CONSULTANT'S REPORT

UPDATE OF A MARKET STUDY FOR TALC

Prepared by:
M. Harris and G.N. Ionides
Temanex Consulting Inc.

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TEMANEX REPORT

UPDATE OF A MARKET STUDY FOR TALC

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EXECUTIVE SUMMARY

A) Background

This report was prepared for Supply and Services Canada under the Canada-British Columbia agreement on mineral development. It represents an updated market study on prospects for commercialization of British Columbia talc deposits.

British Columbia has been blessed with high quality talc deposits, particularly in the southwestern region, within 150-200 km from Vancouver. The talc is pure, soft and can be processed to high brightness, in the 85-90% range. This makes it suitable for utilization in a number of industrial processes and products. Prominent among these are paints, pulp and paper, tires and adhesives. Talc shares many characteristics of the common extender and filler minerals, such as kaolin and calcium carbonate. However, it has two distinguishing characteristics:

a) It is naturally hydrophobic;
b) It has the highest aspect (diameter to thickness) ratio of all natural pigments.

The latter characteristic makes talc a very attractive option for the large, advertising-dollar-driven publication printing paper sector (magazines, catalogs, inserts/flyers). The reason is high aspect ratio enhances paper and print gloss, highly desirable properties for these papers. Unfortunately, talc's hydrophobic nature makes it difficult to disperse in the papermaking or coating slurry. This has limited talc's potential utilization in the large papermaking and coating sector only to pitch and stickies control where its hydrophobic nature is an asset.

A second inhibiting factor for papermaking pigments demand growth in Western North America through the last few decades has been the large transport cost of the primary pigment, kaolin, from its origin in the US South. Currently, transport costs alone are in the CDN $150 to CDN $200 per metric tonne of kaolin for delivery to British Columbia coastal mills.

As a result of the above factors, Western North American extender and filler pigment consumption is only about 5% of total North American consumption, For talc the western region share is 90,000 tonnes/year, or 16% of the total North American 550,000 tonnes/year. The ratio of Western USA to Western Canada demand is roughly 3:1.

The pulp and paper sector shows the greatest prospect for talc demand growth in the 1990's, driven strongly by the explosive trend towards wastepaper recycling/deinking. The application of talc in this sector is in stickies control.

B) Forecasts

For conventional, hydrophobic talc, we forecast a most likely Western North American growth of 4.9% per year between 1993 and 2003. This will raise current talc consumption of 90,000 tonnes/year to 145,000 tonnes/year. The ratio of Western USA to Western Canada will not change significantly from the current (2.5-3):1.

One of two aspiring B.C. talc producers, Pacific Talc, has announced that it possesses proprietary technology which renders talc hydrophilic. This would open a significant new market potential for B.C. talc grades, and it could increase total extender and filler talc market size in Western North America by about 50-75% within 3-5 years of commercialization.

Regarding competitors, the greatest threat comes from the existing US suppliers whose product originates in Montana. Further, over the time horizon to 2003, we do not consider potential Chinese talc competition a serious threat.

C) Summary

In summary, there are significant prospects for British Columbia talc. It has a CDN $100-$150 per metric tonne transport cost advantage over pigments originating in the US South, and about CDN $50 per metric tonne over talc originating in Montana, a major talc producing region of North America. However, there are significant economies of scale in capital and operating costs for a talc plant, as well as in marketing costs and, although the Western regional talc market is sizeable, it is relatively limited. In this sense, a single British Columbia company, perhaps combining two smaller ones, would have a much stronger chance of succeeding than two smaller companies operating individually in competition for a relatively limited market.

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1 INTRODUCTION

1.1 BACKGROUND

This report, prepared for Supply and Services Canada, is an update of earlier studies on market prospects for talc originating in BC. The Southwestern/Central region of the province has been blessed with relatively high quality and purity talc deposits which, in principle, can and should be commercially exploited. This study examines the critical market and economic issues which influence the potential commercial development of these talc deposits. It represents an update of earlier work, specifically our 1988 report TN-875, "North American West Coast Pigment Markets With Emphasis On Talc Prospects". Furthermore, it extends the earlier knowledge by providing a representative, first level analysis of capital, operating and transport costs.

1.2 TALC THE MINERAL

Talc is a mineral which in its pure form is hydrous magnesium silicate. Industrial talc, however, refers to a wide range and mixture of minerals which contain different proportions of talc, some of which in fact contain little or no hydrous magnesium silicate at all. In recent years, talc has become of increasing importance to the papermaking industry as a result both of beneficiation processes to purify ore deposits and of the development of fairly pure talc deposits. Furthermore, developments, primarily in Finland, have demonstrated the potential for using talc both as a filler and a coating pigment, in spite of its hydrophobic nature which poses significant challenges in dispersion.

Pure talc is, in principle, valuable to the papermaking industry because of its adaptability to ultrafine grinding, its softness, and the platelike structure of talc particles. Talc fractures upon grinding to form tiny platelike particles favoured for many papermaking end uses. However, talc is rarely found in a pure state. The degree to which impurities occur determines the hardness and brightness of the final ground product.

Compared to other mineral pigments, such as kaolin and calcium carbonate, used in paper, paint and related industrial products, talc has two significant distinguishing characteristics:

- It is naturally hydrophobic, as opposed to the other common pigments which have a hydrophilic nature. This makes it difficult to disperse in water and limits its utilization in certain applications. For example, in the pulp and paper industry, the primary application for talc is as a pitch or "stickies" control agent, functions for which its hydrophobic nature is an advantage rather than a hindrance;

- It has the highest platelet aspect ratio (diameter-to-thickness ratio) of any of the common pigments used in industrial applications - see Table 1-1. This is a particularly important advantage for certain end uses in which the development of surface gloss is desirable, such as print advertising papers. Unfortunately, talc's hydrophobic nature makes it difficult to use in certain applications.

TABLE 1-1

ASPECT RATIO OF TYPICAL INDUSTRIAL MINERAL PIGMENTS

PIGMENT	AVERAGE ASPECT RATIO	% OF PARTICLES WITH ASPECT RATIO > 40
Talc	30	30
Kaolin	20	15
Calcium Carbonate	2	0

Another advantage of talc over other common industrial minerals is that its abrasiveness (at least in its pure form) is one of the lowest, on account of its relative softness. This makes it a desirable pigment for most end uses, in particular as a paper filler, where abrasiveness is undesirable due to high costs associated with the wear of machinery components.

2 NORTH AMERICAN TALC MARKET ANALYSIS

2.1 GENERAL CHARACTERISTICS

Total talc consumption, **for all end uses**, in North America in-1992-93 is estimated at about 950,000 tonnes per year - see Figure 2-1. The Canadian consumption share is about 6-8% of the total. An additional 200,000 tonnes or so produced in North America is exported offshore. Limited imports come from China and Australia, primarily to the US market.

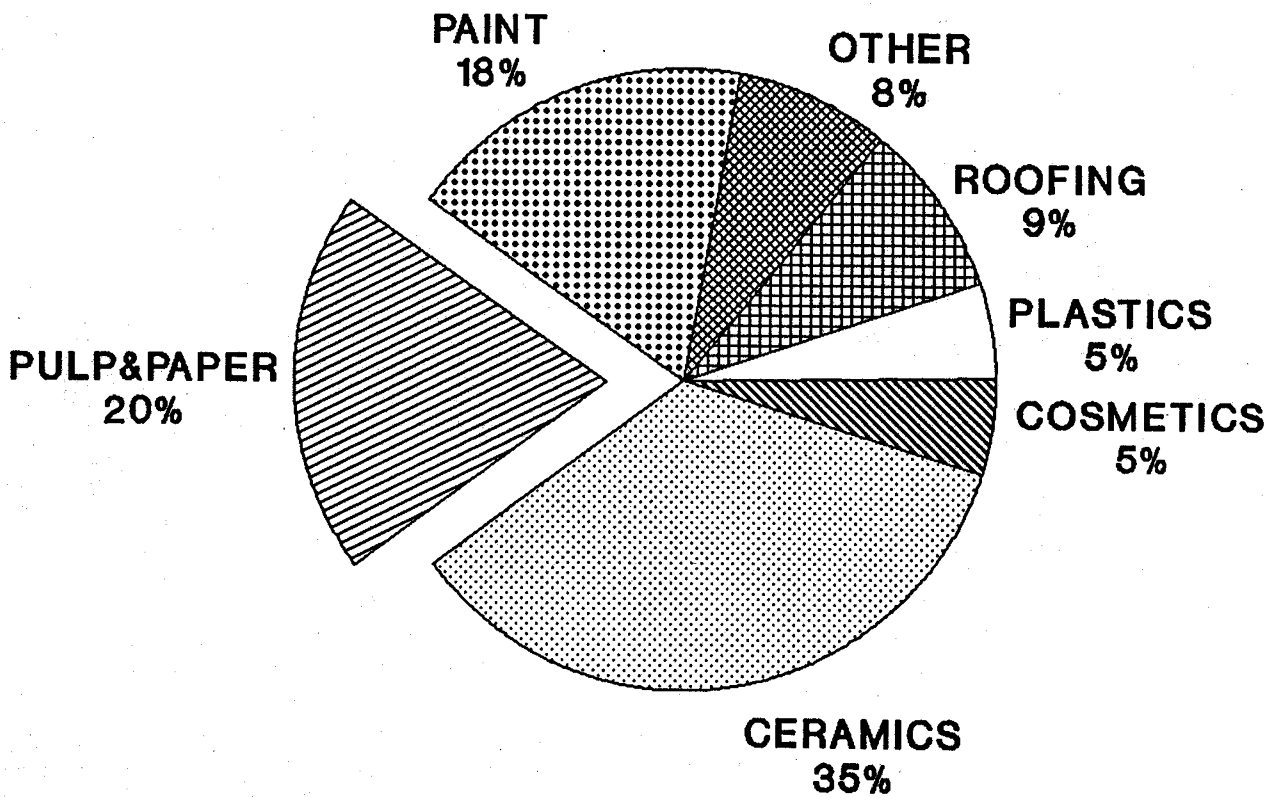
Approximately 550,000 tonnes/year or 55-60% of the total North American consumption falls under extender and filler applications. These are the relatively specialized applications associated with high value end uses, **and the ones of primary interest to us in this study, therefore the market segment on which the analysis is focussed.** Roughly a one-third portion of the extender and filler tonnage, i.e. 190,000 tonnes/year are used by the pulp and paper industry, **which offers the greatest prospects for market growth, albeit in a highly competitive market.** Other end uses, primarily paint, followed by adhesives and sealants, plastics and rubber account for the remaining 360,000 tonnes per year - see Figure 2-2.

The Western North American extender and filler market size, also summarized in Figure 2-2, is about 15% of the total North American. This is considerably smaller than the roughly 25% which would be expected from population and economic activity shares. Essentially, as in the case of other mineral pigments, the lack of regional sources of supply, and the associated transportation cost penalty, has resulted in a lower than average talc utilization share. This clearly opens significant opportunities for potential new suppliers.

Canadian extender and filler talc consumption is heavily concentrated in the pulp and paper industry which accounts for 55-60% of total talc consumption. In contrast, in the United States, the paint and the pulp and paper industries each consumes 30%-35% of extender and filler talc - see Figure 2-3.

