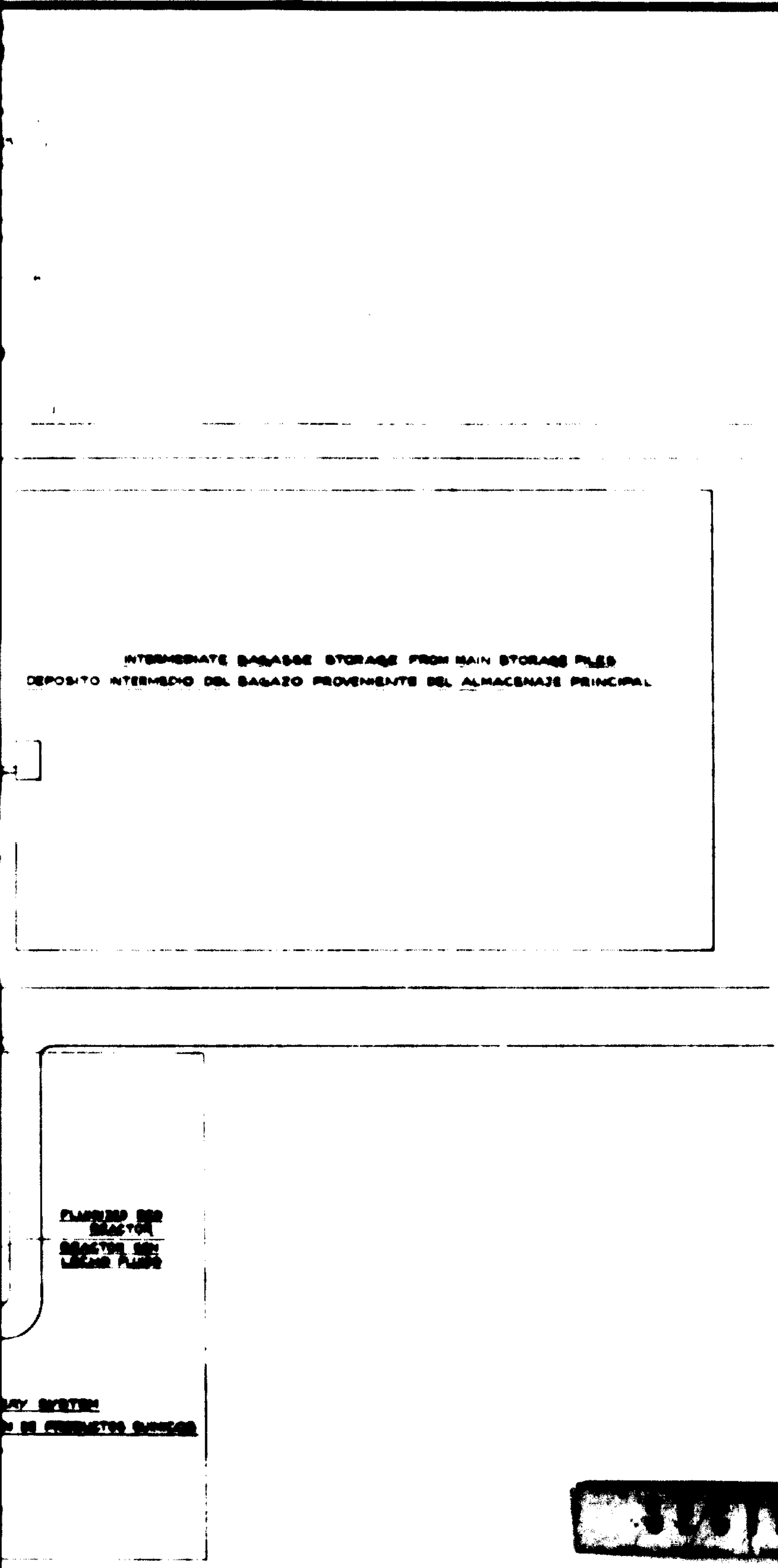
TRATAMIENTO DE EFLUENTES
PAPER MANUFACTURE
FABRICACION DE PAPEL
STOCK PREPARATION
PREPARACION DE STOCK
WASHING & SCREENING
LAVADO Y ZARANDEADO
COOKING
COCINAR
FILTRATE TANKS
TANQUES DE FILTRADO
KRAFT PULP & WASTE PAPER STORAGE
DEPOSITO DE PASTA KRAFT Y RECORTES
BOILERS
CALDERAS
DEPOSITOS DE PASTA DE ALTA CONSISTENCIA
RECAUSTICIZING
RECAUSTICACION
TALLERES Y DEPOSITO DE REPUESTOS
TRATAMIENTO DE AGUA
LIME KILN
HORNO DE CAL
FLUIDIZED BED REACTOR
REACTOR DE LECHO FLUIDO
CHEMICAL RECOVERY SYSTEM
SISTEMA DE RECUPERACION DE PRODUCTOS QUIMICOS



PROYECTO
MODELO II
TUCUMAN

PROJECT
MODEL II
TUCUMAN

PLANTA DE
LINERBOARD Y
CORRUGADO- 496 T/D
PLANO DE MASA TIPICO

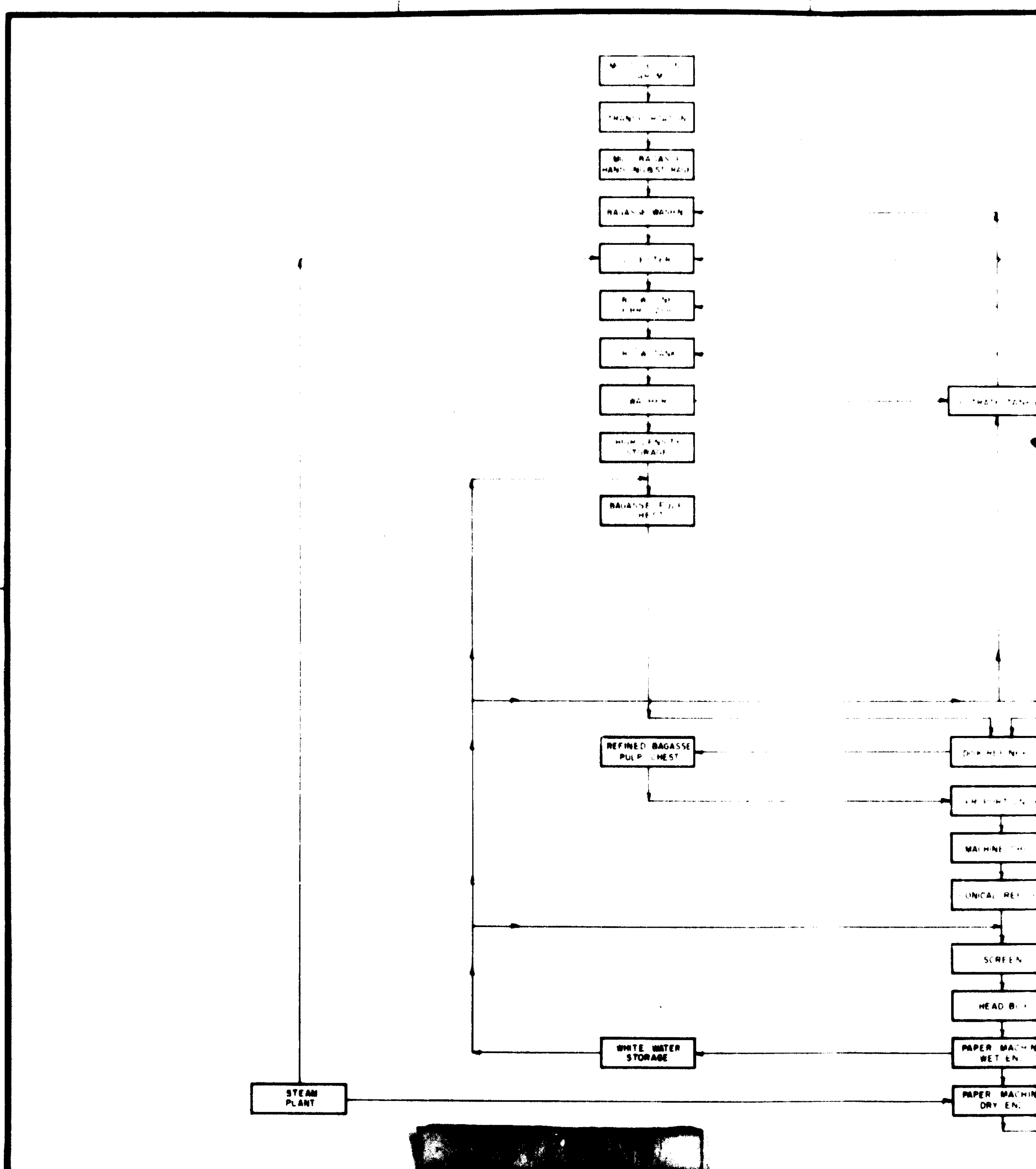
LINER BOARD
AND CORRUGATING
MEDIUM MILL-496 T/D
TYPICAL LAYOUT

Sandwell Hunter
ENGINEERS . CONSULTANTS

SCALE 1:500

UNIDO CONTRACT
71 / 98

1DLG-305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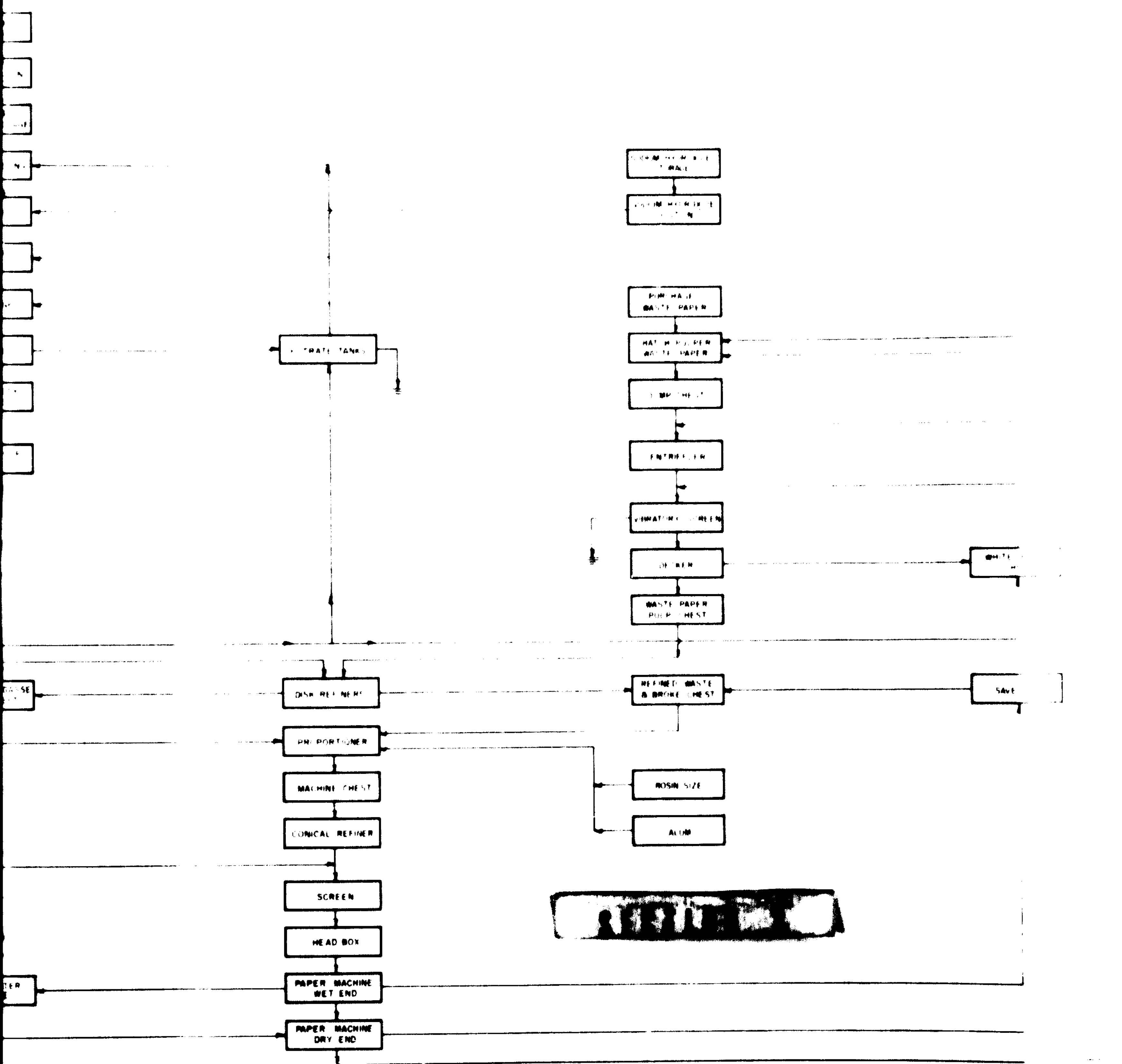
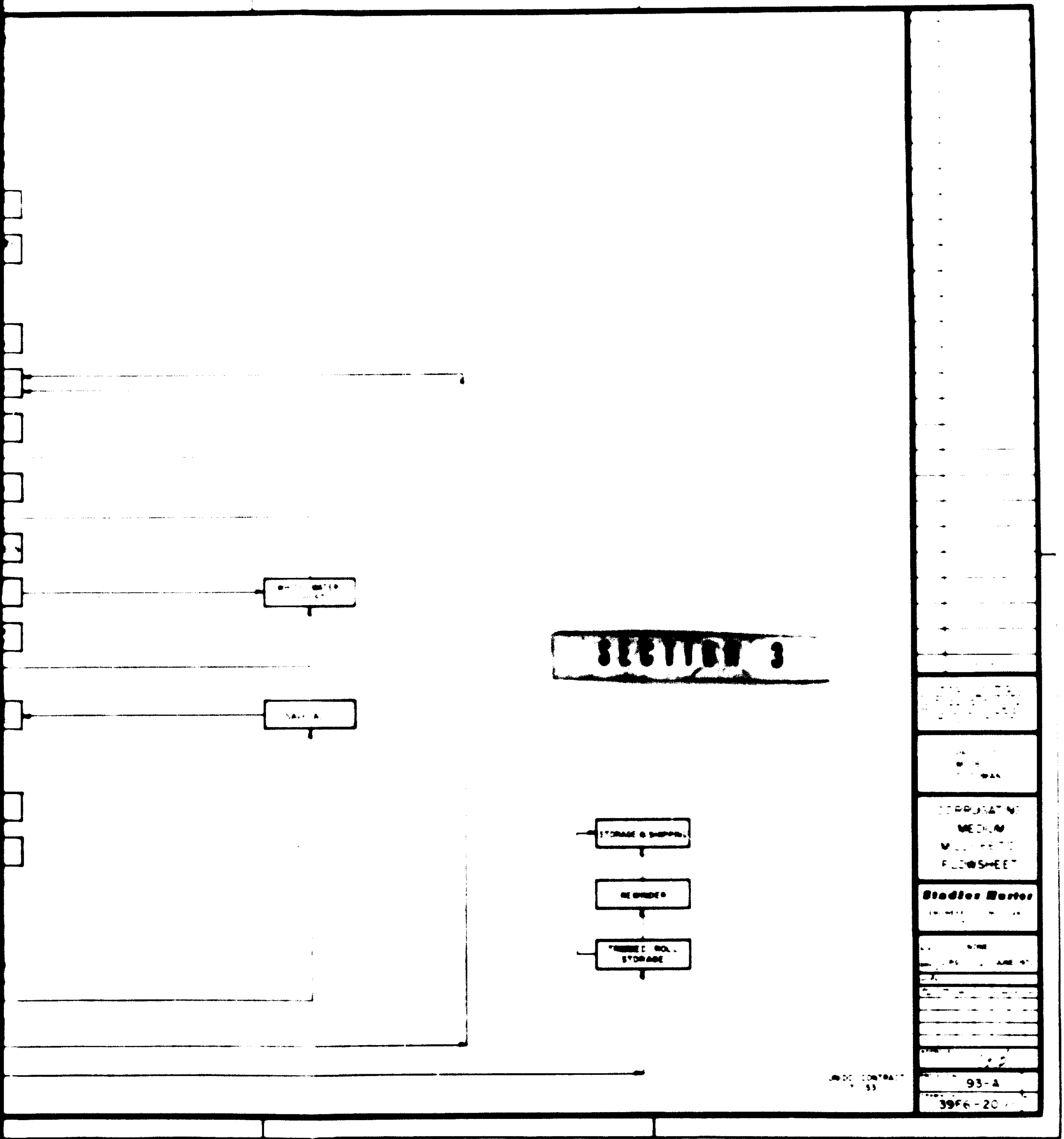
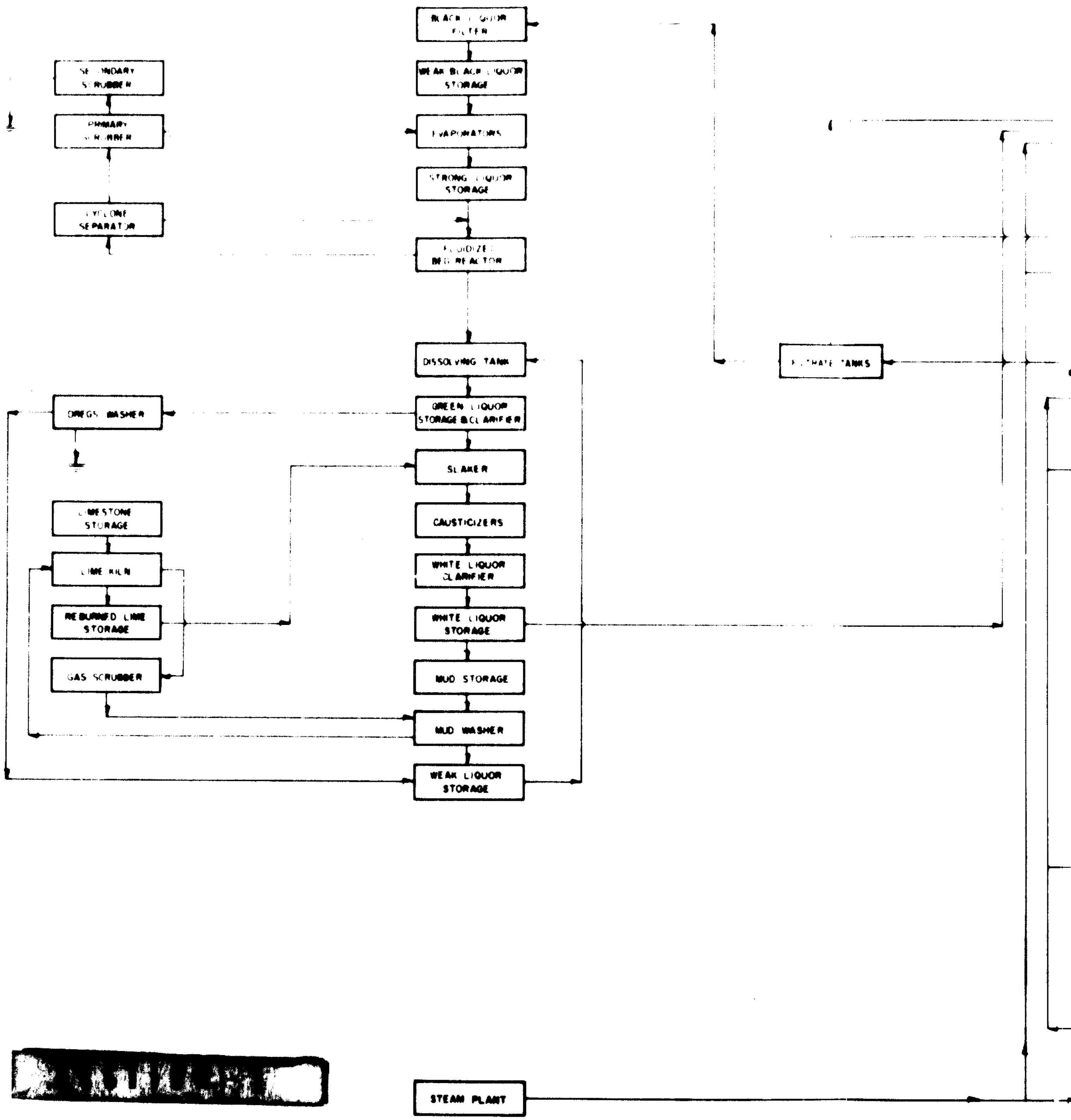
WHITE WATER STORAGE
STEAM PLANT
SCREEN