Figure 2-1

TOTAL TALC CONSUMPTION BY ALL INDUSTRIES IN NORTH AMERICA



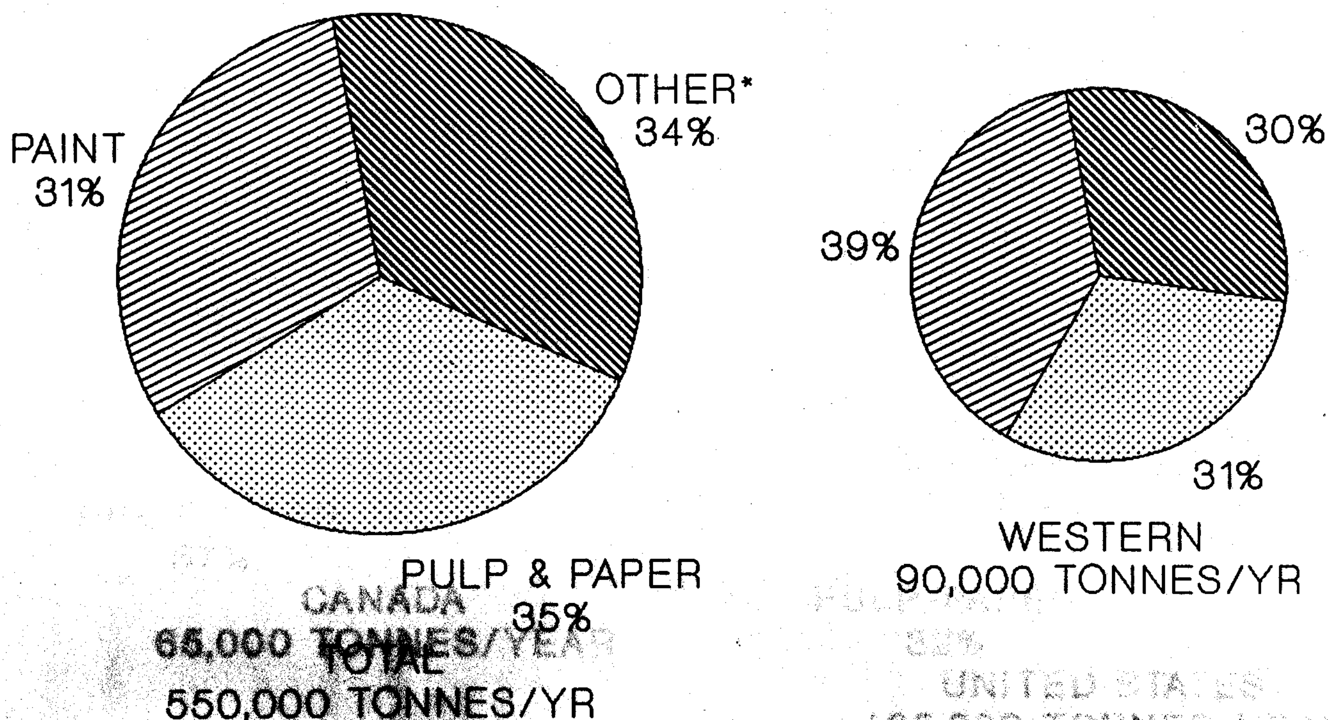
1992-93 TOTAL TONNAGE
950,000 TONNES/YEAR

TE[illegible] CONS

T[illegible] CONSULTING INC (198F21)

Figure 2-2

TOTAL & WESTERN NORTH AMERICAN EXTENDER & FILLER TALC CONSUMPTION



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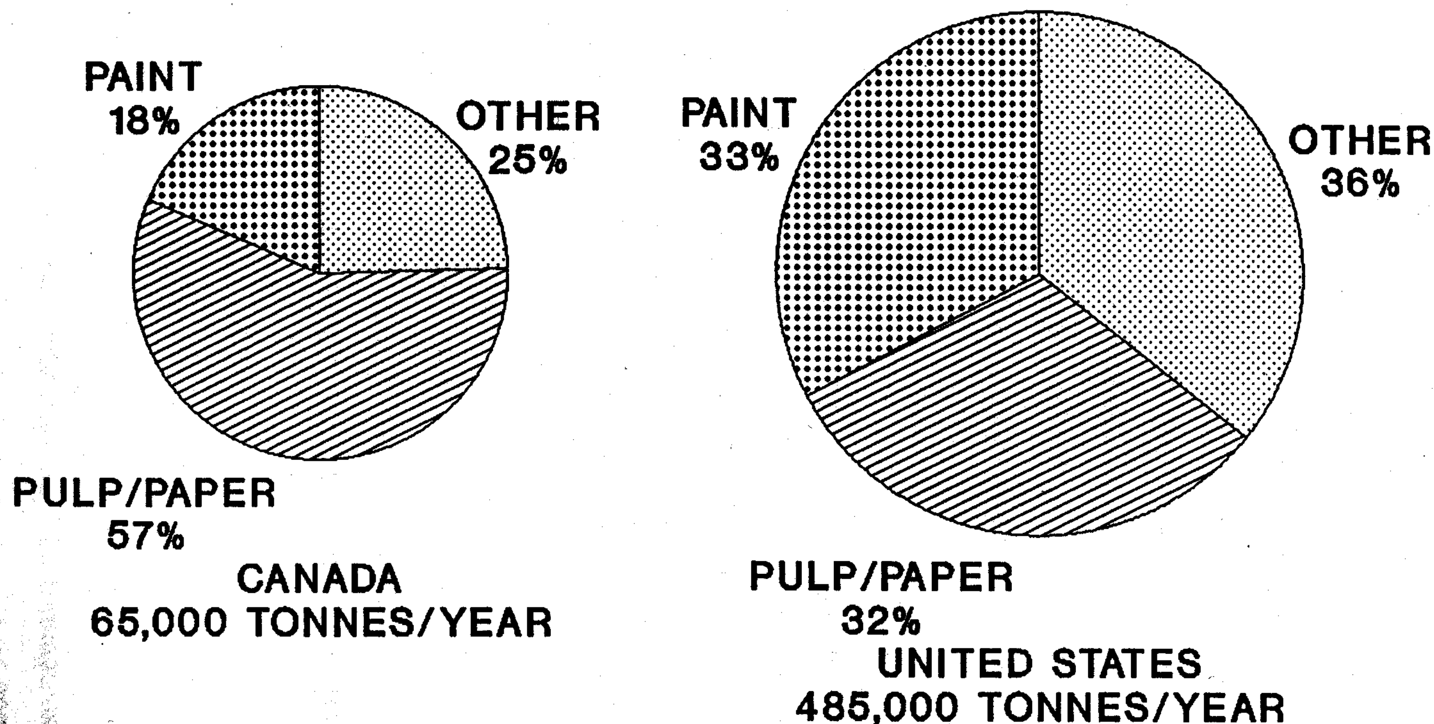
* ADHESIVES/PLASTICS/RUBBER/ETC.

Figure 2-3
CANADIAN & US EXTENDER AND FILLER TALC CONSUMPTION ESTIMATES



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2.2 SPECIAL COMMENTS ON PULP AND PAPER INDUSTRY UTILIZATION

Conventional (hydrophobic and organophilic) talc has traditionally been used by the pulp and paper industry as a pitch control agent. The application level in pitch control is of the order of 1-2% by weight of the pulp or paper, depending on mill philosophy, pulp type and species. The North American pulp and paper industry end use is almost entirely in pitch control. This is quite different from Europe, the world's second largest pulp and paper industry after North America, where most of the talc consumed (pulp and paper industry only) is for filler and coating purposes, with the pitch control share at only about 30% - see Figure 2-4.

Whereas talc has been used (in particular in Finland) as a papermaking filler, its hydrophobic nature prevents its utilization in offset printing papers, confining it instead to rotogravure grades. The rotogravure printing process is insensitive to the presence of talc in printing paper, and its market share in Europe is much larger than offset (see, e.g. Figure 2-5 for a well known, 25-30% filler content grade) thereby explaining the higher use of filler talc in Europe.

In addition to pitch control in conventional pulps, talc is used for both stickies/pitch control and deinking efficiency improvement in wastepaper deinking, a market segment which is experiencing explosive capacity growth in the 1990's. Chapter 3 discusses this in further detail.

2.3 OTHER INDUSTRIES

A significant amount of talc is used in paints, plastics and so on. The tonnage used in paints in 1993 is estimated at 170,000-175,000 tonnes for North America and 35,000 tonnes for Western North America. Figure 2-2 showed that the largest end use market for extender and filler talc in Western North America is in fact paints. This is of special interest to potential BC talc producers, since Western talcs are valued for their softness, low abrasion, and flattening, viscosity and gloss enhancement potential. In addition, 25,000-30,000 tonnes of talc were utilized in plastics, refractories, tires, etc. in Western North America.

Figure 2-4
W. EUROPEAN AND N. AMERICAN PULP & PAPER INDUSTRY TALC USAGE

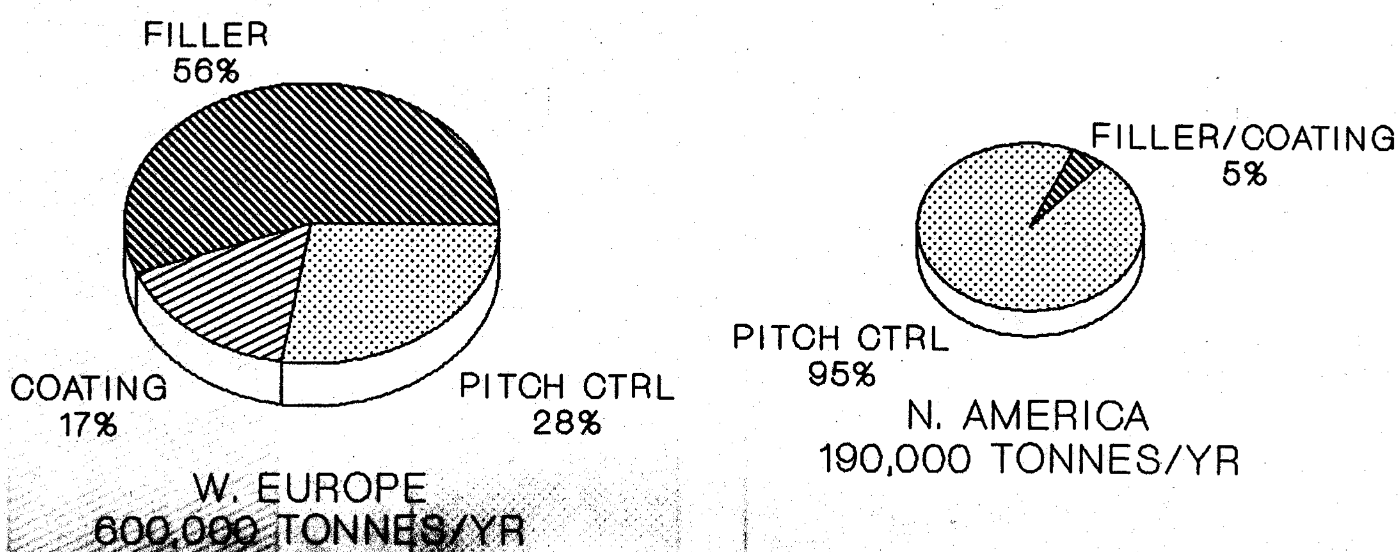

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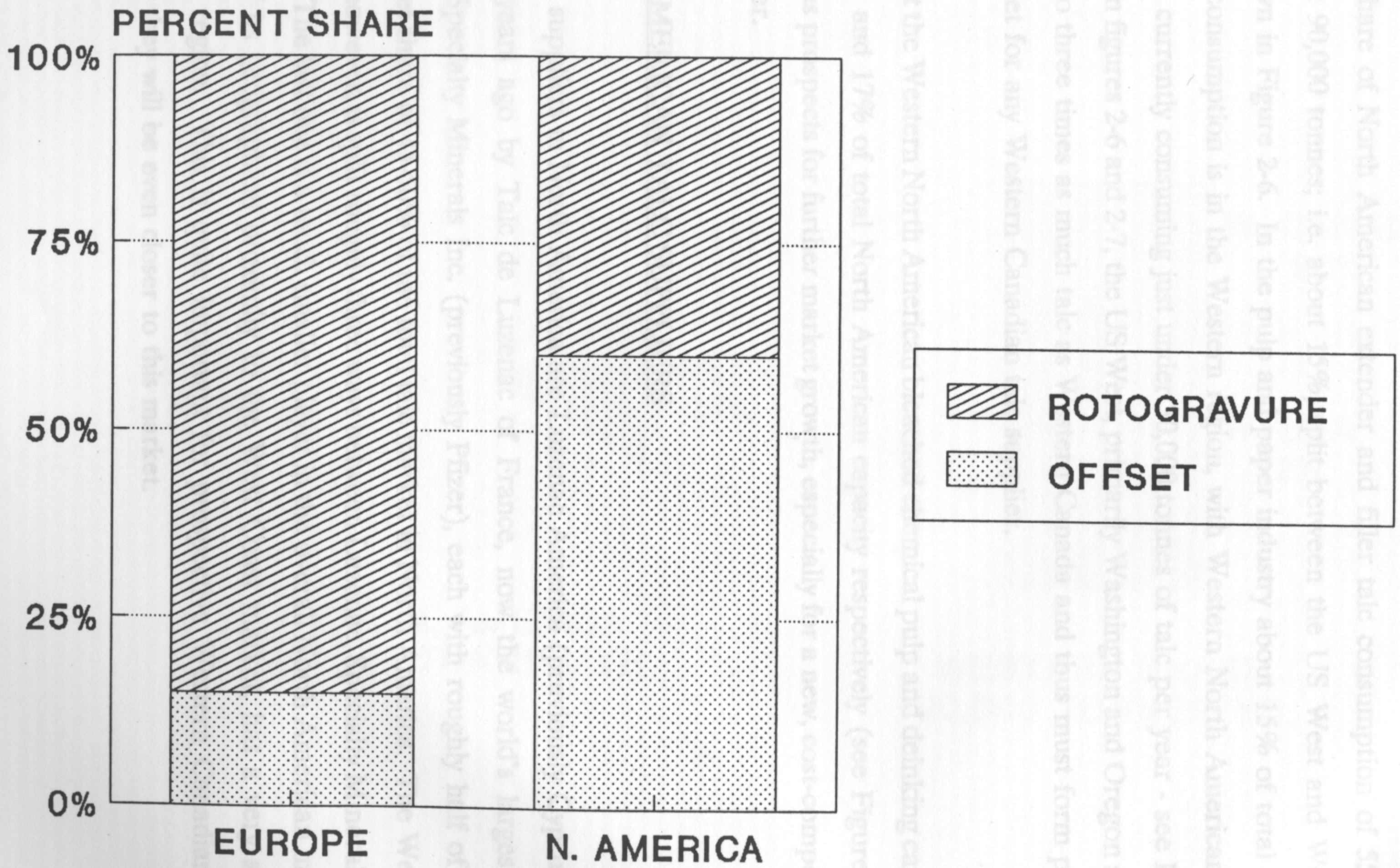
Figure 2-5

PRINT PROCESS BREAKDOWN FOR SC PAPERS - EUROPE & N. AMERICA



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2.4 GEOGRAPHIC BREAKDOWN

The Western share of North American extender and filler talc consumption of 550,000 tonnes is about 90,000 tonnes; i.e. about 15%, split between the US West and Western Canada as shown in Figure 2-6. In the pulp and paper industry about 15% of total North American talc consumption is in the Western region, with Western North American pulp and paper mills currently consuming just under 30,000 tonnes of talc per year - see Figure 2-7. As shown in figures 2-6 and 2-7, the US West, primarily Washington and Oregon states, consumes two to three times as much talc as Western Canada and thus must form part of the target market for any Western Canadian talc supplier.

Considering that the Western North American bleached chemical pulp and deinking capacity shares are 35% and 17% of total North American capacity respectively (see Figure 2-8), there are obvious prospects for further market growth, especially for a new, cost-competitive BC talc producer.

2.5 NORTH AMERICAN TALC SUPPLIERS

The largest talc suppliers in North America are Luzenac America (previously Cyprus, but purchased 1-2 years ago by Talc de Luzenac of France, now the world's largest talc producer) and Specialty Minerals Inc. (previously Pfizer), each with roughly half of their combined market share of 45-50% of the total talc market in North America. The Western region market, however, is split roughly three ways between Luzenac, Specialty Minerals and Montana Talc. The last one is a much smaller player in the overall North American market but, because of its geographical proximity to the West Coast market, has a very strong position in this region. This is quite important for prospective Western Canadian talc producers since they will be even closer to this market.