DISK REFINERS
MACHINE CHEST
CONICAL REFINER
SCREEN
HEAD BOX
PAPER MACHINE WET END
PAPER MACHINE DRY END
ROSIN SIZE
ALUM
REFINED WASTE & BROKE CHEST
SAVE



STORAGE & SHIPPING
REWINDER
TRIMMED ROLL
STORAGE
MEDIUM
FLOWSHEET
93-A

SECTION 3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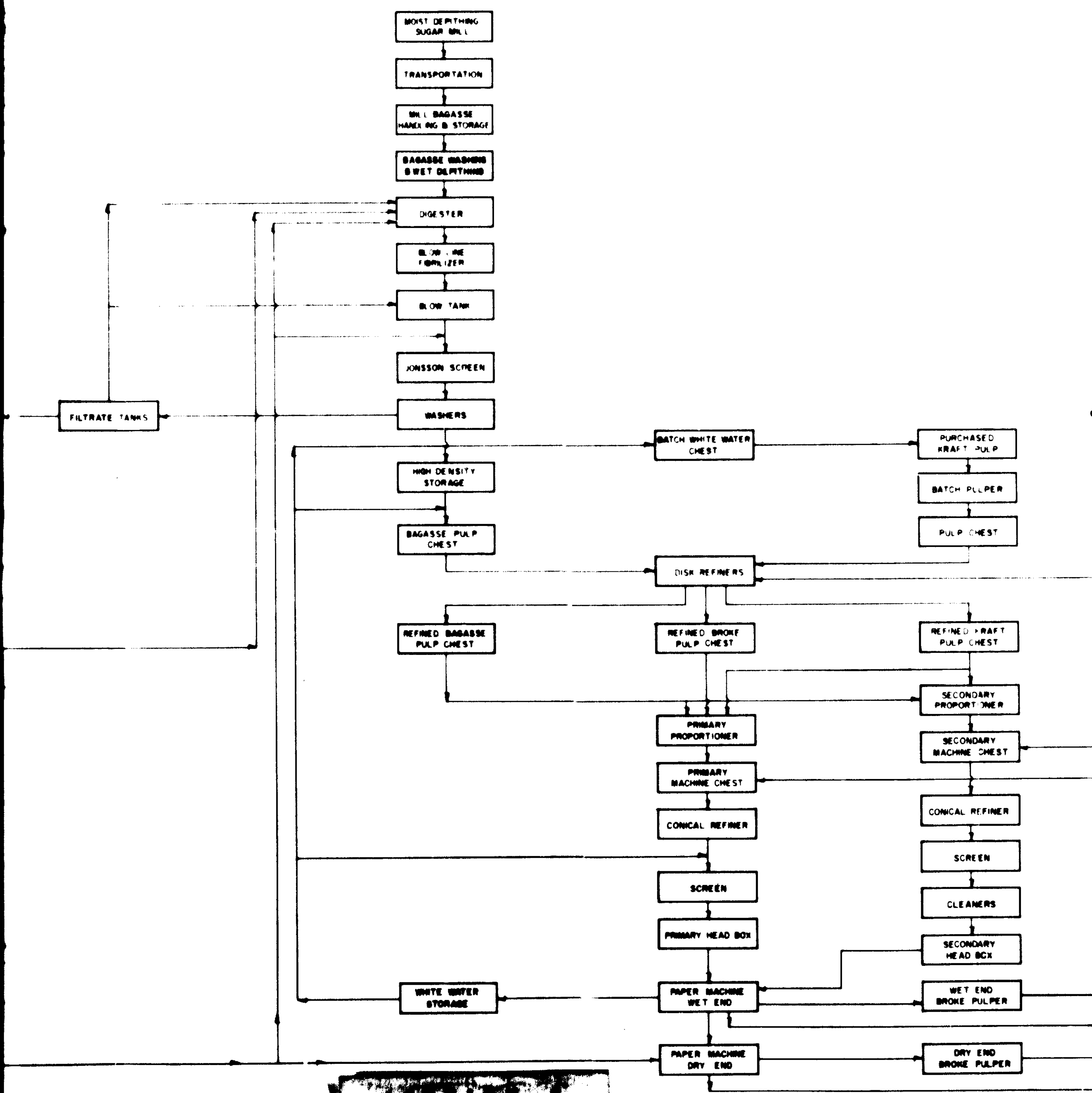
EVAPORATORS
STRONG LIQUOR STORAGE
SEPARATOR
DISSOLVING TANK
FILTRATE TANKS
DREGS WASHER
GREEN LIQUOR STORAGE & CLARIFIER
SLAKER
LIMESTONE STORAGE
CAUSTICIZERS
LIME KILN
WHITE LIQUOR CLARIFIER
REBURNED LIME STORAGE
WHITE LIQUOR STORAGE
GAS SCRUBBER
MUD STORAGE
MUD WASHER
WEAK LIQUOR STORAGE
STEAM PLANT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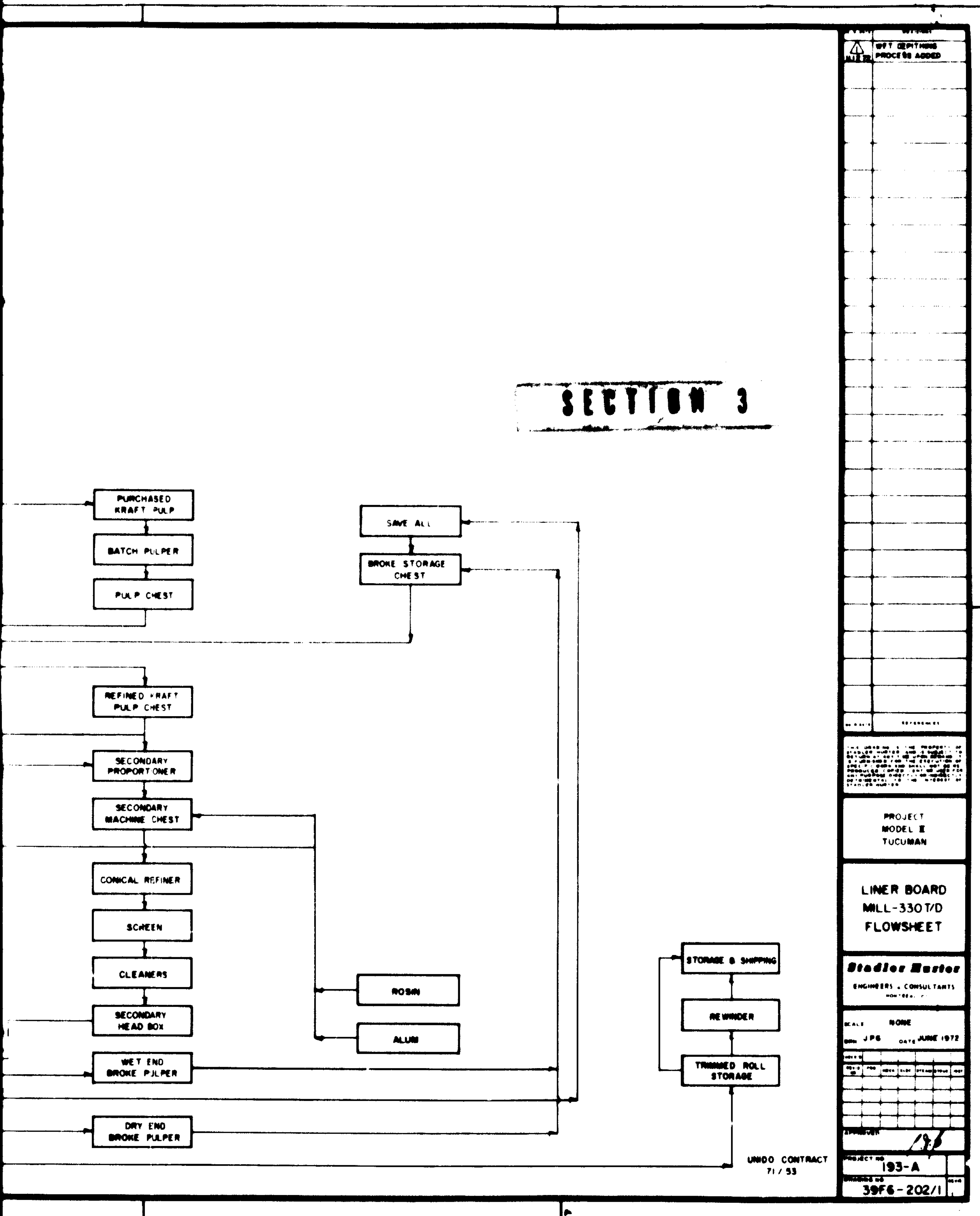
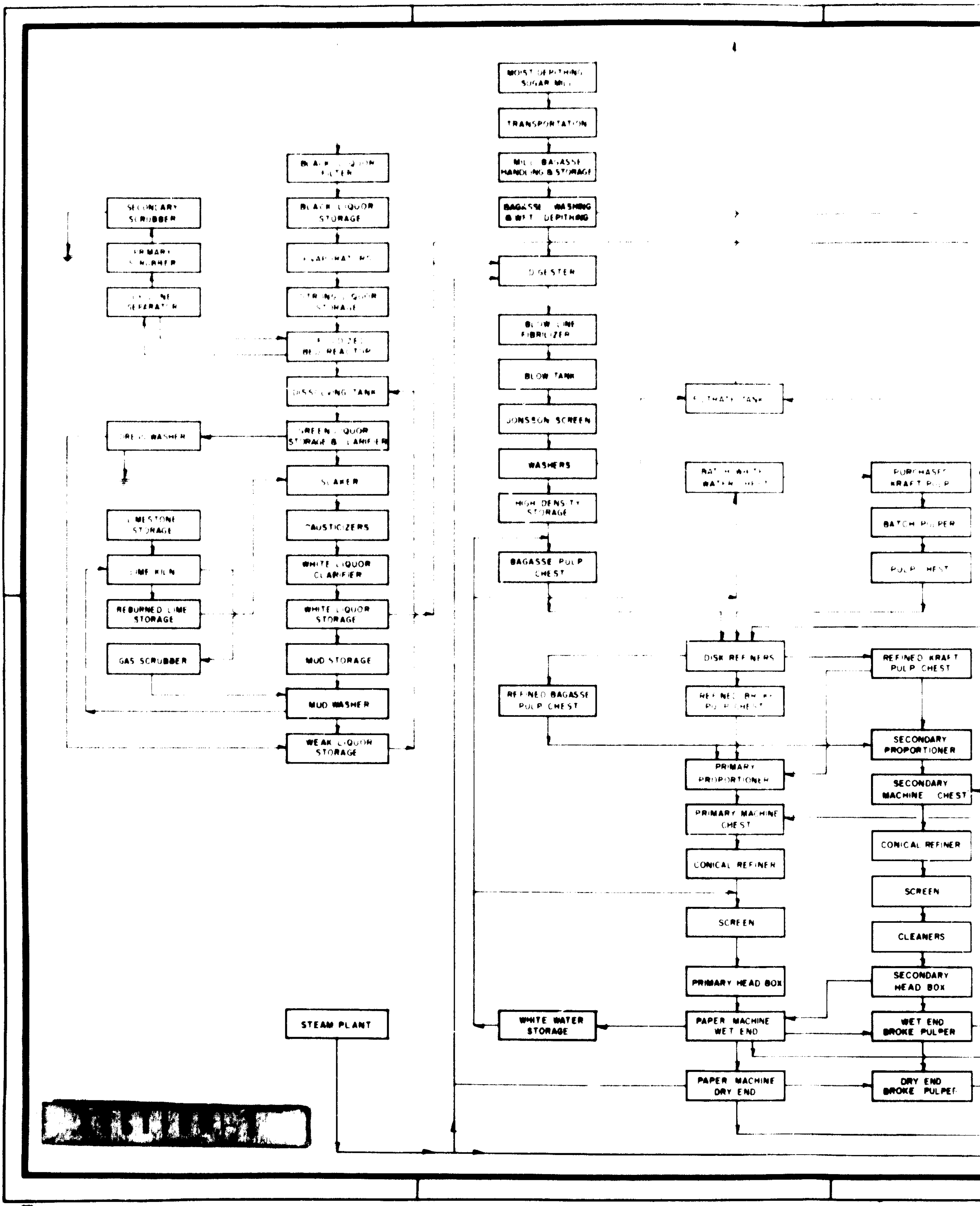
TRANSPORTATION
MILL BAGASSE HANDLING & STORAGE
BAGASSE WASHING & WET DEPITHING
DIGESTER
BLOW LINE FIBRILIZER
BLOW TANK
JONSSON SCREEN
WASHERS
FILTRATE TANKS
HIGH DENSITY STORAGE
BAGASSE PULP CHEST
BATCH WHITE WATER CHEST
PURCHASED KRAFT PULP
BATCH PULPER
PULP CHEST
DISK REFINERS
REFINED BAGASSE PULP CHEST
REFINED BROKE PULP CHEST
REFINED KRAFT PULP CHEST
SECONDARY PROPORTIONER
PRIMARY PROPORTIONER
SECONDARY MACHINE CHEST
PRIMARY MACHINE CHEST
CONICAL REFINER
CONICAL REFINER
SCREEN
SCREEN
CLEANERS
PRIMARY HEAD BOX
SECONDARY HEAD BOX
WHITE WATER STORAGE
PAPER MACHINE WET END
WET END BROKE PULPER
PAPER MACHINE DRY END
DRY END BROKE PULPER