Figure 2-6
WESTERN SHARE OF NORTH AMERICAN EXTENDER AND FILLER TALC CONSUMPTION

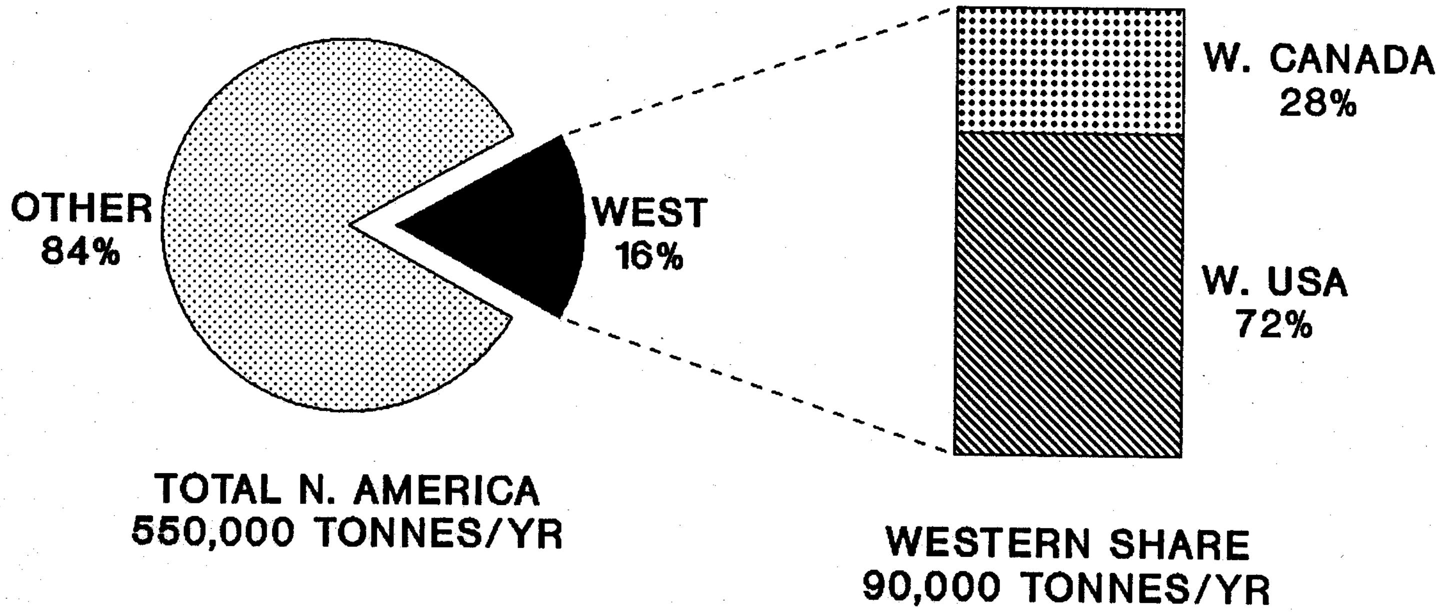

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Figure 2-7

WESTERN SHARE OF NORTH AMERICAN TALC CONSUMPTION BY THE PULP & PAPER INDUSTRY

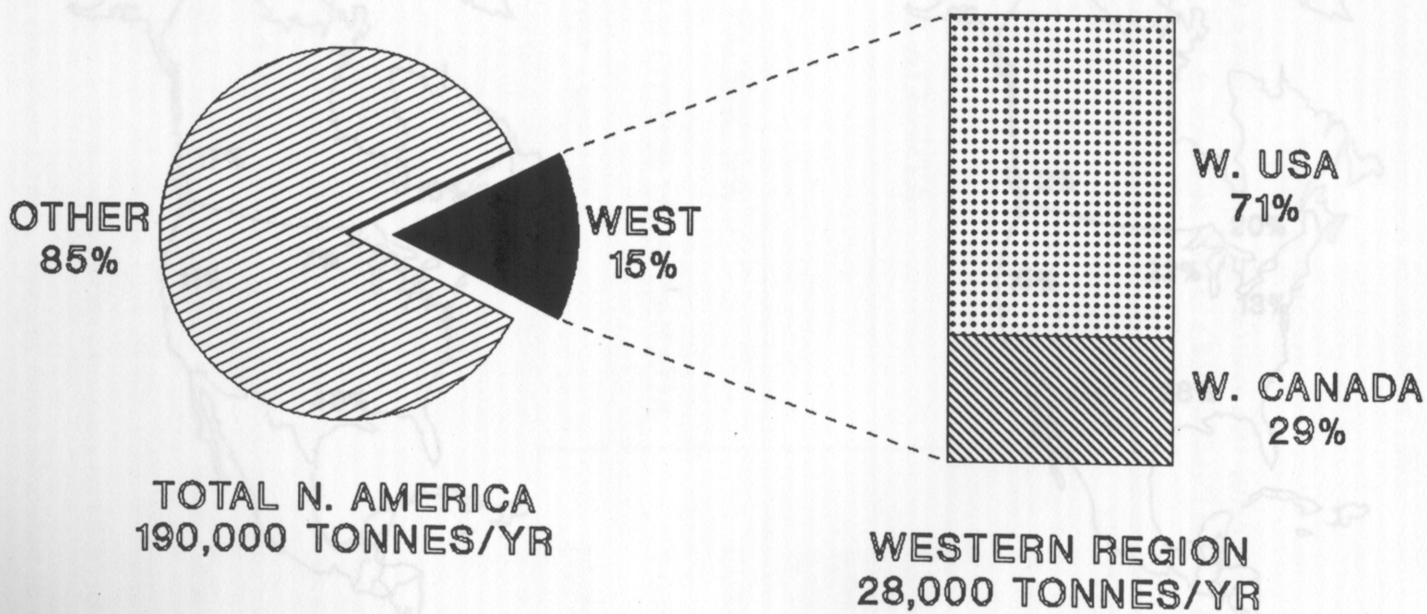

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Figure 2-8

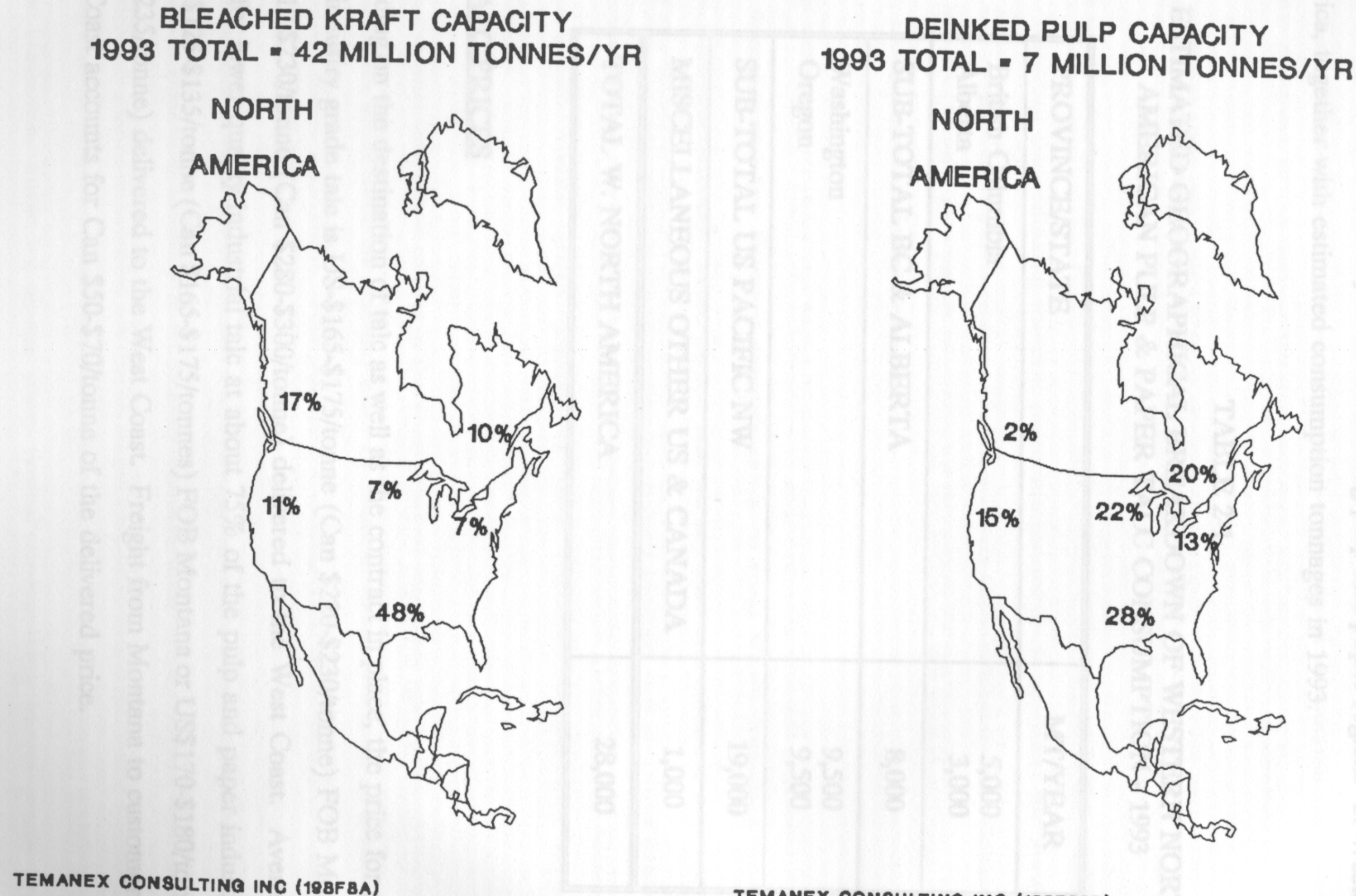
BLEACHED KRAFT CAPACITY
1993 TOTAL = 42 MILLION TONNES/YR
NORTH
AMERICA
17%
10%
7%
11%
7%
48%
TEMANEX CONSULTING INC (198F8A)
DEINKED PULP CAPACITY
1993 TOTAL = 7 MILLION TONNES/YR
NORTH
AMERICA
2%
20%
22%
15%
13%
28%
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Table 2-1 summarizes the major talc consuming pulp and paper regions of Western North America, together with estimated consumption tonnages in 1993.

TABLE 2-1

ESTIMATED GEOGRAPHICAL BREAKDOWN OF WESTERN NORTH AMERICAN PULP & PAPER TALC CONSUMPTION - 1993

PROVINCE/STATE	MT/YEAR
British Columbia Alberta	5,000 3,000
SUB-TOTAL BC & ALBERTA	8,000
Washington Oregon	9,500 9,500
SUB-TOTAL US PACIFIC NW	19,000
MISCELLANEOUS OTHER US & CANADA	1,000
TOTAL W. NORTH AMERICA	28,000

2.6 TALC PRICES

Depending on the destination of talc as well as the contract in place, the price for pulp and paper industry grade talc is US-$165-$175/tonne (Can $220-$230/tonne) FOB Montana or US $210-$230/tonne (Can $280-$300/tonne) delivered to the West Coast. Average FOB prices for lower quality industrial talc at about 75% of the pulp and paper industry grade are US$125-$135/tonne (Can $165-$175/tonnes) FOB Montana or US$170-$180/tonne (Can $225-$235/tonne) delivered to the West Coast. Freight from Montana to customers on the West Coast accounts for Can $50-$70/tonne of the delivered price.

Clearly, these numbers suggest a significant and profitable market which Western Canadian producers would be in a position to serve better than any of the current suppliers. Freight costs for talc from BC to various Western markets are discussed in Section 5.4.

2.7 TALC SHARE OF TOTAL PIGMENTS DEMAND

Just as the North American paper industry and market is the largest in the world, so is the North American papermaking mineral pigments industry. It accounts for about 40% of global consumption and production. This industry has experienced healthy demand growth in the last 10-15 years as a result of supplying the needs of the fastest growing in demand papers, namely communication papers.

Figures 2-9 and 2-10 show the breakdown of papermaking mineral pigments in Western North America and the Western region's share of total North American papermaking mineral pigments demand. From Figure 2-9, we see that talc currently accounts for only 14% of the Western mineral pigments market, mainly because it is currently available only in the conventional (hydrophobic) state. Calcium carbonate (CaCO3) and kaolin account for the largest market share because of their cost-effectiveness and technological performance.

Clearly, the potential share of talc in the total mineral pigments market would be far larger if it could find application as a paper filler or coating; in other words, as a substitute for kaolin and calcium carbonate. This potential is discussed in more detail in Chapter 4.

The availability of high quality (pure, bright) kaolin deposits in the US South explains why the mineral pigments industry is so heavily concentrated in this region, and why kaolin dominated the pigments market. However, its geographical origin increases considerably the delivered cost of kaolin to those regions of the North American continent which are distant from the US South. Table 2-2 shows some typical papermaking kaolin grade prices and

Figure 2-9
WESTERN NORTH AMERICAN MINERAL PIGMENTS CONSUMPTION

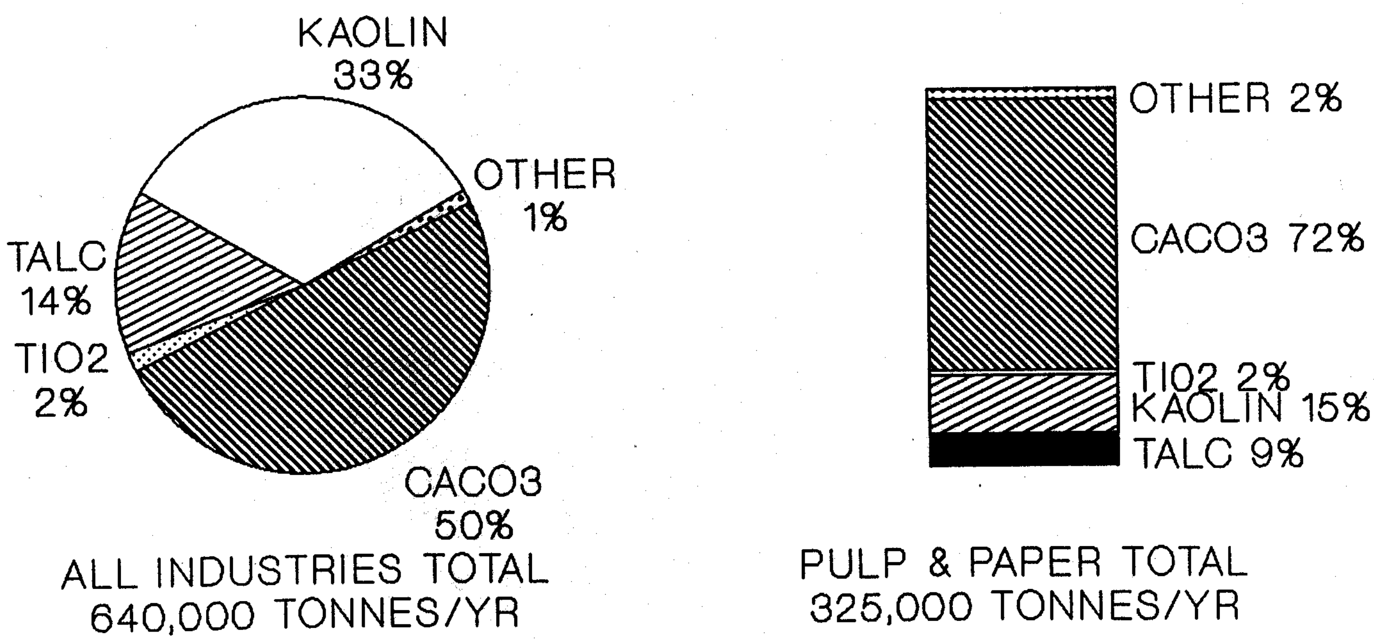

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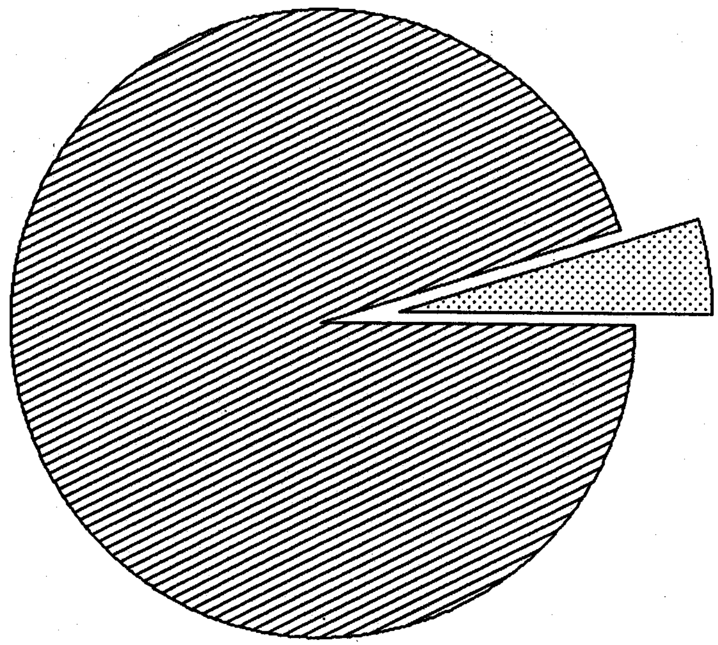
Figure 2-10
WESTERN NORTH AMERICAN SHARE OF PULP & PAPER MINERAL PIGMENTS



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(TOTAL 1993 TONNAGE=6.5 MILLION TONNES)

estimated transportation costs to various regions. It is seen that for some of the lower quality filler grades transportation accounts for more than 50% of the delivered cost to B.C. pulp and paper mills.

TABLE 2-2

DELIVERED COSTS OF KAOLIN ORIGINATING IN THE US SOUTH TO VARIOUS NORTH AMERICAN REGIONS (CAN $/TONNE)

KAOLIN GRADE	DESTINATION	KAOLIN COST+	TRANSPORT COST	TOTAL COST
WW++	US South B.C.	150 150	10-20 150-170	160-170 300-320
CALCINED	US South B.C.	500 500	20-30 200-220	520-530 700-720

\+ Wide range for numerous grades; typical cost quoted
++ Water-Washed

The incremental cost of about $150/ton of kaolin for B.C. translates into an incremental cost per ton of paper of about $30 at a sheet loading of 20%. For a world class paper machine with a capacity around 200,000 tons/year, this represents a $6,000,000 disadvantage for a B.C. paper machine against a US South machine. This has been the major driving force for the virtually full penetration of precipitated calcium carbonate technology in Western North American fine paper mills, while by 1993, it penetrated only about 50% of the fine paper tonnage in the rest of North America. The high transport cost penalty is also a strong and positive driving force towards development of a regional mineral pigments industry in Western North America.

3 PROJECTED DEMAND GROWTH FOR TALC

3.1 ALL INDUSTRIES

Aside from the traditional markets for hydrophobic talc as a pitch control agent in the pulp and paper industry and as an extender and filler in paints and other industries, the market prospects for hydrophobic talc have recently increased significantly in deinking applications, since there is a very strong move towards wastepaper deinking/recycling.

Table 3-1 summarizes 1993 and projected 2003 total talc consumption data for Western North America (including pulp and paper, and utilization in other industries, such as paints, plastics, refractories, etc.). Total talc total demand (for pitch/stickies control, and deinking efficiency enhancement in pulp and paper mills as well as for paints and other products) is estimated to grow from 90,000 tonnes/year in 1993 to 145,000 tonnes/year in 2003; a compound average annual growth rate of 4.9%, largely driven by the trend to wastepaper recycling - see Table 3-1. The pulp and paper share will increase from 31% to 45%.

TABLE 3-1
TOTAL EXTENDER & FILLER TALC CONSUMPTION
IN ALL INDUSTRIAL SECTORS OF WESTERN NORTH AMERICA
('OOO TONNES PER YEAR)

MARKET SEGMENT	1993E	2003F	AVG. ANN. GROWTH RATE
Pulp & Paper (Pitch Control & Deinking)	28	65	9%
Paint	35	45	2.5%
Other Products	27	35	2.5%
TOTAL CONVENTIONAL	90	145	[illegible]

The talc share of total pigments demand will remain stable at 13% unless talc can find applications as a filler and coating pigment in pigmented printing papers. The prospects for this are discussed in detail in Chapter 4.

3.2 SPECIAL COMMENTS ON DEINKING PAPER MILL APPLICATIONS

The hydrophobic and organophilic nature of conventional talc pigment which provides the desirable characteristics for pitch control also make talc an excellent stickies control agent in deinking mills. Furthermore, its surface nature makes it aerophilic in aqueous suspensions, and an important deinking-efficiency-enhancing-additive in flotation wastepaper deinking.

In response to escalating landfill costs and dwindling landfill availability in North America, (especially near densely populated areas such as the US Northeast) federal, state/province and municipal governments have been enacting legislation mandating the utilization by publishers of newsprint with significant - (40-100%) deinked fibre content. The legislation will gradually be extended to other, higher quality papers. The result has been an unprecedented wave of expansion in wastepaper deinking capacity in particulare for old newspaper (ONP and OMG [old magazines]), which should continue through the 1990's. Figure 3-1 shows the rapid growth in North American ONP consumption since 1988.

Typical talc application rates in the deinking operation are 1-1.5% by weight of pulp produced. This means an increase of about 50,000-60,000 tonnes/year in talc demand for newsprint deinking mills alone in North America over the period 1990 to 1995 and about 90,000-100,000 tonnes/year over the period 1990-2000.

About 15-20% of the total deinking (newsprint, tissue, and deinked market pulp) capacity is in Western North America - see Figure 2-8. Table 3-2 summarizes deinked pulp tonnages in Western North America. Clearly, deinked pulp applications are a rapidly growing talc market segment in the 1990's.

3.3 HYDROPHILIC TALC POTENTIAL

The average growth rate in Western North American talc demand for conventional applications (primarily pitch/stickies control in the pulp mill, paints, adhesives and tires) will be quite healthy, as shown in Table 3-1. Nevertheless the total consumption will still remain a small percentage (10-15%) of total extender and filler pigment applications in the region.

One of the two aspiring B.C. talc producers (Pacific Talc) has announced that it possesses proprietary technology to render conventional (hydrophobic) talc hydrophilic. If this is brought to commercial realization, we expect a significant, new market segment for talc demand in paper filling and, ultimately, coating applications. Our forecast is that, within 3-4 years from start-up, hydrophilic talc tonnage may be of the same order of magnitude as for current conventional (hydrophobic) talc tonnage, shown in Table 3-1. End use applications will be primarily in mechanical pulp-based, gloss grades of publication papers used in inserts/flyers, catalogs and some magazines. Most of the hydrophilic talc tonnage will be consumed in B.C. It is not possible to make further, more detailed comments here without releasing confidential data from recent studies we carried out on behalf of a specific corporate client (Pacific Talc) in this area.

Figure 3-1
NORTH AMERICAN OLD NEWSPAPER CONSUMPTION

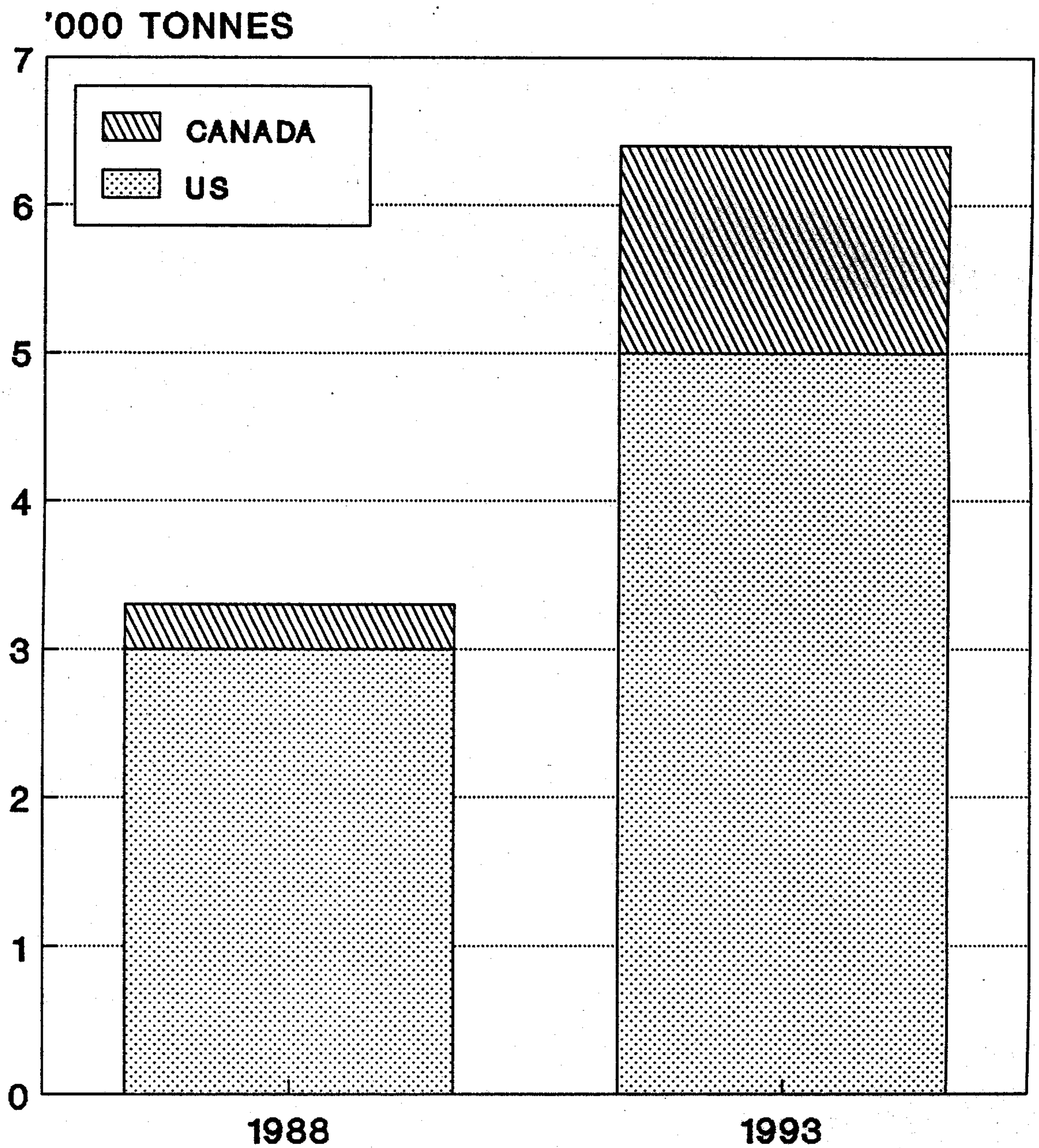

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TABLE 3-2

WESTERN NORTH AMERICAN DEINKING MILLS 1993-94 CAPACITY ESTIMATES

	TONNES/YR
WESTERN CANADA	
NEWSTECH, CQUITLAM, BC	120,000
ALBERTA NEWSPRINT, WHITECOURT, ALB.	20,000
SUBTOTAL 1	**140,000**
WESTERN USA	
SMURFIT, NEWBERG, OR	190,000
SMURFIT, OREGON CITY, OR	110,000
SMURFIT, CA	150,000
NORPAC, WA	180,000
INLAND EMPIRE, WA	40,000
DAISHOWA, PORT ANGELES	60,000
JAMES RIVER, HALSEY, OR	95,000
ORCHIDS PAPER, FLAGSTAFF, AZ	40,000
BOISE CASCADE, WA	80,000
SUBTOTAL 2	**945,000**