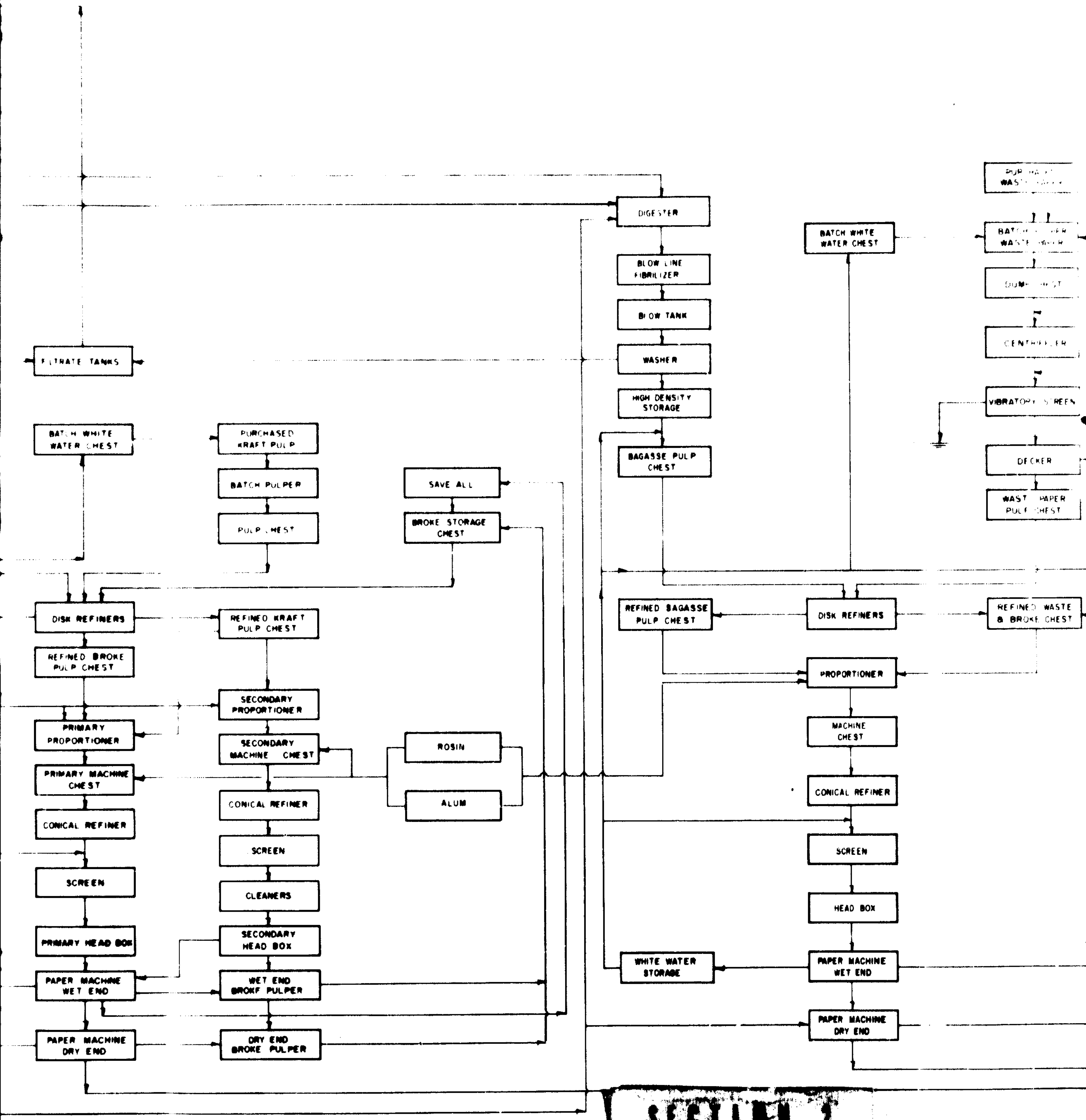
SECTION 3



PURCHASED KRAFT PULP
BATCH PULPER
PULP CHEST
SAVE ALL
BROKE STORAGE CHEST
REFINED KRAFT PULP CHEST
SECONDARY PROPORTIONER
SECONDARY MACHINE CHEST
CONICAL REFINER
SCREEN
CLEANERS
SECONDARY HEAD BOX
WET END BROKE PULPER
DRY END BROKE PULPER
ROSIN
ALUM
STORAGE & SHIPPING
REWINDER
TRIMMED ROLL STORAGE
UNIDO CONTRACT
71 / 53
WET DEPITHING PROCESS ADDED
PROJECT
MODEL II
TUCUMAN
LINER BOARD
MILL-330 T/D
FLOWSHEET
Stadler Hurter
ENGINEERS & CONSULTANTS
SCALE NONE
DRN JPG DATE JUNE 1972
PROJECT NO 193-A
DRAWING NO 39F6-202/1



TRANSPORTATION
MILL BAGASSE HANDLING & STORAGE
BAGASSE WASHING & WET DEPITHING
DIGESTER
BLOW LINE FIBRILIZER
BLOW TANK
JONSSON SCREEN
WASHERS
HIGH DENSITY STORAGE
BAGASSE PULP CHEST
REFINED BAGASSE PULP CHEST
WHITE WATER STORAGE
STEAM PLANT
BLACK LIQUOR STORAGE
DISSOLVING TANK
GREEN LIQUOR STORAGE & CLARIFIER
SLAKER
CAUSTICIZERS
WHITE LIQUOR CLARIFIER
WHITE LIQUOR STORAGE
MUD STORAGE
MUD WASHER
WEAK LIQUOR STORAGE
SECONDARY SCRUBBER
LIMESTONE STORAGE
LIME KILN
REBURNED LIME STORAGE
GAS SCRUBBER
PURCHASED KRAFT PULP
BATCH PULPER
PULP CHEST
DISK REFINERS
REFINED KRAFT PULP CHEST
PRIMARY PROPORTIONER
PRIMARY MACHINE CHEST
CONICAL REFINER
SCREEN
PRIMARY HEAD BOX
PAPER MACHINE WET END
PAPER MACHINE DRY END
SECONDARY PROPORTIONER
SECONDARY MACHINE CHEST
CONICAL REFINER
SCREEN
CLEANERS
SECONDARY HEAD BOX
WET END BROKE PULPER
DRY END BROKE PULPER


DIGESTER
BLOW LINE FIBRILIZER
BLOW TANK
WASHER
HIGH DENSITY STORAGE
BAGASSE PULP CHEST
BATCH WHITE WATER CHEST
FILTRATE TANKS
BATCH WHITE WATER CHEST
PURCHASED KRAFT PULP
BATCH PULPER
PULP CHEST
SAVE ALL
BROKE STORAGE CHEST
DECKER
DISK REFINERS
REFINED KRAFT PULP CHEST
REFINED BROKE PULP CHEST
REFINED BAGASSE PULP CHEST
DISK REFINERS
PROPORTIONER
SECONDARY PROPORTIONER
PRIMARY PROPORTIONER
SECONDARY MACHINE CHEST
ROSIN
ALUM
MACHINE CHEST
PRIMARY MACHINE CHEST
CONICAL REFINER
CONICAL REFINER
CONICAL REFINER
SCREEN
SCREEN
SCREEN
CLEANERS
HEAD BOX
PRIMARY HEAD BOX
SECONDARY HEAD BOX
PAPER MACHINE WET END
WET END BROKE PULPER
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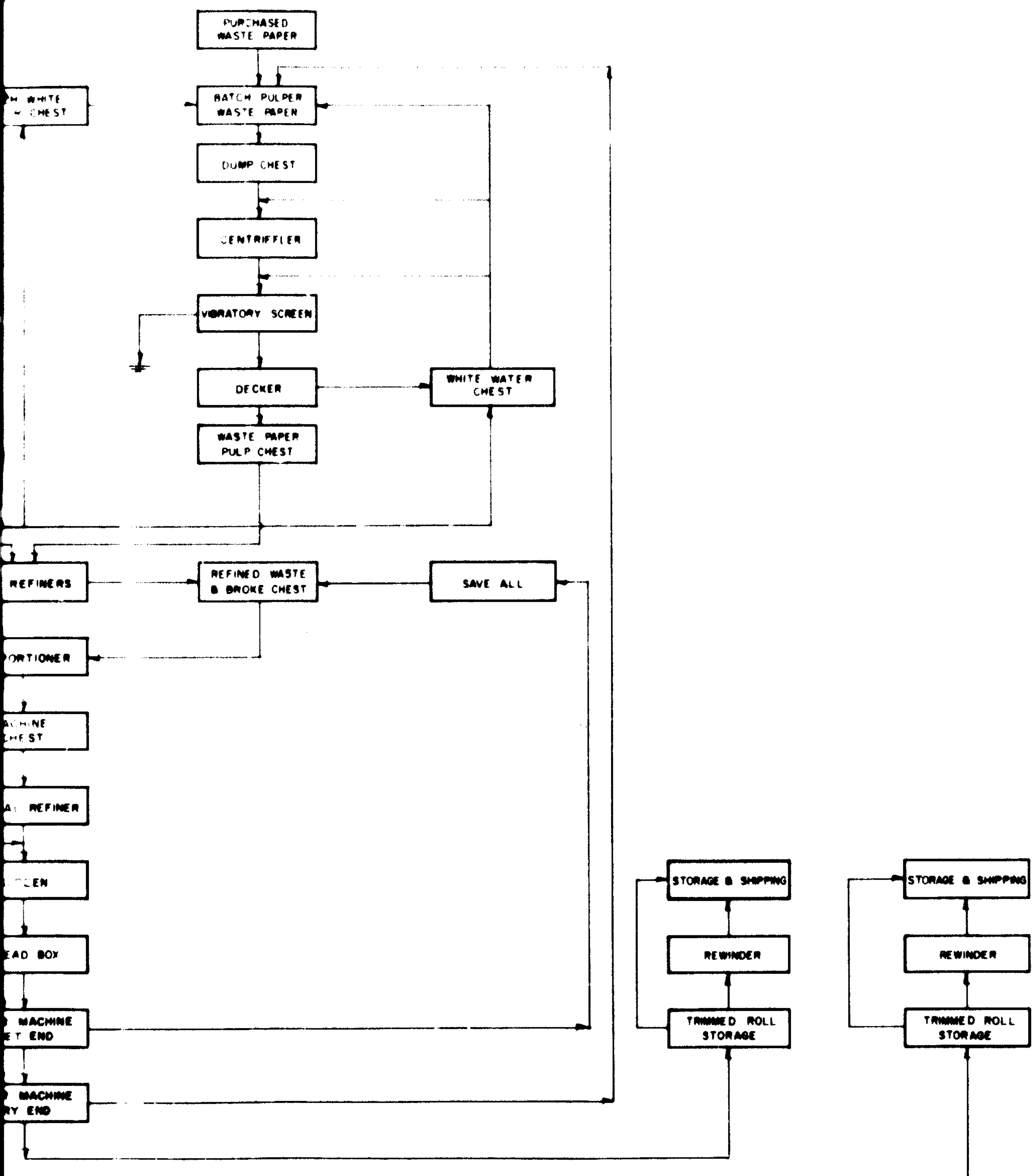
DRY END BROKE PULPER
PAPER MACHINE DRY END



WET DEPITHING PROCESS ADDED

PROJECT MODEL III TUCUMAN

LINER BOARD AND CORRUGATING MEDIUM MILL-496T/D FLOWSHEET

Stadler Hurter
ENGINEERS & CONSULTANTS

SCALE NONE

DRN. J P B DATE JUNE 1972

PROJECT NO 193-A

DRAWING NO 39F6-203/1

UNIDO CONTRACT 71/53

SECTION 3

N. CAPITAL COSTS

N.1 General

The estimated cost of construction of any pulp and paper mill may be divided into a number of components such as the Direct Plant Cost, the Indirect Plant Cost, Development Cost and the Working Capital. These are described in detail in the following sections.

(a) Direct Plant Cost

The Direct Plant cost of mill site, equipment, buildings and civil works, completely erected and with the plant ready to run. The equipment includes all machinery and materials, other than buildings and foundations as well as freight and handling charges required to deliver the equipment to the site.

Buildings and civil works include all buildings, construction and foundations, anchor bolts, building floor and roof drains, roads, sewers, grading and fencing.

The cost of land for each mill site is the estimated price of the area required for the plant under consideration. The assumption has been made that only the necessary area would be purchased initially but, obviously, for the smaller mills it would be wise to ensure that room for later expansion would be available.

Equipment costs are based on preliminary quotations received from manufacturers for major items of equipment and on data from quotations for similar projects that have been engineered recently by Stadler Hurter. It has been assumed that all equipment will be new equipment, primarily manufactured in North America. Certain items which are known to be available in Argentina have been assumed to be purchased there.

Freight and handling charges include all charges for freight to destination, insurance, and special charges for handling. The costs will vary depending on the supplier's location, but have been based on shipment from Montreal to Buenos Aires as a foreign exchange expense and delivery to site as a local expense. It may be possible to ship from Montreal in Argentina vessels but no guarantee of availability can be made at this time.

Building costs and the cost of civil works are based on unit costs for similar construction in Argentina.

Installation labour costs are based on direct estimates of the labour involved using Canadian experience and data on similar construction. Estimates made on this basis have proven in practice to be quite accurate.

As the mill will be far from the manufacturers of the machinery and equipment, a special allowance for the salaries and living expenses of erectors and personnel engaged to assist in the erection and start-up of this machinery has been provided.

The direct plant cost does not include any inventory items.

As the estimates of Direct Capital Cost have been prepared without extensive design work, a contingency allowance of 10% has been provided. The additional funds thus included will cover unforeseen or unforeseeable costs which may reveal themselves during the design or construction stages of the proposed projects.

(b) Indirect Plant Costs

The Indirect Plant Costs are the items described in the following paragraphs.

(i) Preproject Expenses

To initiate any project there are engineering, legal, financial and administrative costs, and expenses for the preparation of feasibility studies, loan applications and the like before the final decision is taken whether to go ahead with the project or not. The preproject expenses depend on the size and complexity of the project. For the projects under study it is estimated that these costs could be 1% to 1-1/2% of Direct Capital Costs.

(ii) Price Escalation

During the construction of the mill there are slight increases in the cost of equipment and labour which have to be added to the Direct Plant Cost. Major increases may also occur due to the lapse of time between when the estimate is made and when the project is implemented. Due to the combination of Argentine and foreign costs which is involved and the unsettled state of Argentine economy, it is difficult even to approximate what escalation might amount to. At the time of implementation all prices and costs will, no doubt, require complete review, but in order to recognize the existing inflationary trend the potential magnitude of price increase has been estimated and included at 7%.

(iii) Purchasing and Expediting

The cost of purchasing and expediting includes the expense involved in purchasing the equipment and ensuring that it is delivered on site on schedule. Normally this item would vary with the size of the project and would amount to about 1% of Direct Capital Costs.

(iv) Construction Overhead

The allowance for construction overhead provides for such items as construction management, warehousing of equipment on site, accounting, construction equipment rental or depreciation, facilities required at the site such as temporary structures, job cleanup, miscellaneous job services and contractor's profit, plus the cost of administration, client's engineering supervision, and overhead during the construction period. Estimated allowance about 1.5-3% of Direct Costs.