4 NEW POTENTIAL APPLICATIONS OF TALC AS A PAPER FILLER AND COATING PIGMENT

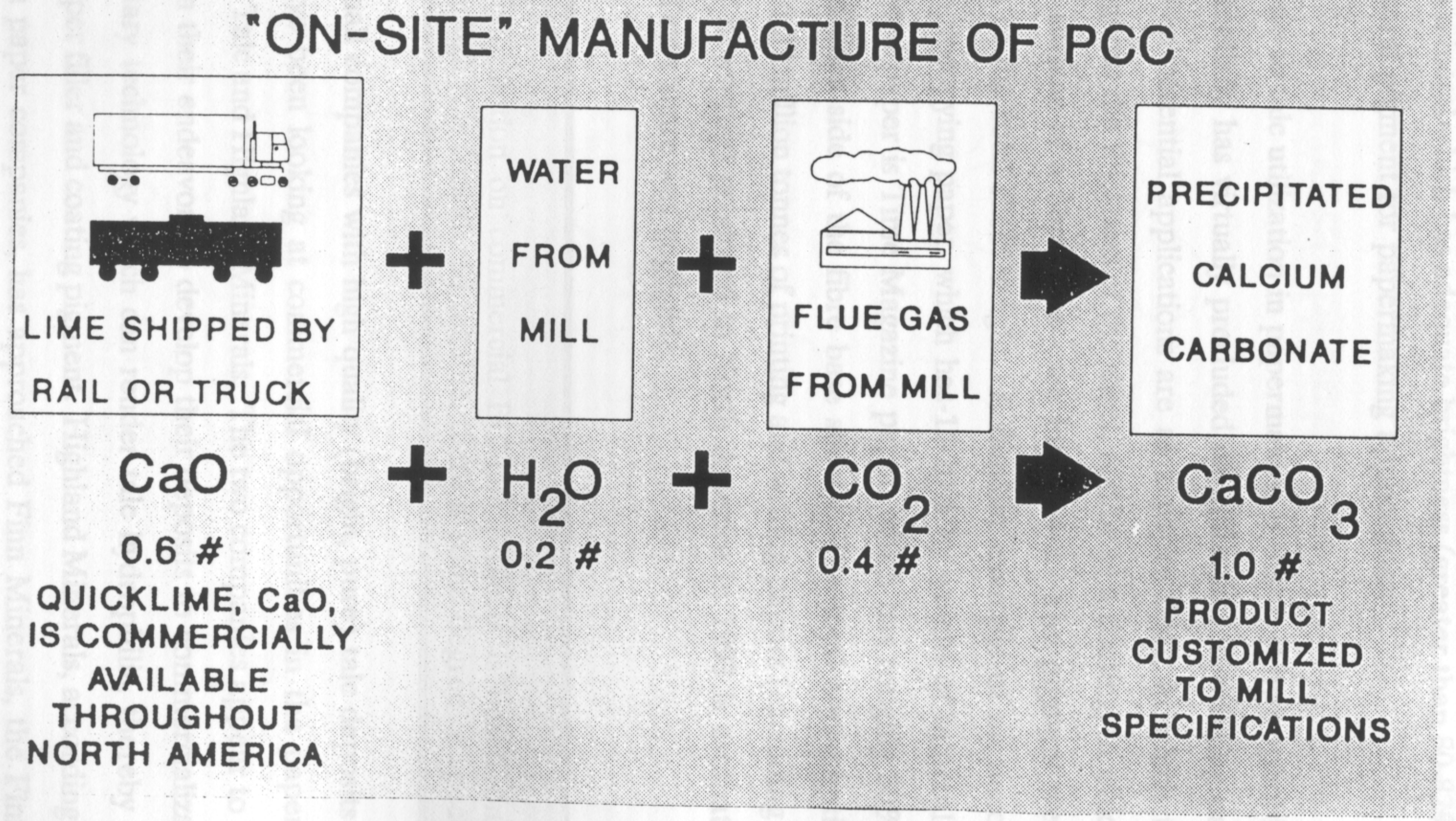
4.1 BACKGROUND

In principle, there is a large potential market for talc producers who market high grade talc for filler and coating applications in papermaking, in addition to pitch control and deinking applications. A recent parallel example has been the phenomenal penetration of precipitated calcium carbonate (PCC) and neutral/alkaline papermaking (PCC goes into solution under the traditional acid conditions) in the Western North American papermaking industry.

PCC plants are commonly built on the paper mill grounds as economies of scale permit (i.e. as the paper mill demand is sufficient to justify building a plant), but are normally owned and operated under long term contract by the PCC supplier company. This essentially eliminates transportation costs for delivering the mineral to the paper mill. Depending on the contract, producers will sell PCC under long term contract (10 years) for as little as CAN$(200-225)/tonne. For a high brightness product (brightness around 95%), this is a highly competitive price vs. kaolin in the 83-92% brightness range, which delivers at anywhere from CAN$300 to CAN$700 per tonne, depending on grade - see Table 2-2. Figure 4-1 shows the principle of on-site PCC.

By far the largest and most successful has been Specialty Minerals Inc (SMI), previously known as Pfizer. The rate at which the Western paper industry accepted PCC, was roughly double that of the rest of North America. We believe that this is largely due to the fact that the Western industry is more sensitive to pigment transport costs from the pigment origin in the US South than any other regional industry. In fact, between the mid-1980's and early 1990's virtually all the fine paper operations West of the Rockies had been converted to calcium carbonate and alkaline/neutral papermaking, whereas only something around 40% of the rest of the North American fine paper capacity had been converted. Clearly, there are significant opportunities for a Western regional pigment supplier, and talc seems to be

Figure 4-1



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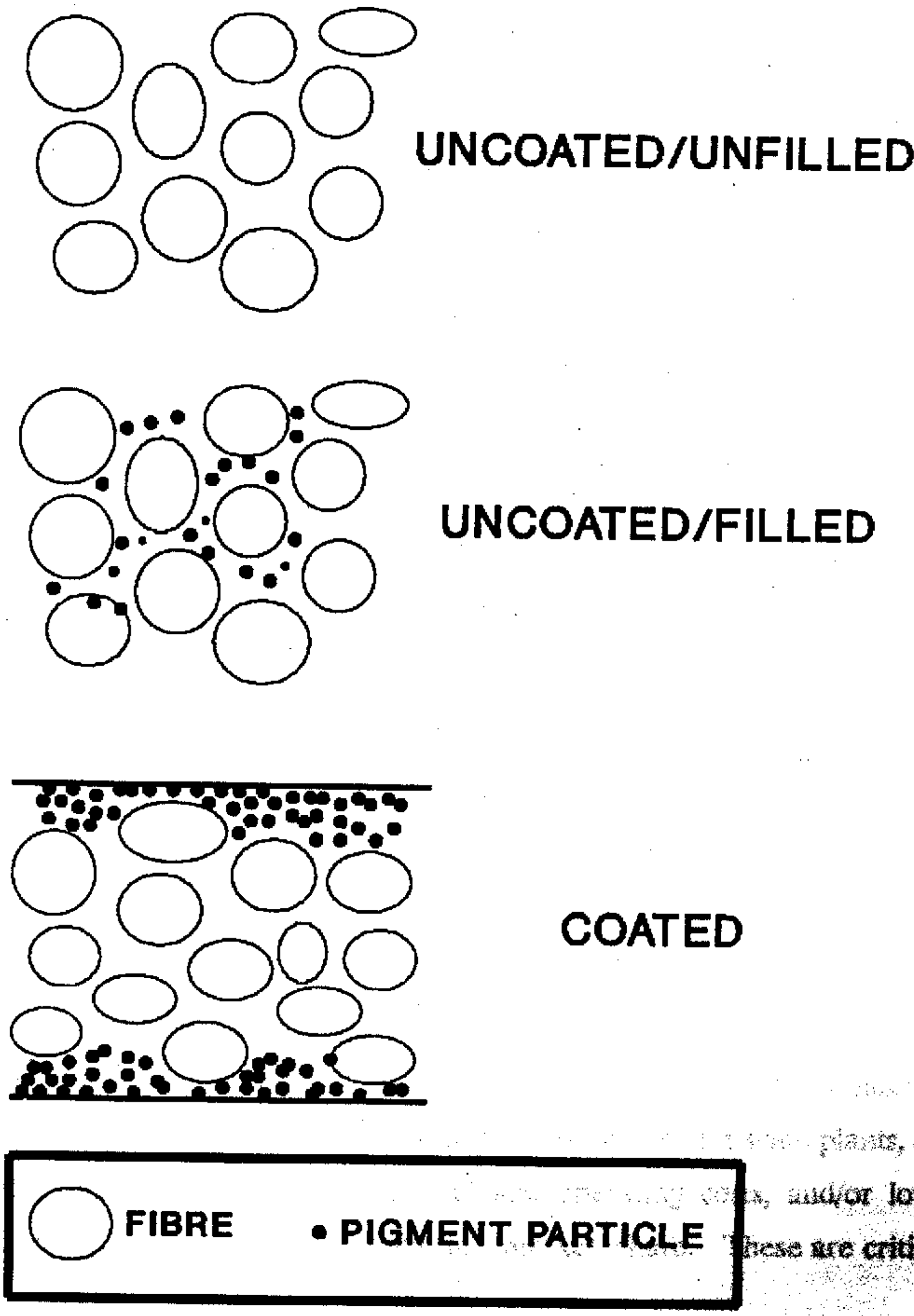
the one Western mineral which has adequate brightness (greater than 80-82%) to qualify as a high value mineral pigment for papermaking applications.

The major obstacle to talc utilization in papermaking is that it is hydrophobic, as discussed earlier. This essentially has virtually precluded its utilization in printing papers in North America. The two potential applications are as a paper filler, in which the pigment is distributed throughout the thickness of the sheet, and/or as a coating, in which the pigment is applied to the surface of a fibre base - see Figure 4-2. The pigment weight can be as much as 30-35% of the total sheet weight. A familiar example of an uncoated, pigment filled paper is photocopying paper, which has-15-20% by weight of mineral pigment. An example of a coated paper is Time Magazine paper, which has roughly 30% by weight of pigment (15% on each side of the fibre base sheet). The total consumption of mineral pigments in the 26-27 million tonnes of printing and writing papers (excluding another 15-16 million tonnes of newsprint) produced in North America in 1993 is estimated at about 6 million tonnes. Talc's share was negligible.

Note:
The following information on commercial BC talc projects is based on market intelligence. Although it is considered reliable, there is some degree of speculation in it.

There are two small companies with high quality (bright, pure) talc deposits in BC, which are known to have been looking at commercial opportunities in the papermaking field. These are Pacific Talc and Highland Minerals. The two companies appear to have followed different routes in their endeavors to develop their deposits to commercialization. Pacific Talc has proprietary technology which can render talc hydrophilic, thereby facilitating its utilization as a paper filler and coating pigment. Highland Minerals, according to statements made to Western paper companies, has approached Finn Minerals, the Finnish company which has had twenty years expertise in utilizing talc as a papermaking mineral pigment for filling and some coating applications, for know-how. The talc in this case is apparently still

Figure 4-2
UNCOATED, FILLED AND COATED PAPER STRUCTURE



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hydrophobic, but is rendered usable in papermaking and coating by resorting to chemical (dispersion agents) and mechanical (ultra high shear) treatment. The concern still remains, in this case, that the talc is still hydrophobic after papermaking, and would react adversely with the water applied in the offset printing process, which is more prevalent in North America - see Figure 2-5.