(v) Taxes and Duties

In most instances when pulp and paper mills are built the new industry is subject to both federal and state or provincial sales and other taxes and duties. It is our understanding that there will be no charges applicable in this instance due to the application of the law which provides for customs exemption in the case of new industry.

(vi) Engineering

For mills constructed in North America it has been customary for manufacturing enterprises to employ consulting engineers for the specific purpose of designing the project and supervising its construction. This practice is not usual in Europe, where the cost of engineering is often included in the cost of machinery. However, engineering has to be paid for, whether it is shown as a separate item as in this study or whether it is hidden in the cost of machinery.

For the preparation of this estimate it has been assumed that the process, mechanical, and the major part of the electrical engineering would be done by foreign specialists and that civil and structural design would be handled by Argentine engineers. It has also been assumed that equipment installation in particular, and the overall supervision of construction would be carried out largely by foreign personnel, experienced in pulp and paper. The cost of this work would vary between 6.5 and 7.5%, being somewhat higher for the smaller projects.

(vii) Interest During Construction and Start-up

In the determination of interest during construction, for simplicity it has been assumed that the average construction period for any of the mills would be 33 months and the start-up period a further 3 months, with the equipment being purchased and capital being drawn down over the period as required. On this basis, interest during construction has been calculated in accordance with standard loan terms of the Inter-American Development Bank (Banco Interamericano de Desarrollo) (BJD) and Export Development Corporation (EDC - Canada) for both of which the loan periods and interest rates are essentially the same. Interest has been assumed at 8% on capital costs as expended.

(c) Development Costs

This item, although treated separately here, is usually included among the items of Indirect Capital Cost. Development Costs are costs involved in starting up a mill which cannot properly be charged to production. These expenses consist of the following items:

(i) Training

This heading includes two items:

- The cost of expatriate assistance required to supervise the mill(s) in the initial years and to train Argentines for eventual performance of management functions (See Tables 1-G and 2-G)
- The expenditures made to hire and train a nucleus of operating staff for the mill prior to the beginning of the start-up period.

(ii) Start-up

Inevitably during the start-up of any paper mill there is a period of very poor operation before a saleable product can be produced. The costs of labour, materials and services consumed unproductively is usually taken into Indirect Capital Costs. Although a period of three months has been allowed for the start-up, it may reasonably be expected that the total loss during this phase would approximate the costs of one full month of operation at rated production including all variable and fixed costs. This amount has therefore been shown as the cost of starting up.

(iii) A management contract has been discussed and recommended in sub-section G.6. The estimated cost of such a contract would vary from 1.5 to 3.5% of Direct Capital Cost being approx. inversely proportional to the mill size.

(d) <u>Working Capital</u>

There is sometimes a question as to whether this requirement, which can be rather large, should be included as an Indirect Cost or should be shown as a separate item. However, since it forms an appreciable part of Capital which must be provided and therefore must be shown, it is here included with Indirect Costs. The major aspects for which working capital is required are:

(i) <u>Cash and Stores</u>

Cash includes the sums required at all times by the mill to cover payrolls and other expenses from the start of construction and thereafter.

Stores include the stocks of bagasse, chemicals and other consumable items which must be maintained at the mill to be available as and when required. Spare parts are not a stores item in this sense, as they must be included with the mill equipment so that they may be depreciated.

(ii) <u>Inventory</u>

It is expected that in a mill of this nature an average stock of finished pulp and paper will have to be maintained equal to one month's production at the applicable production rate to be able to ship customers' orders promptly and also to allow fairly long runs of each product. The value of this item is equal to one month's production cost.

(iii) Receivables

In Argentina average terms of payments would be 90 days, thus capital equivalent to three months production costs must be kept in reserve to cover the period between shipment and payment.

N.2 Cost Estimates

The total of all of the above items represents the "Plant Capital Costs". Tables 1-N, 2-N, and 3-N show estimated Direct Capital Costs, and Table 4-N shows the corresponding Indirect Capital Costs for the three sizes of mill which are being considered.

Summarizing Tables 1-N, 2-N, 3-N and 4-N therefore, total capital requirements for each of the three alternative mills are estimated as follows.

	Model I	Model II	Model III
		u$s	
Direct Capital Costs	24,000,000	41,500,000	60,300,000
Indirect Capital Costs	10,450,000	17,200,000	23,100,000
Sub-total	34,450,000	58,700,000	83,400,000
Working Capital	2,360,000	6,360,000	8,400,000
Total Capital Required	36,810,000	65,060,000	91,800,000
Pesos Ley 18188	184,050,000	325,300,000	459,000,000

N.3 Foreign Exchange Requirements

The ratio of national to foreign capital required would be essentially identical for each of the three mills.

Taking into account that all labour and all costs estimated in terms 22 to 28 would be Argentine, and allowing realistic proportions of other material cost estimates according to manufacturing facilities existing in Argentina, it is estimated that direct capital would be evenly divided - 50% Argentine and 50% foreign.

Examination of Indirect Capital Costs shows a similar relationship thus foreign exchange in each case would amount to about 1/2 of total capital required.

In computing the foreign exchange requirement it has been considered that paper machines would be purchased from a foreign supplier. Paper machine manufacturing facilities however do exist in Argentina - complete paper machines cannot be made but, particularly for the smaller machine, a substantial percentage of the machinery could be supplied by Argentine firms. A large and well known foreign paper machinery manufacturer has stated that approx. 60% of the smaller machine could be made in Argentina and 30% of the larger one (under license).

If it is considered that paper machines would be purchased as much as possible in Argentina the foreign exchange requirement would be reduced to somewhat less than 50% particularly for the corrugating medium mill where it could become 40-45%.

The possibilities of purchasing the paper machines under such arrangement would require thorough investigation in a detailed feasibility study. The attraction of foreign exchange savings would have to be carefully considered in the light of delivery time and total cost compared with other machines of completely foreign manufacture. The possible problems which might arise would have to be assessed and judgement made accordingly.

N.4 Time Schedule

In accordance with present day delivery times for major equipment and the part experience of the consultant, it is estimated that engineering and construction would take between 2-1/2 and 3 years from initiation of the work until start-up. For simplicity it has been assumed that a period of 2-3/4 years would be required for any of the three alternatives. The calculations of Working Capital and other pertinent items of Indirect Cost have been made on this basis.

A production schedule has also been assumed allowing a start-up period of 3 months at the end of which production at 50% of rated capacity would be anticipated. Costs of start-up have been included as Indirect Capital Expense. During the first year of production it is estimated that production will progress from 50% to 90% of rated and would reach full production by the end of the second year.

Scheduling during the construction, start-up and initial production phases is shown graphically in Fig. I-N.

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TABLE 1-N

COST MODEL I

SUMMARY OF DIRECT CAPITAL REQUIREMENTS

Item		Labour	Material	Total
1	Bagasse Depithing	41,400	345,800	387,200
2	Bagasse Handling & Storage	60,100	401,900	462,000
3	Digester and Pulp Washing	88,300	738,300	826,600
4	Screening and Refining	32,700	251,700	284,400
5	Stock Prep. & Paper Machine	700,000	4,677,800	5,377,800
6	Finish, Store & Ship	9,100	129,500	138,600
7	Heat & Chemical Recovery	-	-	-
8	Electrical (Mill)	410,300	2,729,600	3,139,900
9	Water Supply & Effluent Treat	34,400	313,200	347,600
10	Mobile Equipment	-	407,500	407,500
11	Fire Protection	11,200	88,300	99,500
12	Heating & Ventilation	14,700	114,000	128,700
13	Laboratory & Test Stations	7,800	113,600	121,400
14	Mill Shops and Stores	21,900	371,100	393,000
15	Offices, First Aid, etc.	6,400	124,500	130,900
16	Chemical Handling and Prep.	8,600	97,200	105,800
17	Transport & Communication	2,400	31,800	34,200
18	Steam Plant & System	193,700	1,935,200	2,128,900
19	Misc. & Spare Parts	-	1,436,300	1,436,300
20	Freight & Handling	-	1,050,000	1,050,000

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TABLE 1-N (Cont'd)

Item		Labour	Material	Total
21	Erectors Fees & Living Expenses	-	300,000	300,000
22	Boiler Conversions	-	150,000	150,000
23	Mill Bldgs. & Other Structures	-	2,693,500	2,693,500
24	Land Purchase & Size Prep (20 Ha)	-	500,000	500,000
25	Roads & Rwy Sidings	-	750,000	750,000
26	Bagasse storage pad	-	290,000	290,000
27	Gas supply to mill & ingenios	-	50,000	50,000
28	Power supply to Mill	-	120,000	120,000
29	Duty	-	-	-
	Total	1,643,000	20,210,800	21,853,800
30	Contingency	157,000	1,989,200	2,146,200
	TOTAL DIRECT PLANT COST US$	1,800,000	22,200,000	24,000,000
	$a	9,000,000	111,000,000	120,000,000

Note: Items 22 to 28 would be fully contracted and are local expense thus labour figures not estimated.

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TABLE 2-N

COST MODEL II

SUMMARY OF DIRECT CAPITAL REQUIREMENTS

	Item	Labour	Material	Total
1	Bagasse Depithing	65,000	541,500	606,500
2	Bagasse Handling & Storage	91,600	612,100	703,700
3	Digester & Pulp Washing	130,100	1,003,700	1,133,800
4	Screening & Refining	105,100	873,300	978,400
5	Stock Prep. & Paper Machine	820,800	6,800,800	7,621,600
6	Finish, Store & Ship	18,500	263,500	282,000
7	Heat & Chemical Recovery	300,000	2,700,000	3,000,000
8	Electrical (mill)	570,400	4,399,800	4,970,200
9	Water Supply & Effluent Treat	83,700	831,300	915,000
10	Mobile Equipment	-	679,200	679,200
11	Fire Protection	18,400	147,400	165,800
12	Heating & Ventilation	24,200	190,000	214,200
13	Laboratory & Test Stations	13,000	222,800	235,800
14	Mill Shops and Stores	37,200	618,800	656,000
15	Offices, First Aid, etc.	9,800	208,400	218,200
16	Chemical Handling and Prep.	10,900	127,000	137,900
17	Transport & Communication	4,300	52,700	57,000
18	Steam Plant & System	311,400	3,110,800	3,422,200
19	Misc. & Spare Parts	-	2,534,000	2,534,000
20	Freight & Handling	-	1,360,000	1,360,000

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TABLE 2-N (Cont'd)

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Item		Labour	Material	Total
21	Erectors Fees & Living Expenses	-	547,000	547,000
22	Boiler Conversions	-	300,000	300,000
23	Mill Bldgs. & Other Structures	-	4,640,000	4,640,000
24	Land Purchase & Site Prep.(30 Ha)	-	750,000	750,000
25	Roads & Rwy Sidings	-	800,000	800,000
26	Bagasse Storage Pad	-	450,000	450,000
27	Gas Supply to Mill & Ingenios	-	50,000	50,000
28	Power Supply to Mill	-	200,000	200,000
29	Duty	-	-	-
	Total	2,614,400	35,024,100	37,638,500
30	Contingency	285,600	3,575,900	3,861,500
	TOTAL DIRECT PLANT COST US$	2,900,000	38,600,000	41,500,000
	$a	14,500,000	193,600,000	207,500,000

Note: Items 22 to 28 would be fully contracted and are local expense, thus labour figures not estimated.

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TABLE 3-N

COST MODEL III

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SUMMARY OF DIRECT CAPITAL REQUIREMENTS

Item		Labour	Material	Total
1	Bagasse Depithing	100,300	825,800	926,100
2	Bagasse Handling & Storage	135,900	907,800	1,043,700
3	Digesters & Pulp Washing	210,500	1,753,100	1,963,600
4	Screening and Refining	175,600	1,347,500	1,523,100
5	Stock Prep. & Paper Machines	1,280,600	11,700,000	12,980,600
6	Finish, Store & Ship	25,500	368,100	393,600
7	Heat & Chemical Recovery	400,000	4,400,000	4,800,000
8	Electrical (Mill)	787,700	5,242,100	6,029,800
9	Water Supply & Effluent Treat	100,600	1,224,200	1,324,800
10	Mobile Equipment	-	793,600	793,600
11	Fire Protection	25,800	193,500	219,300
12	Heating & Ventilation	27,700	211,700	239,400
13	Laboratory & Test Stations	17,100	276,100	293,200
14	Mill Shops & Stores	41,000	687,400	728,400
15	Offices, First Aid, etc.	14,400	282,700	297,100
16	Chemical Handling & Prep.	21,100	182,800	203,900
17	Transport & Communication	7,900	88,000	95,900
18	Steam Plant & System	382,400	3,821,200	4,203,600
19	Misc. & Spare Parts	-	3,135,300	3,135,300
20	Freight & Handling	-	2,360,000	2,360,000

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TABLE 3-N (Cont'd)

Item		Labour	Material	Total
21	Erectors Fees & Living Expenses	-	850,000	850,000
22	Boiler Conversions	-	500,000	500,000
23	Mill Bldgs. & Other Structures	-	6,600,000	6,600,000
24	Land Purchase & Site Prep. (50 Ha)	-	1,250,000	1,250,000
25	Roads & Rwy Sidings	-	850,000	850,000
26	Bagasse Storage Pad	-	750,000	750,000
27	Gas Supply to Mill & Ingenios	-	100,000	100,000
28	Power Supply to Mill	-	300,000	300,000
29	Duty	-	-	-
	Total	3,754,100	51,000,900	54,755,000
30	Contingency	395,000	5,150,000	5,545,000
	TOTAL DIRECT PLANT COST US$	4,149,100	56,150,900	60,300,000
	$a	20,745,500	280,754,500	301,500,000

Note: Items 22 to 28 would be fully contracted are are local expense, thus labour figures not estimated.

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TABLE 4-N

SUMMARY OF INDIRECT CAPITAL REQUIREMENTS

Item		CLASS	MODEL I	MODEL II	MODEL III
1)	Price Escalation	A	1,950,000	2,900,000	4,200,000
2)	Purchasing & Expediting	A	250,000	400,000	550,000
3)	Construction Overhead	A	900,000	1,500,000	2,000,000
4)	Engineering & Supervision of Construction	A	1,900,000	3,000,000	4,000,000
5)	Int. During Construction	A	2,700,000	4,800,000	6,700,000
	(Sub-Total-A)		(7,700,000)	(12,600,000)	(17,450,000)
6)	Pre-Project Expense	B	250,000	300,000	350,000
7)	Development Costs	B	900,000	1,200,000	1,300,000
8)	Start-up Expense	B	800,000	2,200,000	3,000,000
9)	Management Contract	B	800,000	900,000	1,000,000
	(Sub-Total-B)		(2,750,000)	(4,600,000)	(5,650,000)
	Total A + B	US$	10,450,000	17,200,000	23,100,000
	WORKING CAPITAL	US$	2,360,000	6,360,000	8,400,000