Based on talc's technical strengths, namely low abrasion, relatively high brightness, and high aspect ratio (which is very desirable in gloss development for uncoated and coated advertising- driven papers such as inserts, catalogs and magazines) we foresee applications initially as a filler and ultimately a coating pigment. The strongest potential is in mechanical pulp based papers, where calcium carbonate cannot normally be used due to the fact that these papers must be produced under acid papermaking conditions (otherwise the mechanical pulp yellows) such as are made by several Western producers.

In BC, Fletcher Challenge and MacMillan Bloedel are two prominent companies which already use other papermaking pigments, primarily kaolin from the US South. However, competing with PCC in fine (no mechanical pulp) papers will be much more difficult, since PCC has a higher opacifying power (light scattering coefficient) and brightness. Furthermore for uncoated fine papers, used primarily in photocopying, business forms and commercial printing, gloss development is not a critical performance parameter, and it is difficult to see how another pigment can compete with PCC.

Competition is healthy in a given market, and the mineral pigments market in Western North America is no exception. However, we feel that, if both Pacific Talc and Highland Minerals build talc plants to produce papermaking grade talc for the Western North American market, they will find themselves into a no-win situation, where each of them has about a 50% share of a rather limited market. This implies either smaller scale plants, and therefore higher unit (per tonne of product) capital and operating costs, and/or lower capacity utilization and low prices as they fight for market share. These are critical considerations weighing heavily against the success of these projects, especially since both companies have very limited technical and financial resources, and they will be competing for market share with existing kaolin and calcium carbonate suppliers. Finally, the established and successful mineral pigment suppliers have a heavy investment in technical expertise, both in laboratory/pilot plant equipment and in scientific expertise. The chances of success for a potential papermaking talc development project in BC will be strengthened significantly by a partnership or alliance with one of the existing papermaking pigment suppliers.

4.2 END-USE VALUE ANALYSIS

Based on Temanex work over the last 6-7 years we have defined a unique Value Index for printing papers. This is $/Area, which is the true value to the printer. As shown in Appendix 1, increasing brightness and print gloss increases product value. The addition of talc would increase both of these performance parameters.

It was not within the terms of reference of this project to run papermaking trials to define the potential increase in brightness and print gloss. However, based on the application of established theories of optical properties of paper, and the high aspect ratio of talc particles (which enhances gloss development) we expect roughly the following contributions per percentage point of talc added to paper furnishes, such as groundwood specialty advertising papers:

- 0.2-0.3 percentage points of brightness increase;
- 0.4-0.6 percentage points of print gloss increase.

Assuming an addition level of 10% talc the brightness and print gloss increases translate to a value number of incremental paper value as follows:

- Brightness increase : $15/tonne of 50 gsm per tonne;
- Print gloss increase: $40/tonne of 50 gsm per tonne.

5 MINERAL PIGMENT CAPITAL AND OPERATING COST ANALYSIS

5.1 BACKGROUND AND BASIC ASSUMPTIONS

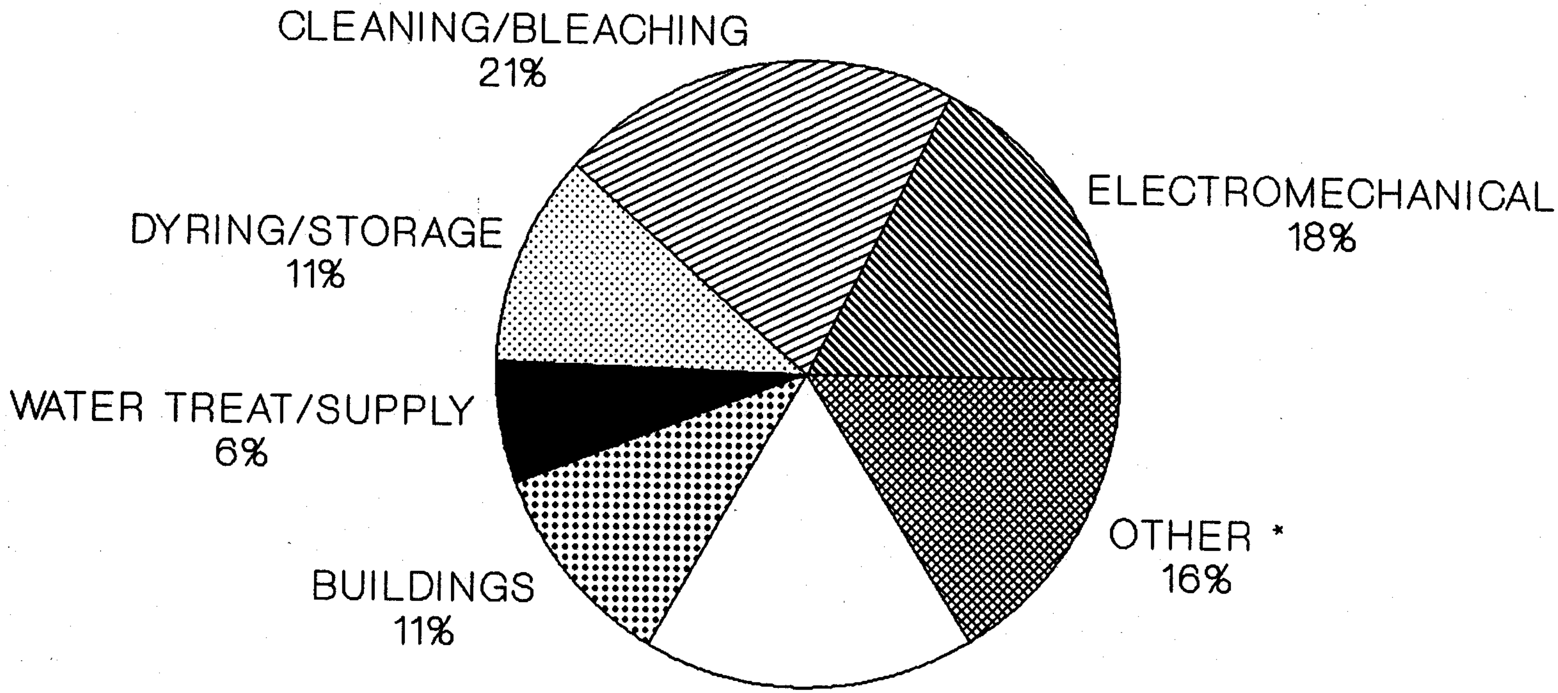
The terms of reference of this project included an update on financial aspects of talc projects in BC. In view of it being an update, we were given to believe that some work in the area of financial analysis had already been done. In retrospect, the only available report was prepared by Temanex Consulting Inc. and it covered talc markets but did not address any economic or financial concerns. Therefore, the economic analysis in this chapter had to be built up from existing information in the Temanex database about the manufacturing economics of similar mineral pigments, specifically water-washed kaolin. Neither the budget nor the scope of the project made allowance for a detailed capital cost analysis for a talc facility. Therefore, for this rough, order of magnitude estimate, the costs of mining, processing, and shipping talc are assumed similar to those for water-washed kaolin clay.

Throughout this chapter, except where otherwise stated, prices and costs are given in Canadian dollars per metric tonne. Conversion of US to Canadian dollars is based on an exchange rate of Can $1.32 = US $1.00.

5.2 CAPITAL COSTS

Capital related costs for a talc processing facility with capacity of 100,000 tonnes per year are estimated at $45 million to $50 million. As shown in Figure 5-1, the single largest cost component is cleaning and bleaching equipment, followed by electromechanical equipment (e.g. blunger, degritter, size classifier, and magnetic separator) and drying/storage equipment (e.g. spray drier and storage silos). Based on 15 year amortization and an interest rate of 8%, an investment of $45-$50 million for a 100,000 tonne per year plant translates into an annual levelized cost of $50-$55/tonne.

Figure 5-1
CAPITAL COSTS FOR 100,000 TONNES PER DAY TALC OPERATION



TOTAL: $45 MILLION - $50 MILLION

*** PIPELINE, LOADOUT SYSTEM, MAINTENANCE LAB, OFFICE EQUIPMENT, UTILITIES**
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The capacity of processing plants varies, typically between 50,000 tonnes and 150,000 tonnes, depending on market and financial considerations. As shown in Figure 5-2, economies of economies of scale. The capital cost per installed tonne ranges from \$380-\$390/annual tonne for capacity of 150,000 tonnes per year to-\$660-\$670/annual tonne for capacity of 50,000 tonnes per year. An itemized breakdown of capital costs for capacities of 50,000 tonnes per year, 100,000 tonnes per year, and 150,000 tonnes per year is shown in Table 5-1.

5.3 OPERATING COSTS

Aside from capital related costs and freight, operating costs fall into two categories; namely mining and processing. Processing, which includes personnel, chemicals, and energy, is by far the more costly of the two. This is illustrated in Figure 5-3. In a 100,000 tonne per year operation, for example, operating costs associated with processing are about \$85/tonne whereas mining costs are only \$5-\$10/tonne. A detailed breakdown of operating costs for three different sized talc operations is shown in Table 5-2.

TABLE 5-2

PRELIMINARY ESTIMATE OF OPERATING COSTS FOR TALC
(CAN \$/TONNE)

DESCRIPTION	150,000 TPY	100,000 TPY	50,000 TPY
Personnel	19	26	47
Chemicals	33	33	33
Energy/Fuel	22	23	29
Mining	7	7	7
TOTAL	81	89	116

Again, as in the case of capital related costs, there are economies of scale in operating costs.