Note: 1) Sub-Total A is subject to depreciation charges

2) Sub-Total B is expense to be written off against gross profits

3) Working Capital shown only for information

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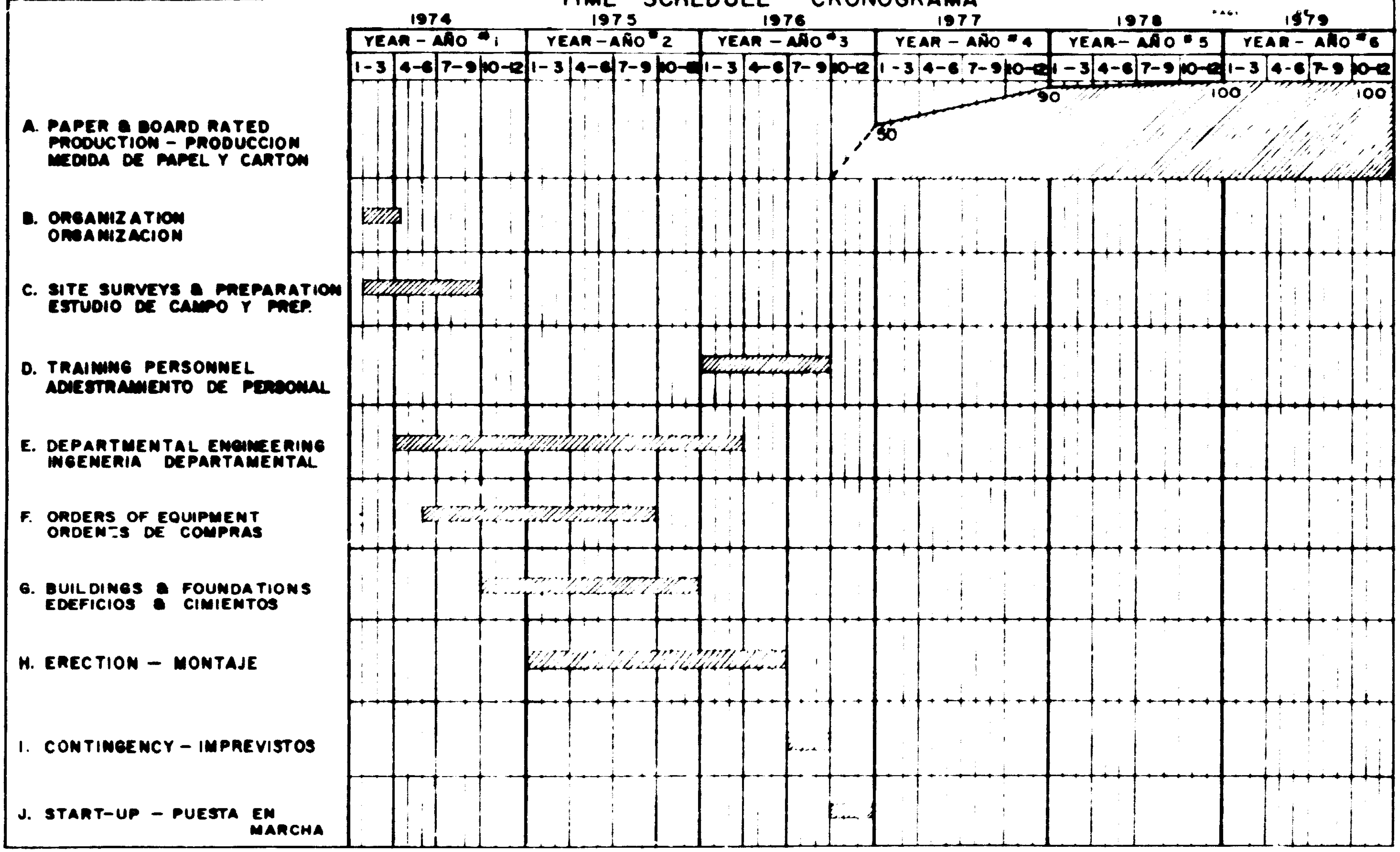
FIG. I-N

MOD I, II, III R-193A 07 3101

TIME SCHEDULE – CRONOGRAMA



O. MANUFACTURING COSTS

0.1 General

For calculation of manufacturing costs the various items have been separated into (1) Variable Costs and (2) Fixed Costs.

Variable costs, in general, will be in proportion to the quantities of finished papers produced. The assumption must be made that all of the items considered will be consumed in proportion to the amount of finished product manufactured.

Fixed costs do not vary with production and represent a total expense which must be charged against whatever quantity of finished product the mill produces.

It should be noted that the above concepts of variable and fixed apply to annual costs. When expressed on a unit product basis annual variable costs become fixed and annual fixed costs become variable.

0.2 Variable and Fixed Costs

(a) Variable Costs

(i) Bagasse - Based on quantities and unit costs developed in Section K.4 and Table 1-L.

(ii) Waste Paper - Based on quantities and unit costs developed in Sections J.3 & E.4

(iii) Kraft Pulp - Based on quantities and unit costs developed in Section J.3 and E.3.

(iv) Pulping Chemicals - Based on quantities and unit costs developed in Section J.3 and Table 1-E.

(v) Papermaking Chemicals - Based on quantities and unit costs developed in Section J.3 and Table 1-E.

(vi) Miscellaneous Chemicals - In addition to the pulping and papermaking chemicals small quantities of a variety of chemicals are required for water and effluent treatment, boiler feedwater treatment, slime control, equipment cleaning etc. A lump sum figure of 6 pesos per ton has been taken to cover these items for corrugating medium and 9 pesos/ton for linerboard.

(vii) Power Consumed - Power required for pulping of bagasse and conversion into paper is estimated according to established standards for each type of paper. Power costs are based on "Regimen Tarifario No. 708/70" according to the extract shown in Subsection F.2. It is assumed that taxes would not be imposed thus the basic power costs only have been applied.

It should be noted that power costs are partly fixed and partly variable. Only the variable portion is shown for this item.

(b) <u>Fixed Costs</u>

(i) Maintenance Materials and Consumable Items - These include paper machine wires and felts, lubricants, refiner plates, thickener wires, screen plates, other consumable spare parts and materials of many kinds. Estimated at 45 pesos per ton of rated production.

The annual cost of such materials has been assumed as fixed because, in general, the equipment and machinery will operate continuously even though production efficiency may vary over a wide range.

(ii) Power Contract - The power supplier must reserve the necessary amount of power for the mill so that it will be available as and when required. Costs are c calculated according to "Regimen Tarifario No. 708/70", assuming that usual taxes will not apply.

(iii) Costs of Personnel - These are considered as fixed because all personnel must be paid regardless of production rate. The various tables in Section G have been used to determine these costs.

(iv) Depreciation - Calculated according to 30 years on buildings and civil works, and 20 years for machinery, equipment and other capital cost times. Straight line basis in both cases.

(v) General Expense - Overhead applied to Head Office and mill administration, personnel salaries and is estimated at 40% of these salaries.

(vi) Insurance - Includes insurance on buildings and their contents and also accident insurance for all personnel. Calculated at current Argentine rates applicable to each type.

(vii) Interest on Capital - This is a book figure calculated at 8% on a decreasing balance over a period of 20 years. The method recommended in United Nations "Manual for Economic Development Projects" has been used to determine the sum which would apply to each alternative.

0.3 Costs of Production

Based on the methods and procedures outlined above total and unit costs for alternative Models I, II and III would be as shown in Tables 0-1, 0-2 and 0-3. (Following pages.)

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TABLE 1-0

MODEL I - MANUFACTURING COSTS

166 ADT/D (6% MOISTURE) CORRUGATING MEDIUM

VARIABLE	Unit	Quantity Per Year	$a Unit Cost	$a Annual Cost	Cost/Ton Product
Bagasse	O.D. tons	83,960	31,199	2,619,468	
Waste Paper	O.D. tons	5,080			
	A.D. tons	(5,640)	310	1,748,400	
Pulping Chemicals for: 46,850 O.D. Tons Bagasse Pulp					
NaOH (120 kg/OD ton Pulp)	Tons	5,620	981	5,513,220	
Papermaking Chemicals					
Alum	Tons	850	575	488,750	
Size	Tons	560	1388	777,280	
Miscellaneous Chemicals				338,600	
Power (consumed)	KWH	55,160,000	*	1,600,000	
Fuel (natural gas)	m^3	22,112,500	**	1,742,300	262.72
				14,828,018	

* See Appendix BX.3

** See Appendix BX.5

TABLE 1-0 (Cont'd)

FIXED	$a Annual Cost	Cost/Ton Product
Maintenance Materials & Consumables	2,539,800	
Power Contract	1,483,400	
Personnel-Head Office	1,031,800	
-Mill Admin.	1,975,000	
-Mill Operating	2,106,300	
-Mill Maint.	675,440	
Depreciation	7,440,000	
General Expense	1,202,000	
Insurance	1,000,000	
Interest on Capital	6,657,000	
	26,110,740	462.63
TOTAL	40,938,758	725.35

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TABLE 2-3

MODEL II - MANUFACTURING COSTS

330 ADT/D (6% MOISTURE) LINERBOARD

VARIABLE	Unit	Quantity Per Year	$a Unit Cost	$a Annual Cost	Cost/Ton Product
Bagasse	O.D. tons	157,280	35,397	5,567,240	
Imported Pulp	O.D. tons	29,730			
	A.D. tons	(33,030)	890	29,396,700	
Pulping Chemicals for: 69,560 O.D. Tons Bagasse Pulp					
Na_2CO_3 (45 kg/Ton Pulp)	Tons	3,130	585	1,831,000	
Limestone (90 kg/O.D. Ton Pulp)	Tons	6,260	33,75	211,300	
Papermaking Chemicals					
Alum	Tons	3,930	575	2,259,800	
Size	Tons	2,250	1388	3,123,000	
Starch	Tons	560	860	481,600	
Miscellaneous Chemicals				1,009,800	
Power	KWH	99,960,000	*	2,898,800	
Fuel	m^3	42,660,600	**	3,293,400	
				50,072,640	446.28

* See Appendix BX.3

** See Appendix BX.5

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TABLE 2-0 (Cont'd)

	$s Annual Cost	Cost/Ton Product
FIXED		
Maintenance Materials & Consumables	5,049,000	
Power Contract	2,686,300	
Personnel-Head Office	1,031,800	
-Mill Admin.	2,424,000	
-Mill Operation	2,694,100	
-Mill Maint.	788,140	
Depreciation	12,675,000	
General Expense	1,382,000	
Insurance	1,642,000	
Interest on Capital	11,361,000	
	41,733,340	371.95
TOTAL	91,805,980	818.23

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TABLE 3-0

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MODEL III - MANUFACTURING COSTS

166 ADT/D (6% MOISTURE) CORRUGATING MEDIUM
+330 ADT/D (6% MOISTURE) LINERBOARD

VARIABLE	Unit	Quantity Per Year	$a Unit Cost	$a Annual Cost	Cost/Ton Product
Bagasse	O.D. tons	241,240	38,768	9,418,000	
Waste Paper	O.D. tons	5,080			
	A.D. tons	(5,640)	310	1,748,400	
Kraft Pulp	O.D. tons	29,730			
	A.D. tons	(33,030)	890	29,396,700	
Pulping Chemicals for:					
46,850 O.D. Tons Corrugating Bagasse Pulp					
Na_2CO_3 (30 kg/O.D. Ton Pulp)	Tons	1,400	585	819,000	
Limestone (60 kg/O.D. Ton Pulp)	Tons	2,800	33,75	94,500	
69,560 O.D. Tons Linerboard Bagasse Pulp					
Na_2CO_3 (45 kg/O.D. Ton Pulp)	Tons	3,130	585	1,831,100	
Limestone (90 kg/O.D. Ton Pulp)	Tons	6,260	33,75	211,300	
Papermaking Chemicals					
Alum	Tons	4,780	575	2,748,500	
Size	Tons	2,810	1388	3,900,300	
Starch	Tons	560	860	481,600	
Miscellaneous Chemicals				1,348,400	

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TABLE 3-0 (Cont'd)

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VARIABLE	Unit	Quantity Per Year	$e Unit Cost	$a Annual Cost	Cost/Ton Product
Power	KWH	155,120,000	*	4,498,800	
Fuel	m^3	64,773,100	**	4,873,700	
				61,370,300	363.91

* See Appendix BX.3

** See Appendix BX.5

FIXED	$a Annual Cost	Cost/Ton Product
Maintenance Materials & Consumables	7,588,800	
Power Contract	4,169,700	
Personnel-Head Office	1,031,800	
-Mill Admin.	2,653,200	
-Mill Operation	3,370,500	
-Mill Maint.	1,081,240	
Depreciation	18,220,000	
General Expense	1,474,000	
Insurance	2,297,000	
Interest on Capital	16,327,500	
	58,213,740	345.20
TOTAL	119,584,040	709.11

P. FINANCIAL AND ECONOMIC ANALYSIS

P.1 Tables

Tables for the evaluation of financial aspects have been prepared and are included as follows: (expressed in Argentine pesos)

- Income Statement Projection
- Resume of Financial Appraisal

In reference to the different cost models, numbering of the above tables is arranged (in the order in which they appear above):

Model I : 1-P, 2-P

Model II : 3-P, 4-P

Model III : 5-P, 6-P

P.2 Methods and Assumptions

(a) General

Tables 1-P, 3-P and 5-P (Income Statement Projection), having been developed by standard methods, require no explanation.

(b) Tables 1-P, 3-P and 5-P

In calculation of the Income Statement Projections (1-P, 3-P and 5-P) the following assumptions have been made:

Col. A: Sales would begin January 1 of the 4th year after the beginning of construction, averaging 70% of rated mill capacity in the 1st operating year, 95% in the 2nd and 100%

the 3rd year and thereafter.

Col. B: The only sales costs which have been included are provincial and municipal taxes on profitable enterprises, which we estimate at about 2%, and the national sales tax, basically 10%, but which will vary over the 1st ten years because application of Law No. 19614 and Decree No. 2558 of the National Executive Authority will grant partial exemptions to the mill.

Other sales expenses have been considered to be included in Manufacturing Costs.

Col. D: Production costs have been taken from Tables 1-0, 2-0 and 3-0 taking into account that variable costs would be 70% in the 1st operating year and 95% in the 2nd.

Col. E: Indirect Capital Costs (not subject to depreciation) would be amortized over a period of five years as permitted by local regulations and standards.

Col. G: Capital has been assumed to be 40% equity and 60% loans, which we consider to be realistic within the actual possibilities of the market. Loans would be over a 13 year period at 8% interest the first payment on principal being made at the end of the first year of operation, i.e. ten equal payments starting the 4th year after the beginning of construction.

For calculation of loan development, basic totals have been estimated as follows: ($[a])

	Model I	Model II	Model III
Capital Costs	172,250,000	293,500,000	417,000,000
Less: Int. on Capital	13,500,000	24,000,000	33,500,000
	158,750,000	269,500,000	383,500,000
Working Capital	11,800,000	31,800,000	42,000,000
	170,550,000	301,300,000	425,500,000
Equity Capital (40%)	68,220,000	120,520,000	170,200,000
Loan Capital (60%)	102,330,000	180,780,000	255,300,000

Col. I: Income tax for limited companies is 33% on net profits. Also the companies must pay 1.5% per year on capital, reserves, and undistributed profits.

A preferential system also exists for enterprises which make investments in the Province of Tucuman. By law No. 19614 and Decree No. 2558 of May 2, 1972, the National Executive Authority established a system of exemption from different taxes, among them the sales tax and taxes on revenue and capital. This relief can be up to 100% in the first four years from start-up and is progressively reduced until it reaches 10% in the tenth year, the last year of exemption. Different promotional zones have been designated, some of which benefit from the 100% exemption already mentioned, and others only up to 60%. For purposes of calculation it has been considered that any of the mills proposed would receive the 60% exemption rete. Income subject to taxes is derived by adding the total of column H (1-P, 3-P and 5-P) to the intereet on capital so that it is not, in fact, a bookkeeping deduction.

Col. N, O, P, R: In order to compere the economic desir-ebility of the three selected models the following anelyeee, shown in the above tables, heve been made. The internal rate of return is the rete of interest which equalizes the real value of the belance of the ennuel caeh flow with the real value of ennual investmente.

Col. M: The period for recovery of capitel (pey-out period) ie derived from Col. L which shows the net cash flows.

Col. P: For calculation of the rate of return on total investment and on equity capital the average annual groee income hae been taken. Thess repreeent reepectively income before taxes, and includes interests.

As this index is only for the purpoee of comparing the three models the "break-even" point hae been calculated on the baeie of profite without teking into account the amorti-sation of Indirect Capital Costs or intereet on loane, i.e. columns E and G of Tables 1-P, 3-P and 5-P, but estimating an allowance for taxes on capital.

P.3 Analysis

To facilitate evaluation of each of the models in respect to the others the individual economic indices in Tables 2-P, 4-P and 6-P have been summarized as shown below:

	Model I	Model II	Model III
Internal Rate of Return	Not	9.6%	9.0%
Years for Pay-back	Viable	6	6 1/2
Return on Investment			
(a) Total Capital		19.6%	17.9%
(b) Equity Capital		48.9%	45.0%
Break-even Point (% Prod.)		77%	84.0%

This summary illustrates the economic advantage of the Model II and Model III alternatives which may be considered of about equal profitability within the limits of error of the present study and without the analysis in greater depth which would be made in a definitive feasibility study. It is evident that the selection of the Model to be implemented would be influenced by the availability of capital.

Looking a little more closely at the Model I and III analyses and examining especially the production costs in Tables 1-0, 2-0 and 3-0, it may be observed that the costs of corrugating medium production improve to a great extent when it is combined with linerboard.

	Model I Corr.	Model II Liner	Model III Corr	Model III Liner
Sales Price per Ton	$[a] 900.00	$[a]1500.00	$[a]900.00	$[a]1500.00
Production Cost	723.33	822.01	554.18	804.69
Gross Profit	176.67	677.99	345.82	795.31

This clearly shows the desirability of implementing Model III if sufficient capital is available. If the availability of capital is reetricted Modal II could be considered because, even if a dividend policy in the order of 10% is assumed, it would be possible to expand to Model III within four to five years with considerable increase in financial advantage through reinvestment of the profits generated.

To consider starting with Model II, or production of linerboard only, the definitive feasibility study would have to be very thorough in respect to the possible markete and potential sources of corrugating medium during the period required to accumulate the funds necessary for expansion to production of both products. The risk would always exist that other enterprises might start up in the interim manufacturing both components of containerboard which could make it difficult to market linerboard only.

P.4 Balance of Payment Benefits

In 1970 Stadler Hurter (with COARA) carried out for the Argentine government an inveetment study for a newsprint mill which had ae its fundamental purpose the achievement of the savings which such an industry would imply. In 1968 imports of newsprint represented an annual expenditure of some U$S 40,000,000. Imports of this magnitude still exist and will continue to be necessary until national production can be initiated, hence the Government has recently issued a call for tenders for this industry. The demand for newsprint is increasing and could reach U$S 100,000,000 worth of imports by 1985.

In the above study it was concluded that, in order to achieve the production levels indicated by the demand projections, the required long fibre pulp would have to be imported. In view of the existing surplus of wood on the Delta of the Panama River it would not be necessary, however, to import the mechanical (or short fibre) portion of the furnish. By means of some substantial increases in planting of wood on the Delta, which were recommended in the report, the essentially short fibre portion of even the largest production visualized could be satisfied using wood from this source.

The study which is here presented shows a large demand for containerboard which will occur during essentially the same period for which the newsprint projections were made and which could require very appreciable imports of finished products of this type.

In the event that industries to produce this latter product are installed in the country, these also will require very large quantities of short fibre pulp which, if not produced from sugar cane bagasse and the production of newsprint is implemented, must inevitably be obtained through importation of short fibre pulps. Based on the short fibre consumption rates of the alternative mills considered the value of such imports could reach U$S 12,000,000 per year.

Although these latter supplies from abroad could eventually be replaced by means of new plantations this would require quite a number of years. At least 7 to 8 years would be required before harvesting of wood planted in the first year would be possible.

MODEL I - IN

Year	A Sales	B Sales Tax and Costs	C Net Receipts A-B	D Manufacturing Costs	E Amortization of Indirect Capital Cost	F Net Operating Income C-D-E	Int on
1							
2							2.80
3							5.0
4	35.557.200	1.882.344	33.674.856	36.490.340	2.750.000	(5.565.484)	8.13
5	48.256.200	2.554.624	45.701.576	40.197.340	2.750.000	2.754.236	7.3
6	50.796.000	2.689.020	48.106.980	40.938.758	2.750.000	4.418.222	6.54
7	50.796.000	3.191.020	47.604.980	40.938.758	2.750.000	3.916.222	5.7
8	50.796.000	3.692.920	47.103.080	40.938.758	2.750.000	3.414.322	4.91
9	50.796.000	4.194.920	46.601.080	40.938.758		5.662.322	4.0
10	50.796.000	4.696.820	46.099.180	40.938.758		5.160.422	3.47
11	50.796.000	5.198.720	45.597.280	40.938.758		4.658.522	2.45
12	50.796.000	5.198.720	45.597.280	40.938.758		4.658.522	1.63
13	50.796.000	5.198.720	45.597.280	40.938.758		4.658.522	81
14	50.796.000	5.198.720	45.597.280	40.938.758		4.658.522	
15	50.796.000	5.198.720	45.597.280	40.938.758		4.658.522	
16	50.796.000	5.198.720	45.597.280	40.938.758		4.658.522	
17	50.796.000	5.198.720	45.597.280	40.938.758		4.658.522	
18	50.796.000	5.198.720	45.597.280	40.938.758		4.658.522	
19	50.796.000	5.198.720	45.597.280	40.938.758		4.658.522	
20	50.796.000	5.198.720	45.597.280	40.938.758		4.658.522	
21	50.796.000	5.198.720	45.597.280	40.938.758		4.658.522	
22	50.796.000	5.198.720	45.597.280	40.938.758		4.658.522	
23	50.796.000	5.198.720	45.597.280	40.938.758		4.658.522	
	998.141.400	90.485.028	907.656.372	813.585.324	13.750.000	80.321.048	53.4
Ano	Ventas	Impuestos y Gastos de Venta	Ingresos Netos	Costo de Produccion	Amortizacion de Costos Indirectos	Resultado Neto Operativo	Inte Sc Cred

TABLE 1-F

MODEL I - INCOME STATEMENT PROJECTION ($a)

E	F	G	H	I	J	K	L
ortization of Indirect apital Cost	Net Operating Income C-D-E	Interest on Debt	Net Income F-G	Income and Capital Tax	Net Income After Taxes F-I	Outlay for Assets	Net Cash Flows J-K
						58.000.000	(58.000.000)
		2.800.000	(2.800.000)			58.000.000	(58.000.000)
		5.600.000	(5.600.000)			54.550.000	(54.550.000)
.750.000	(5.565.484)	8.186.400	(13.733.884)	316.700	(5.882.184)		(5.882.184)
.750.000	2.754.236	7.367.760	(4.613.524)	327.300	2.426.936)		2.426.936
.750.000	4.418.222	6.549.120	(2.130.898)	352.800	4.065.422		4.065.422
.750.000	3.916.222	5.730.480	(1.814.258)	380.000	3.536.222		3.536.222
.750.000	3.414.322	4.911.840	(1.497.518)	500.000	2.914.322		2.914.322
	5.662.322	4.093.200	1.569.122	2.096.000	3.566.322		3.566.322
	5.160.422	3.274.560	1.885.662	2.623.700	2.536.722		2.536.722
	4.658.522	2.455.920	2.202.602	3.082.700	1.575.822		1.575.822
	4.658.522	1.637.280	3.021.242	3.736.900	921.622		921.622
	4.658.522	818.640	3.839.882	4.438.900	219.622		219.622
	4.658.522		4.658.522	4.890.000	(231.478)		(231.478)
	4.658.522		4.658.522	4.806.000	(147.478)		(147.478)
	4.658.522		4.658.522	4.806.000	(147.478)		(147.478)
	4.658.522		4.658.522	4.806.000	(147.478)		(147.478)
	4.658.522		4.658.522	4.806.000	(147.478)		(147.478)
	4.658.522		4.658.522	4.806.000	(147.478)		(147.478)
	4.658.522		4.658.522	4.806.000	(147.478)		(147.478)
	4.658.522		4.658.522	4.806.000	(147.478)		(147.478)
	4.658.522		4.658.522	4.806.000	(147.478)		(147.478)
	4.658.522		4.658.522	4.806.000	(147.478)		(147.478)
3.750.000	80.321.048	53.425.200	26.913.648	65.999.000	14.322.048	170.550.000	
Amortizacion de Costos Indirectos	Resultado Neto Operativo	Intereses Sobre Creditos	Beneficio Neto	Impuesto a Los Reditos y Capital	Beneficio Neto de Impuestos	Gastos de Bienes de Uso	Flujo de Fondos Neto

K Outlay for Assets	L Net Cash Flows J-K	M Cumulated Cash Flows	N Present Value Factor 5%	O Present Value of Cash Flows M x N
58.000.000	(58.000.000)	(58.000.000)	0.9524	(55.239.000)
58.000.000	(58.000.000)	(116.000.000)	9070	(52.606.000)
54.550.000	(54.550.000)	(170.550.000)	8638	(47.120.000)
	(5.882.184)	(176.432.184)	8227	(4.839.000)
	2.426.936	(174.005.248)	7835	1.902.000
	4.065.422	(169.939.826)	7462	3.034.000
	3.536.222	(166.403.604)	7107	2.513.000
	2.914.322	(163.489.282)	6768	1.972.000
	3.566.322	(159.922.960)	6446	2.299.000
	2.536.722	(157.386.238)	6139	1.557.000
	1.575.822	(158.962.060)	5847	921.000
	921.622	(158.040.438)	5568	513.000
	219.622	(157.820.816)	5303	116.000
	(231.478)	(158.052.294)	5051	(117.000)
	(147.478)	(158.199.772)	4810	(71.000)
	(147.478)	(158.347.250)	4581	(68.000)
	(147.478)	(158.494.728)	4363	(64.000)
	(147.478)	(158.642.206)	4155	(61.000)
	(147.478)	(158.789.684)	3957	(58.000)
	(147.478)	(158.937.162)	3769	(56.000)
	(147.478)	(159.084.640)	3589	(53.000)
	(147.478)	(159.232.118)	3419	(50.000)
	(147.478)	(159.379.596)	3256	(48.000)
170.550.000				(145.623)
Gastos de Bienes de Uso	Flujo de Fondos Neto	Acumulado Flujo de Fondos	Factor de Valor Presente	Valor Presente de Flujo de Fondos

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FORM 3

Stadler Hurter ENGINEERS • CONSULTANTS	UNIDO	REFERENCE NO.	INDEX NO.	SERIAL NO.
DATE July 20, 1972		R-193A	07	3101

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TABLE 2-P MODEL I - RESUME OF FINANCIAL APPRAISAL
The project economically is not viable

MODEL II

Year	A Sales	B Sales Tax and Costs	C Net Receipts A-B	D Manufacturing Costs	E Amortization of Indirect Capital Cost	F Net Operating Income C-D-E	G Inter- on D
1							
2							4.300.
3							9.600.
4	117.810.000	6.006.400	111.303.600	76.784.140	4.600.000	30.419.460	14.462.
5	159.385.000	8.151.600	151.733.400	89.302.340	4.600.000	57.831.060	13.016.
6	168.300.000	8.580.600	159.719.400	91.805.980	4.600.000	63.313.420	11.569.
7	168.300.000	10.145.000	158.155.000	91.805.980	4.600.000	61.749.020	10.123.
8	168.300.000	11.709.400	156.590.600	91.805.980	4.600.000	60.134.620	8.677.
9	168.300.000	13.273.800	155.026.200	91.805.980		63.220.220	7.231.
10	168.300.000	14.838.200	153.461.800	91.805.980		61.655.820	5.784.
11	168.300.000	16.402.600	151.897.400	91.805.980		60.091.420	4.338.
12	168.300.000	16.402.600	151.897.400	91.805.980		60.091.420	2.392.
13	168.300.000	16.402.600	151.897.400	91.805.980		60.091.420	1.446.
14	168.300.000	16.402.600	151.897.400	91.805.980		60.091.420	
15	168.300.000	16.402.600	151.897.400	91.805.980		60.091.420	
16	168.300.000	16.402.600	151.897.400	91.805.980		60.091.420	
17	168.300.000	16.402.600	151.897.400	91.805.980		60.091.420	
18	168.300.000	16.402.600	151.897.400	91.805.980		60.091.420	
19	168.300.000	16.402.600	151.897.400	91.805.980		60.091.420	
20	168.300.000	16.402.600	151.897.400	91.805.980		60.091.420	
21	168.300.000	16.402.600	151.897.400	91.805.980		60.091.420	
22	168.300.000	16.402.600	151.897.400	91.805.980		60.091.420	
23	168.300.000	16.402.600	151.897.400	91.805.980		60.091.420	
	3.307.095.000	285.938.800	3.021.156.200	1.813.594.120	23.000.000	1.179.562.080	93.943
Ano	Ventas	Impuestos y Gastos de Venta	Ingresos Netos	Costo de Produccion	Amortizacion de Costos Indirectos	Resultado Neto Operativo	Inter- Sob Credi

TABLE 3-F

MODEL II - INCOME STATEMENT PROJECTION ($a)

[illegible]	F	G	H	I	J	K	L	Cum[illegible]
...zation Direct ...l Cost	Net Operating Income C-D-E	Interest on Debt	Net Income F-G	Income and Capital Tax	Net Income After Taxes F-I	Outlay for Assets	Net Cash Flows	Cum... C... F...
						90.000.000	(90.000.000)	(90.
		4.300.000	(4.[illegible])		(4.[illegible])	90.000.000	(94.300.000)	(134.
		9.600.000	(9.6[illegible])		(9.600.000)	121.300.000	(130.900.000)	(315.
.000	30.419.460	14.462.400	15.957.[illegible]	2.314.600	28.104.860		28.104.860	(237.
.000	57.831.060	13.016.160	44.314.9[illegible]0	8.423.500	4[illegible].4[illegible].560		49.407.560	(233.
.000	63.313.420	11.569.920	51.743.[illegible]	9.[illegible].200	5[illegible].711.220		53.711.220	(134.
.000	61.749.020	10.123.630	51.625.340	9.368.500	51.830.420		51.830.420	(132.
.000	60.184.620	8.677.440	51.507.130	12.399.300	47.735.320		47.735.320	(84.
	63.220.220	7.231.200	55.989.020	15.889.100	47.331.120		47.331.120	(37[illegible]
	61.655.820	5.784.960	55.870.860	18.667.900	42.987.920		42.987.920	5.
	60.091.420	4.338.720	55.752.700	21.467.000	38.624.420		38.624.420	
	60.091.420	2.892.480	57.198.940	24.719.600	35.371.820		35.371.820	
	60.091.420	1.446.240	58.645.130	28.060.600	32.030.820		32.030.820	
	60.091.420		60.091.420	30.294.900	29.796.520		29.796.520	
	60.091.420		60.091.420	31.523.000	28.568.420		28.568.420	
	60.091.420		60.091.420	31.523.000	28.568.420		28.568.420	
	60.091.420		60.091.420	31.523.000	28.568.420		28.568.420	
	60.091.420		60.091.420	31.523.000	28.568.420		28.568.420	
	60.091.420		60.091.420	31.523.000	28.568.420		28.568.420	
	60.091.420		60.091.420	31.523.000	28.568.420		28.568.420	
	60.091.420		60.091.420	31.523.000	28.568.420		28.568.420	
	60.091.420		60.091.420	31.523.000	28.568.420		28.568.420	
	60.091.420		60.091.420	31.523.000	28.568.420		28.568.420	
...0.000	1.179.562.080	93.943.200	1.085.618.880	465.414.300	699.747.780	139.300.000		
...zacion Costos ...rectos	Resultado Neto Operativo	Intereses Sobre Creditos	Beneficio Neto	Impuesto a Los Reditos y Capital	Beneficio Neto de Impuestos	Gastos de Bienes de Uso	Flujo de Fondos Neto	Ac... F... F...

L Net Cash Flows	M Cumulated Cash Flows	N Present Value Factor 8%	O 10%	P Present Value of Cash Flow 8% L x N	R 10% L x M
(90.000.000)	(90.000.000)	0.9259	0.9091	(83.331.000)	(81.819.000)
(94.300.000)	(184.800.000)	8573	8264	(81.272.000)	(78.343.000)
(130.900.000)	(315.700.000)	7938	7513	(103.908.000)	(98.345.000)
28.104.360	(287.595.140)	7350	6830	20.657.000	19.196.000
49.407.560	(238.190.580)	6806	6209	33.627.000	30.677.000
53.711.220	(184.479.360)	6302	5645	33.849.000	30.320.000
51.880.420	(132.598.940)	5835	5132	30.272.000	26.625.000
47.735.320	(84.813.620)	5403	4665	25.818.000	22.292.000
47.331.120	(37.482.500)	5002	4241	23.675.000	20.073.000
42.987.920	5.505.420	4632	3855	19.912.000	16.572.000
38.624.420		4289	3505	16.566.000	13.538.000
35.371.820		3971	3186	14.046.000	11.270.000
32.030.820		3677	2897	11.778.000	9.279.000
29.796.520		3405	2633	10.146.000	7.846.000
28.568.420		3152	2394	9.005.000	6.839.000
28.568.420		2919	2176	8.339.000	6.216.000
28.568.420		2703	1978	7.722.000	5.651.000
28.568.420		2502	1799	7.148.000	5.139.000
28.568.420		2317	1635	6.619.000	4.671.000
28.568.420		2145	1486	6.128.000	4.245.000
28.568.420		1987	1351	5.676.000	3.860.000
28.568.420		1893	1228	5.254.000	3.508.000
28.568.420		1703	1117	4.865.000	3.191.000
				32.591.000	(7.499.000)
Flujo de Fondos Neto	Acumulado Flujo de Fondos	Factor de Valor Presente		Valor Presente de Flujo de Fondos	

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TABLE 4-P

MODEL II - RESUME OF FINANCIAL APPRAISAL

1. Internal Rate of Return: 9.6%

2. Payback Period

   On Equity Capital

   9 years from start of construction
   6 years from start of operation

3. Return on Investment

   a. On Total Capital

   $$\frac{\text{Average Gross Income}}{\text{Assets}}$$

   $$\frac{58,978,100}{301,300,000} = 19.6\%$$

   b. On Equity Capital

   $$\frac{58,978,100}{120,520,000} = 48.9\%$$

4. Break-Even Point

   Approximately 77% of production

MODEL

Year	A Sales	B Sales Tax and Costs	C Net Receipts A–B	D Manufacturing Costs	E Amortization of Indirect Capital Cost	F Net Operating Income C–D–E
1						
2						
3						
4	153.367.200	7.922.444	145.444.756	101.172.950	5.650.000	38.621.806
5	203.141.200	10.751.924	197.389.276	116.515.525	5.650.000	75.223.750
6	219.096.000	11.317.820	207.773.180	119.584.040	5.650.000	82.544.140
7	219.096.000	13.398.620	205.697.380	119.584.040	5.650.000	80.463.340
8	219.096.000	15.479.420	203.616.580	119.584.040	5.650.000	78.382.540
9	219.096.000	17.560.120	201.535.880	119.584.040		81.951.840
10	219.096.000	19.640.920	199.455.080	119.584.040		79.871.040
11	219.096.000	21.721.720	197.374.280	119.584.040		77.790.240
12	219.096.000	21.721.720	197.374.280	119.584.040		77.790.240
13	219.096.000	21.721.720	197.374.280	119.584.040		77.790.240
14	219.096.000	21.721.720	197.374.280	119.584.040		77.790.240
15	219.096.000	21.721.720	197.347.280	119.584.040		77.790.240
16	219.096.000	21.721.720	197.347.280	119.584.040		77.790.240
17	219.096.000	21.721.720	197.347.280	119.584.040		77.790.240
18	219.096.000	21.721.720	197.347.280	119.584.040		77.790.240
19	219.096.000	21.721.720	197.347.280	119.584.040		77.790.240
20	219.096.000	21.721.720	197.347.280	119.584.040		77.790.240
21	219.096.000	21.721.720	197.347.280	119.584.040		77.790.240
22	219.096.000	21.721.720	197.347.280	119.584.040		77.790.240
23	219.096.000	21.721.720	197.347.280	119.584.040		77.790.240
	4.305.236.400	378.453.628	3.926.782.772	2.370.201.195	28.250.000	1.523.331.576
Ano	**Ventas**	**Impuestos y Gastos de Venta**	**Ingresos Netos**	**Costo de Produccion**	**Amortizacion de Costos Indirectos**	**Resultado Neto Operativo**

TABLE 5-[illegible]

MODEL III - INCOME STATEMENT [illegible]

E Amortization of Indirect Capital Cost	F Net Operating Income C-D-E	G Interest on Debt	H Net Income F-G	I Income and Capital Tax	J Net Income After Taxes F-I	K Outlay for Assets	L Net Cash Flows
						130.000.000	(130.000.
		6.800.000	(6.800.000)			130.000.000	(130.000.
		13.600.000	(13.600.000)			165.500.000	(165.500.
5.650.000	38.621.806	20.424.000	18.197.306	2.969.200	35.652.600		35.652.
5.650.000	75.223.750	18.381.600	56.842.151	11.002.600	64.221.150		64.221
5.650.000	82.544.140	16.339.200	66.204.940	1[illegible].619.[illegible]	69.924.540		69.924.
5.650.000	80.463.340	14.296.800	66.166.540	12.937.100	67.476.240		67.476.
5.650.000	78.382.540	12.254.400	66.128.140	16.339.300	62.043.240		62.043.
	84.951.840	10.212.000	71.739.840	20.[illegible]75.700	61.076.140		61.076.
	79.871.040	8.169.600	71.701.440	24.549.200	55.321.840		55.321.
	77.790.240	6.127.200	71.663.040	28.256.200	49.534.040		49.534.
	77.790.240	4.084.800	73.705.440	32.573.400	45.216.840		45.216.
	77.790.240	2.042.400	75.747.840	37.015.400	40.774.840		40.774.
	77.790.240		77.790.240	39.979.700	37.810.540		37.810.
	77.790.240		77.790.240	41.508.000	36.822.240		36.822.
	77.790.240		77.790.240	41.508.000	36.822.240		36.822.
	77.790.240		77.790.240	41.508.000	36.822.240		36.822.
	77.790.240		77.790.240	41.508.000	36.822.240		36.822.
	77.790.240		77.790.240	41.508.000	36.822.240		36.822.
	77.790.240		77.790.240	41.508.000	36.822.240		36.822.
	77.790.240		77.790.240	41.508.000	36.822.240		36.822.
	77.790.240		77.790.240	41.508.000	36.822.240		36.822.
	77.790.240		77.790.240	41.508.000	36.822.240		36.822.
28.250.000	1.523.331.576	132.732.000	1.395.599.577	612.739.4[illegible]	920.452.170	425.500.000	
Amortizacion de Costos Indirectos	Resultado Neto Operativo	Intereses Sobre Creditos	Beneficio Neto	Impuesto a Los Reditos y Capital	Beneficio Neto de Impuestos	Gastos de Bienes de Uso	Flujo Fondo Net[illegible]

K ..tlay ..or ..sets	L Net Cash Flows	M Cumulated Cash Flows	N Present Value Factor 8%	O 10%	P Present Value of Cash Flows 8%	R 10%
..000.000	(130.000.000)	(130.000.000)	0.9259	0.9091	(120.367.000)	(118.183.000)
.000.000	(130.000.000)	(260.000.000)	8573	8264	(111.449.000)	(107.432.000)
.500.000	(165.500.000)	(425.500.000)	7938	7513	(131.374.000)	(124.340.000)
	35.652.600	(389.847.400)	7350	6830	26.205.000	24.351.000
	64.221.150	(325.626.250)	6806	6209	43.709.000	39.875.000
	69.924.540	(255.701.710)	6302	5645	44.067.000	39.473.000
	67.476.240	(188.225.470)	5835	5132	39.372.000	34.629.000
	62.043.240	(126.822.230)	5403	4665	33,522.000	28.943.000
	61.076.140	(65.106.090)	5002	4241	30.550.000	25.902.000
	55.321.840	(9.784.250)	4632	3855	25.625.000	21.327.000
	49.534.040	39.749.790	4289	3505	21.245.000	17.362.000
	45.216.840		3971	3186	17.956.000	14.406.000
	40.774.840		3677	2897	14.993.000	11.813.000
	37.810.540		3405	2633	12.875.000	9.956.000
	36.822.240		3152	2394	11.606.000	8.815.000
	36.822.240		2919	2176	10.784.000	8.012.000
	36.822.240		2703	1978	9.953.000	7.283.000
	36.822.240		2502	1799	9.213.000	6.624.000
	36.822.240		2317	1635	8.532.000	6.020.000
	36.822.240		2145	1486	7.898.000	5.472.000
	36.822.240		1987	1351	7.317.000	4.975.000
	36.822.240		1839	1228	6.772.000	4.521.000
	36.822.240		1703	1117	6,271,000	4.113.000
..500.000					24.975.000	(26.043.000)
..astos de ..ienes de Uso	Flujo de Fondos Neto	Acumulado Flujo de Fondos	Factor de Valor Presente		Valor Presente de Flujo de Fondos	

TABLE 6-F

MODEL III - RESUME OF FINANCIAL APPRAISAL

1. Internal Rate of Return: 9.0%

2. Payback Period

On Equity Capital

9 1/2 years from start of construction
6 1/2 years from start of operation

3. Return on Investment

a. On Total Capital

$$\frac{\text{Average Gross Income}}{\text{Assets}}$$

$$\frac{76,417,000}{425,500,000} = 17.9\%$$

b. On Equity Capital

$$\frac{76,417,000}{170,200,000} = 45.0\%$$

4. Break-Even Point

Approximately 84% of production

Q. DEVELOPMENT PROGRAMS

The Contract requests two suggested development programs - one to 1975, and a second to 1985.

Between the present and 1975 little can be done from the point of view of increasing production of papers from bagasse in Tucuman - at least not within the scope of this study. The two existing paper manufacturing plants operated by Ingenio Leales and Celulosa Argentina are of very small capacity and the possibilities of expanding either of them to the production ranges being considered are remote. It is true that usually it is less costly to expand an existing facility than to build a new one but this applies within a limited range. It is considered that contemplation of increasing capacity of the existing mills into a range of 5-8 times present production (Model I) would be impractical.

It has already been established that the most optimistic date for a completely new project would be 1977 and that even this timing can be achieved only by prompt and decisive action. Thus the most constructive immediate program would be to initiate at once the various procedures necessary for implementation of a new project (See Section R).

Financial analysis indicates that the Model II and Model III alternatives are about equally attractive and that, from this point of view, Model I appears unattractive. If Model II has once been constructed the expansion to include production of corrugating medium (Model I), however, presents a much improved financial prospect.

If the availability of capital may be ignored the logical selection would be to proceed as rapidly as possible with implementation of Model III which, it is estimated, could be in full production by 1979. Since even this large mill would consume less than one half of the bagasse available and the market analysis shows that by 1982 (conservatively) demand will exist for a similar quantity of the same papers, a duplicate project could conceivably be planned for implementation before 1985.

It would seem unlikely that such large amounts of capital could be made available within such a short period.

An alternative program would be to proceed with Model II as the initial step and then, using the profits generated, to add the production of corrugating medium at a later time. The indications are that the addition could be totally financed in this way before 1984, thus making the expansion very remunerative.

A definite feasibility study for either or both of these possible alternatives would indicate definitely which one would yield optimum benefits both nationally and provincially.

R. IMPLEMENTATION OF PROJECTS

R.1 General

Inasmuch as prefeasibility studies are often considered as interesting economic exercises and are frequently shelved or long postponed, even if very viable projects are indicated, because of a lack of understanding as to how projects can be or should be implemented, and also because such projects as do proceed on the basis of prefeasibility studies often take years to implement or develop poorly, this section on the implementation of projects has been prepared as a general guide.

Once a decision is reached on the basis of this prefeasibility study to proceed with one or more of the projects proposed, several further steps are required. In generally chronological order these are:

- Formation of a company or government agency that will carry out and operate the project.
- Selection of consulting engineers.
- Preparation of a definitive feasibility study suitable for financing the project.
- Financing arrangements.
- Selection of the method of contracting for the supply of the plant.
- Construction of the plant.

- Arrangement for the training of operating and management personnel.
- Arrangement for start-up and management contracts.

Dependent on the method and organization selected for implementation some of these various steps may be combined, some may be eliminated, and the sequence may vary, but, in general, all must receive consideration for effective and efficient planning. Training and management contracts have been treated under Section G but the other steps also merit discussion in some detail.

R.2 Formation of Company

Unless administration of the project can be assumed by an existing private company or government agency, the first step is the formation of an organization that will carry out the project and be the eventual owner and operator of the proposed plant. Initially, such a company or agency would require a very small staff, but personnel involved should have full power of decision concerning all aspects of the project and should be provided with sufficient funds to proceed with further steps. Later on, upon completion of the definitive feasibility study, the staff would be increased and, at that stage, should consist of at least a President or Managing Director, a General Manager, an Engineer with technical experience of the process involved, an Office Manager, an Accountant, as well as the necessary clerical help. This staff should be augmented as work proceeds until, at the time of mill start-up, the entire management staff is available.

If the project is taken up by an existing company or agency, it is possible to proceed through the phases of selection of consultant and the definitive feasibility study using company or agency personnel, but at least one or two senior people should be assigned specifically to the project. Once the definitive feasibility study is completed, a subsidiary company or division within the organization should be set up with a staff having full power of decision concerning all aspects of the project and provided with sufficient funds to proceed with further steps. The initial staff of this subsidiary company or division would be similar to that mentioned above and would be augmented in the same manner as the work proceeds.

Unless a definite entity with funds and powers of decision is set up it is very difficult for the necessary work to proceed efficiently thus this step assumes primary importance.

R.3 Selection of Consultants

If the project is taken up by an existing firm or agency which has a staff of experienced technical personnel capable of conducting feasibility studies, the selection of consultants may be unnecessary. In most cases, however, to obtain an accurate and definitive feasibility study suitable for financing negotiations,

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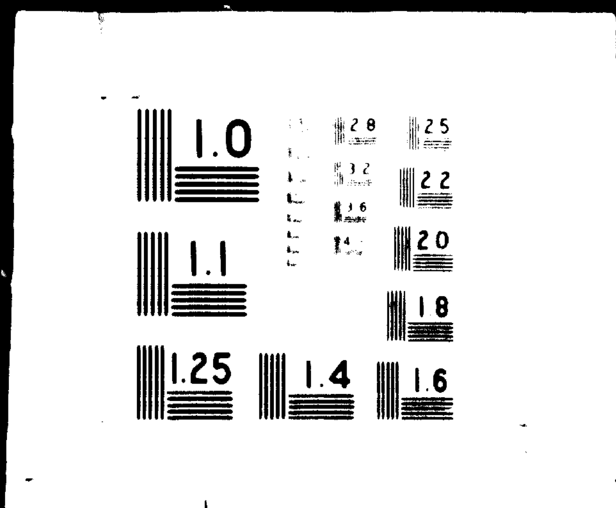

the engagement of an independent and experienced consulting firm will be essential. If the administrative organization which has been set up has experienced supervisory personnel the formation of a subsidiary or division specifically for execution of the project may sometimes be omitted but, even under these circumstances it is preferable to first form a subsidiary or division to administer the project to ensure that highest priority and full attention will be given continuously to the planned implementation.

The consultants may be engaged for the feasibility study alone, or for the partial or total implementation of the project as well. The consultants must be experienced in the design of the type of plant proposed and, if for technological reasons the consulting firm must be a foreign firm, the foreign consultants should be obliged to associate themselves with a local engineering firm. This will not only permit savings in foreign exchange, but will also result in a plant that is better adapted to local conditions.

The preparation of feasibility studies by equipment suppliers is not recommended, even though such services may be offered "free of charge". The suppliers' prime interest is the sale of equipment and any such "free" study will naturally favour the equipment and processes marketed by the supplier, sometimes with disregard for suitability and/or economy. Since the equipment supplier usually is not responsible for civil and structural work, miscellaneous local costs, and product manufacturing costs, these may be estimated on the low side to make the project appear more viable, thereby increasing the possibility of the sale of equipment. Such engineering is not, and cannot be, at no cost, it is eventually included in equipment pricing. Although it may be argued that nothing is lost by obtaining such a "free" study (since there is usually no obligation to purchase the suppliers' equipment), the information obtained is of little or no value as a basis for financing, especially as regards civil and local costs. In fact, most financial institutions will not provide financing on the basis of an equipment supplier's study. About the only exception is financing by supplier's credits, which would apply only to the equipment furnished by the supplier.

Although nothing is lost through obtaining a "free" feasibility study from equipment suppliers, these studies are of limited value and generally result in a loss of time until a study acceptable to financial institutions is prepared.

The best assurance of obtaining a feasibility study that is reliable and acceptable to financial institutions is for the study to be prepared independently either by the company's own staff (if they have experienced technical people available) or by an independent consulting engineering firm.

R.4 Preparation of a Definitive Feasibility Study

A definitive feasibility study is prepared with sufficient accuracy to allow negotiation of financing for a specific project. Some of the work of the prefeasibility study will be repeated, but with a much higher degree of accuracy in order to arrive at market figures, raw material availability and cost, capital costs and manufacturing costs which can be thoroughly substantiated. The work for such a study would include:

- thorough market survey including, if possible, advance commitments by potential customers,
- thorough raw material survey covering availability, quantities and qualities and delivered cost at mill site with, if possible, advance commitments from potential suppliers,
- thorough analysis of the plant site, including preliminary ground surveys and soil tests to allow accurate estimates of civil and structural engineering costs, and thorough hydrographic surveys to establish the quantities and qualities and temperatures of water available,
- laboratory analyses of raw materials and pulping tests,
- an analysis establishing the type and size of project,
- complete description of the proposed project,
- preparation of detailed flowsheets with material balances,
- complete preliminary plant layouts showing equipment locations and building dimensions,

- capital cost estimates of a high degree of accuracy to allow financial budgets to be finalized. (This would involve calling preliminary quotations on all major equipment and obtaining unit costs for civil and structural work),
- preparation of very accurate manufacturing cost estimates,
- very complete economic analysis, including discounted cash flow, rate of return, break-even analysis, sensitivity analysis, etc.

Although changes will inevitably occur as any project proceeds, a definitive feasibility study is required as the sound basis on which to proceed. Such a study would cost in the order of $200,000.00. However, many portions of such a feasibility study, such as the site survey, soil tests, water analyses, flowsheets, plant layout, equipment lists and sizing etc., can be used in subsequent stages of the development of the project since they actually constitute a portion of the preliminary engineering. Subsequent engineering costs would accordingly be reduced to some extent.

R.5 Financing the Project

(a) General

Once the feasibility study has been completed, the next step is to arrange for the financing of the project. In most cases, there are two types of capital required to finance a project - equity capital and loan capital.

Equity capital is the portion of funds pledged by the participants of the company desiring to build the project. Equity capital is also known as share capital since shares are usually issued to raise the money required from the participants or owners. Loan capital is borrowed on the basis of project viability and arrangement must be made to cover interest charges and repayment of the principal.

In a few cases, projects are implemented with equity capital alone, but because of the large amount of capital required for pulp and paper projects, it is more common to use loan capital in addition to equity capital. Usually most lending agencies require that equity capital should amount to at least 30% and preferably 40% of the total capital required. The range of debt/equity ratio may be increased or decreased according to indications of the economic analysis of the project in question and, in particular, the degree of risk (economical, political, market) involved.

Loan capital may be obtained in the following forms:

- untied or direct loans,
- debentures,
- buyer's credits,
- seller's credits

The loans must be repaid over a period of years and interest must be paid on the borrowed capital. Terms and interest rates vary greatly and depend on the methods of contracting and financing, and the risk factors related to the project.

Interest payments begin from the time the money is borrowed. As the construction period may take several years this means that additional capital has to be provided to pay for interest during construction. (In the case of package deals and turnkey contracts, the interest payments due during the construction period are sometimes included in the contract price). Repayment of the principal usually begins only after completion of the project or after commissioning of the plant.

Many projects are financed by using two or more categories of credits mixed in the manner that best suits the particular circumstances. For instance, assuming a project where 50% of the total capital cost will be spent locally and 50% will be imported, and with 25% in the form of equity, the following breakdown might be considered:

Total capital cost	100%
Equity	25%
Seller's credit	45%
Seller's credit local costs	7%
Direct loan	28%

Note: Total capital is 105% as 5% represents interest on three loans during the construction period.

Since the form of financing chosen may affect contracting, the advantages and limitations of the different financing methods are discussed in the following paragraphs.

(b) Untied or Direct Loans

Untied or direct loans are available from banks, or international lending agencies such as I.F.C. or the I.A.D.B. Such loans are "untied" because they are not subject to the supply of equipment, materials, or services from any specific country or for any particular application. Interest rates are the prevailing commercial rates. The period for repayment of the loan is also usually that normally obtainable, though in some cases longer terms may be available.

Under certain circumstances untied loans are available as well through various national aid programs at very low interest rates and very long period for repayment. Such untied aid loans are usually administered by an international commission or an international lending agency such as I.F.C. or the I.A.D.B. In most cases certain specific criteria must be met to qualify for such aid loans.

Untied loans have the advantage of allowing the borrowed money to be used for any portions of the project including purchase of equipment, materials, and services, contracting for buildings and civil works, or payment of local costs. Also such funds permit the free choice of suppliers so that equipment, materials, and services may be purchased from any source in the world on an internationally competitive basis.

A thorough feasibility study by a reputable independent consulting engineering firm is essential for obtaining such loans unless the funds are requested by a company experienced in the particular field and the feasibility study has been prepared by company personnel.

(c) Debentures

Debentures are in effect a mortgage on the company being formed. They may be taken up by banks, trusts, insurance companies or private subscription but they confer no ownership rights upon the subscribers. Debentures are a common method of obtaining loan capital in developed western nations. Loans obtained in this way are almost identical to untied or direct loans in application but they usually have long repayment terms.

(d) Buyer's Credits

Certain countries will offer a "line of credit" to other countries on a government-to-government basis. These funds are usually administered by the local central bank or national development bank, and interest rates are subject to a small additional charge making them higher than in (b) or (c). Normally the borrower also has to meet certain specific criteria to qualify for such loans.

Funds obtained in this manner are, in effect, a form of buyer's credits and can be used for any acceptable projects but expenditures are restricted to the purchase of a major portion of the equipment, material, and services from the donor country.

Many countries also have "export" credits available which constitute in affect, a line of credit for a specific project and are usually administered by a government agency of the country from which the credit is available. The Export Development Corporation of Canada is a typical example. Interest rates usually conform to commercial rates but, because such credits are to promote exports from the countries making them available, the terms of repayment may be somewhat better than untied loans (except aid loans) and the time for repayment longer.

Buyer's credits are generally limited to the purchase of equipment, materials, and services from the country providing the credit although limited amounts may be made available for local costs (usually a minor percentage of the goods and services supplied). The number of suppliers is not restricted but the agency providing the credit normally wishes to deal with only one "exporter".

The employment of a consulting engineering firm to perform the functions of the exporter has distinct advantages in that the consultants would be in a position to purchase in accordance with standards of optimum suitability and best price and delivery based on competitive bids from any qualified supplier (piecemeal).

Since with buyer's credits, the suppliers are paid directly by the lending agency in accordance with normal progress payment schedules and other commercial terms, refinancing charges are avoided and consequently costs are kept to minimum, particularly for piecemeal purchasing based on competitive bidding. As with untied loans and seller's credits, project purchasing may also be done on a "package deal" or "turnkey" basis if desired but properly supervised piecemeal buying can achieve substantial savings.

The chief disadvantages are that buyer's credits are for the most part restricted to purchases within the donor nation and little or no funds can be used to cover local costs. The first of these is not usually a serious drawback in any industrialized country granting buyer's credits. The second is quite often covered by loan guarantees to banks of the donor nation which provide funds for local work.

(e) Seller's Credits

Seller's (or supplier's) credits are provided by suppliers of equipment and materials and may be provided by a single manufacturer or a consortium. Because of the financing complications that would occur with piecemeal purchasing (due to the large number of suppliers and contractors that would be involved), seller's credits are almost always used only for purchasing on a package deal or turnkey basis.

Seller's credits are applicable only to the equipment, materials, and services supplied by the package deal or turnkey contractor, and are thus much more restrictive than any of the types of loan previously discussed. Many of the advantages of piecemeal purchasing are lost. Seller's credits like buyer's credits are limited to the supply of equipment, materials, and services from the country from which the capital is obtained, and further restricted in most cases to products of specific suppliers. A portion of local costs can usually be covered, but if all costs must be covered as in the case of a turnkey project, the contractor must make special arrangements.

Seller's credits often appear to have low interest rates but, this is usually merely optical. In order to be able to provide credit, the contractor for a package or turnkey project must first obtain insurance coverage from his national export insurance agency, such insurance covers default in payments to the contractor to the extent of 80 to 85%. With this insurance coverage plus the contractor's guarantee for the 15 to 20% balance, the contracting supplier can obtain loans from commercial banks to provide the capital required.

The financial charges for seller's credits are appreciably higher than for direct loans or buyer's credits. If they appear low, it is because a portion of the inherent additional expenses has been discounted forward and added into the price of the package deal. Seller's credits are the most expensive form of financing a project but, on the other hand, are usually easily and quickly arranged.

R.6 Method of Contracting

(a) General

In previous sections mention has been made of "piece-meal purchasing", the "package deal" and "turnkey contracts" which are standard methods of procuring necessary equipment, materials, and services for execution of a project. As these are to a large extent related to the type of financing which can be obtained and can have substantial effect on the efficiency and cost of implementation they are discussed at some length in the following paragraphs.

(b) Piecemeal Purchasing

Unrestricted piecemeal purchasing is possible only with financing through untied or direct loans, or funds raised from the sale of debentures. Buyer's credits will also permit a degree of piecemeal purchasing but purchases are generally limited to the nation extending the credit unless the particular item or service is unobtainable in that nation.

In the case of piecemeal purchasing the equipment and materials are purchased individually from a number of suppliers on a competitive basis and contracts for foundation work, construction of buildings, mechanical and electrical installation, and erection work are let on the same basis. In order to purchase in this manner a government agency or a company usually must engage the services of a consulting engineering firm to carry out the process design and the layout of the plant, to select and size the type of equipment to be used, to prepare specifications so that the various items of equipment can be purchased item by item from different suppliers, and to carry out the complete detailed design of the plant so that contracts can be let for its construction. In addition, the consulting engineer would supervise the construction and carry out the project management, purchasing, expediting, scheduling and cost control, if the client cannot or does not wish to perform these functions.

Piecemeal purchasing has the primary advantage that the best and most suitable equipment can be purchased at the lowest possible price. Since the consulting engineer can work directly in the interest of his client and can be completely impartial in the selection of process, equipment, and design alternatives, this flexibility also ensures the most efficient and economic design of the mill with consequent savings in both capital and operating costs.

Another advantage is that a project can be completed more rapidly using piecemeal purchasing with detailed design and coordination by an engineering firm (as opposed to a package deal or a turnkey contract). Time savings in excess of one year may be achieved. For example, process design work and equipment purchasing can proceed almost simultaneously, and construction can begin before completion of all structural design details.

The chief disadvantage of this system is that there is no precise fixed price for the complete plant and financing must be arranged on the basis of accurate estimates by the consulting engineer.

In industrially advanced nations, piecemeal purchasing with detailed design by a consulting engineer is the method most commonly used for pulp and paper projects because it assures the lowest cost and the best and most suitable equipment for the project.

The cost of engineering in the detail necessary to permit piecemeal purchasing depends on the scope of the work and the size and complexity of the project. For the average pulp and paper project process design, specifications, detailed piping, mechanical, electrical and structural design, and supervision of construction would cost approximately 6 to 7-1/2% of direct capital costs.

If purchasing, expediting, cost control, and project management are also included engineering expense would be in the order of 9 to 10%.

(c) <u>Package Deal or Turnkey Purchasing</u>

In the case of a package deal, a contractor, an equipment supplier, or a consortium of equipment suppliers, furnishes a "package" usually consisting of all equipment for the proposed project and all engineering services, as well as specialized erection assistance for the installation of the equipment. The purchaser provides the civil works, construction of the buildings, common labour for erection, and other local costs.

Turnkey is essentially the same as the package deal except that civil works, buildings, all erection labour and all local costs (except working capital) are included in the total price. Turnkey is not as common as the package deal since local costs cannot usually be financed by buyer's or seller's credits and special arrangements must be made to cover such expense.

Both package deal and turnkey type contracts may be financed in any of the ways which have been discussed but they are most commonly associated with financing through buyer's or seller's credits. If untied loan or debenture funds are available a client will usually favour piecemeal purchasing unless other factors make package or turnkay more suitable.

Tha chiaf advantaga of the package deal or turnkay contract is that the client deals with only ona party who assumes full responsibility for tha whole projact. Also costs ara mora precisaly definad sinca, for the turnkay arrangement the total price is fixed, and for tha packaga deal the foreign exchange portion can be fixed. In both cases payment are usually made in three to five installments, frequently including interest during construction, so that little work is involved in processing payments.

The two principal features - assignment of responsibility for the entire project, and fixed price - have a powerful appeal especially to governments, state companies, and private firms with limited technical resources as only one decision has to be made, the selection of the package deal or turnkey contractor. The purchaser assumes a minimum of responsibility and requires only a small staff to administer the implementation of the project.

Offsetting these advantages are factors which can cause package or turnkey arrangements to be unattractive. The most significant of these are:

- Increased capital costs
- Increased time for implementation
- Unsuitable equipment or equipment layout

The cost of detailed engineering for accurate pricing would be prohibitive so the contractor must determine price from preliminary engineering only. For protection, therefore, contingency provision must be ample. Similarly, since completion time and performance penalty clauses are usually included in such contracts, protection must also be included to cover any delays in delivery, construction, or achievement of guaranteed performance which might occur.

The normal arrangement of payment in a relatively small number of installments, and generally unrelated to the rate of expenditure, necessitates an additional allowance for refinancing of subcontractors and suppliers. The costs of such refinancing can be significant and, of course, must be included in pricing.

In many cases too a factor is applied to compensate for the cost of preparation of unsuccessful previous bids for other projects. Typically, the cost of such bid preparation might be in the order of $150,000 to $250,000 which is too much to absorb if it can be recovered.

Relative to the project in hand these are all unproductive costs but they are almost always included in pricing for package deal or turnkey projects. Depending on the extent to which they are applied in the price estimating, overall costs can range from 20 to 35% more than for piecemeal purchasing with independent engineering.

The time required for completion of a project is an important factor to be considered in both the financing and contracting phases. Delay in the start-up of a new enterprise inevitably results in loss of profits which might otherwise have been generated, thus, once the decision to proceed has been made, time saved is equivalent to money earned.

Design by consulting engineers and piecemeal contracting again show advantage in this aspect. When policy decisions have been made and financing has been arranged the consulting engineer may be engaged to begin detailed design work immediately and, under normal circumstances, construction can begin about six months after approval to proceed has been confirmed. From this point, depending on the size and complexity of the project, completion will take 2 to 2-1/2 years, i.e. a total of 2-1/2 to 3 years elapsed time will see the beginning of the operation.

For the package deal or turnkey arrangement, on the other hand, relatively complete specifications must first be drawn up to permit fixed prices to be quoted with any degree of accuracy. This work will normally take four to five months and, adding three to four months for preparation of bids and some additional time for analysis of the bids received and contract negotiations, it is possible that a year or more can elapse between the time of decision to proceed and the beginning of detailed design. From this point the time required would be essentially the same as for piecemeal purchasing with consultants, i.e., 2 to 2-1/2 years.

Some economy in time can be achieved in package and turnkey contracts by preparation of specifications and negotiation with potential contractors concurrently with arrangements for financing, but usually, implementation of the project by package deal or turnkey contract will consume an additional year.

Plant layout and process design, being planned around equipment and processes in which the contractor has interests, may be deficient due to undercapacity, overcapacity, or even improper applications. This is natural since the package deal or turnkey supplier will wish to incorporate as much as possible of his own machines and process systems, but this can easily lead to basic design defects with consequent production problems.

Efficiency in operation and maintenance, in particular, can be adversely affected by inadequate planning and unsuitable equipment selection and/or layout. The contractor has no continuing responsibility for operating and maintenance costs and consequently will devote little engineering time to optimizing these important aspects. Since a fixed price is involved the major part of engineering effort is usually directed towards putting together a plant which will meet production and quality specifications but with a close eye on the quoted price in order to achieve maximum profit from the contract.

Contracting through a consortium of suppliers (as opposed to a single supplier) can increase the probability of operating or maintenance problems since each consortium member will wish to incorporate as much as possible of his own machinery, equipment, and processes. This can result in non-uniformity or lack of standardization in the many minor items such as pumps, motors, couplings, agitators, valves, instrumentation, etc. etc. which are common to most of the process areas. The resultant large spare parts inventories and complicated maintenance procedures contribute to excessive repair and maintenance costs.

R.7 Conclusions

Summarizing the content of what has been stated in this chapter, the following conclusions may be drawn:

(a) For efficient and successful implementation of any project there is a well-defined procedure which, if followed, will yield best results. The listed steps must all be considered in the planning and organisation must be arranged accordingly.

(b) A controlling agency or company must be formed to maintain coordination and administer the work. Personnel or committees must be given full powers of decision and access to adequate funds.

(c) Since any company which is formed is not likely to have sufficient manpower and technical skills, experienced consulting engineers are usually engaged.

(d) The most important basic step is the definitive feasibility study. Both from the point of view of validity and arrangement of financing, such studies are performed best by independent consultants.

(e) Financing may be arranged through a number of generally standard procedures. Each method of financing has its advantages and disadvantages and selection must be based on the requirements and circumstances relevant to any specific project. Untied loans or debenture funds, however, permit maximum flexibility with consequent savings in capital and time.

(f) Design and piecemeal purchasing by experienced engineering consultant will yield best results. Package deal or turn-key contracts should be considered only when financing arrangements or other circumstances leave no alternative.

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