Figure 5-2
ESTIMATED CAPITAL COST PER TONNE OF INSTALLED CAPACITY FOR TALC PLANTS

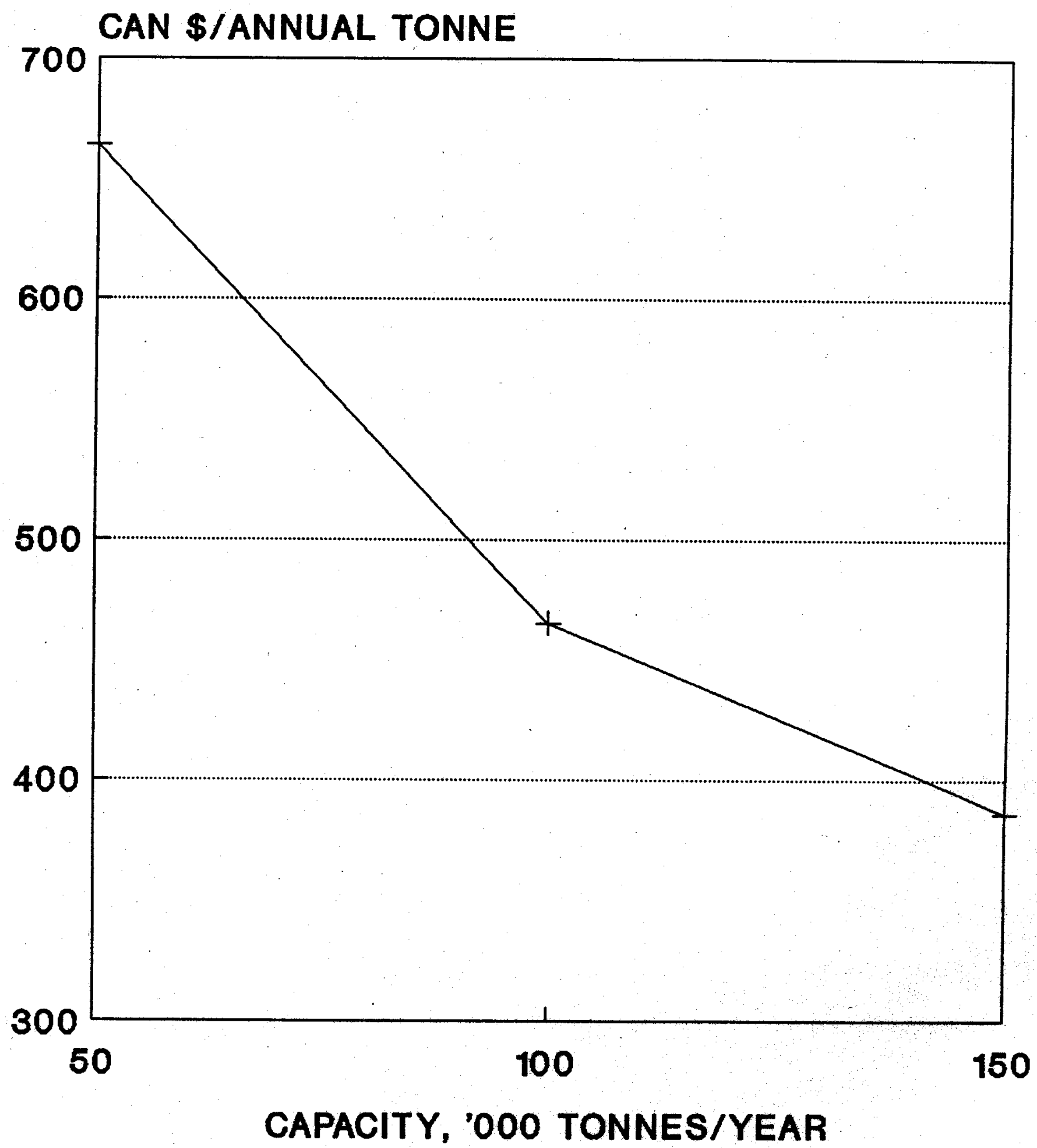

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TABLE 5-1

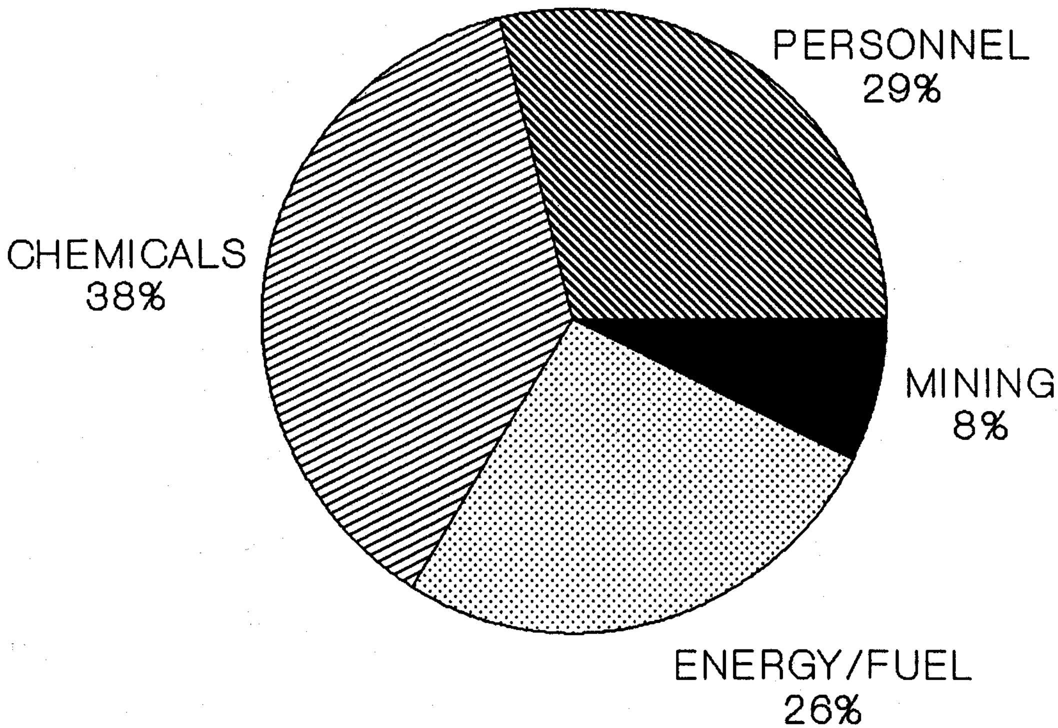
CAPITAL COSTS FOR TALC OPERATION (CAN $)

DESCRIPTION	150,000 tpy	100,000 tpy	50,000 tpy
Blunger/Degritter	1,700,000	1,500,000	1,200,000
Size Classifier	4,000,000	3,200,000	2,500,000
Magnetic Separator	3,700,000	3,500,000	3,200,000
Sub-total electromechanical	**9,400,000**	**8,200,000**	**6,900,000**
De-sliming system	3,700,000	2,700,000	1,600,000
Bleaching system	5,000,000	4,000,000	2,800,000
Filtration System	4,300,000	3,000,000	1,700,000
Sub-total cleaning/bleaching	**13,000,000**	**9,700,000**	**6,100,000**
Spray drier	6,000,000	4,600,000	3,000,000
Storage silos	700,000	500,000	400,000
Sub-total drying/storage	**6,700,000**	**5,100,000**	**3,400,000**
Water Treatment & Supply	3,500,000	3,000,000	1,800,000
Buildings & Foundations	6,000,000	5,000,000	3,000,000
Eng, Contingency, & Admin	10,000,000	8,000,000	6,000,000
Other	9,300,000	7,500,000	6,000,000
TOTAL CAPITAL COST	**57,900,000**	**46,500,000**	**33,200,000**
$/ANNUAL TONNE	**386**	**465**	**664**
ANNUAL LEVELIZED $/TONNE	**45**	**54**	**78**
(@ 8% interest over 15 years)			

Temanex Consulting Inc, 09-Feb-94 (COST.WK1)

Figure 5-3

OPERATING COSTS FOR 100,000 TONNES PER DAY TALC OPERATION *



TOTAL: $85-$90/TONNE

* COSTS INCL. PROCESSING PERSONNEL, CHEMICALS, ENERGY, FUEL & MINING

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As shown in Table 5-2, the economies of scale in operating costs are largely in personnel and to a lesser degree in energy costs. There do not appear to be any significant economies of scale in either of the variable cost inputs, i.e., chemical or mining. Economies of scale for total operating costs are shown in Figure 5-4.

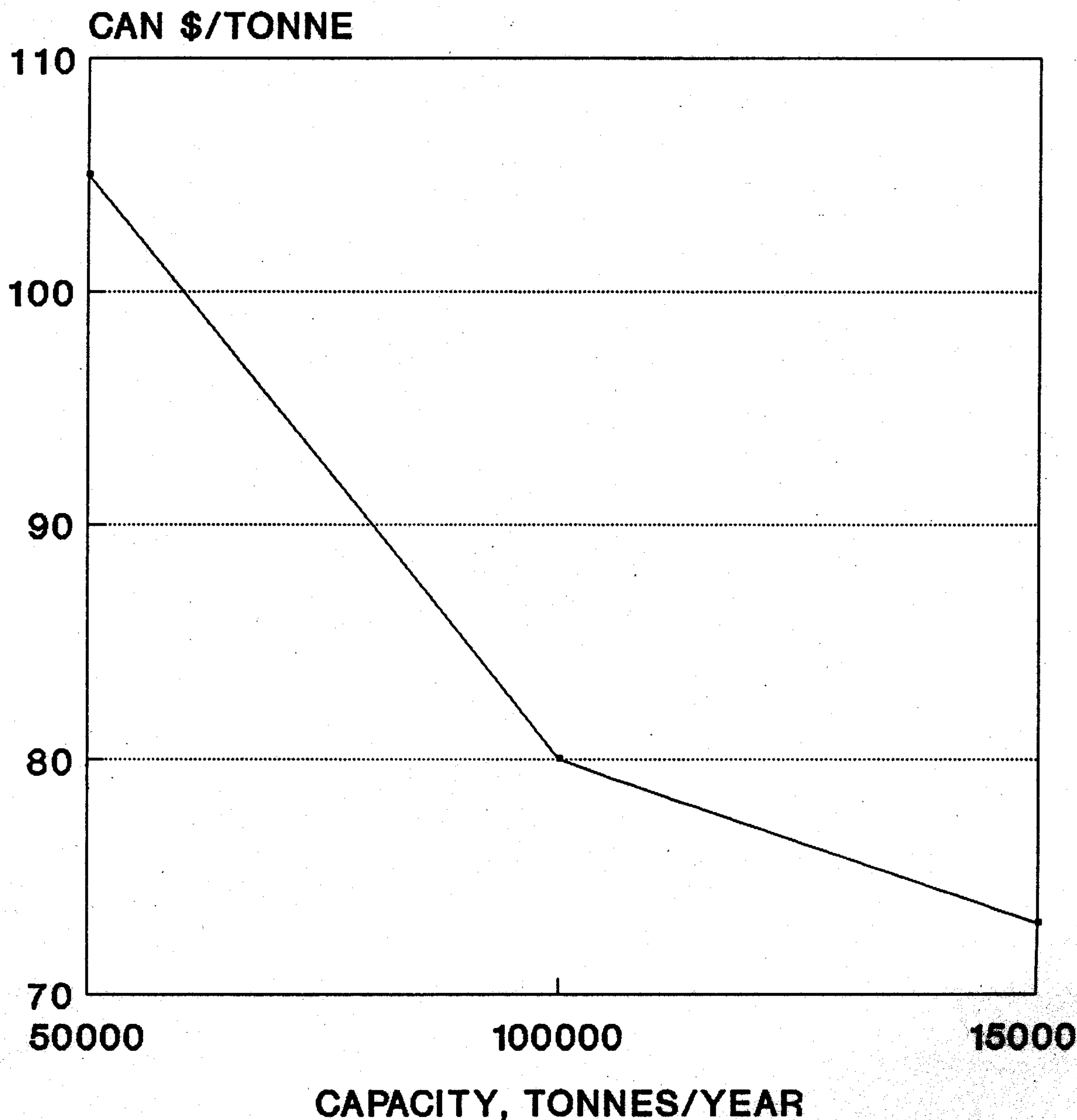
5.4 COMPETITORS AND TALC TRANSPORT COSTS TO POTENTIAL CONSUMERS

The Western North American talc market is currently supplied primarily from Montana as a result of Montana's geographical proximity to the Western market. All the major talc suppliers (Luzenac America, Specialty Minerals and Montana Talc) have talc properties in Montana. Montana talcs are high quality products, bright, pure and, compared to some other regions of North America, free of tremolite. Their best application is in pulp or paper mill pitch control and stickies control in wastepaper recycling and deinking. Typical properties of one of well known talcs used by Western North American paper mills is found in Appendix 2 from a Cyprus Minerals (now Luzenac America) sales brochure. None of these companies appears to have any inclination or proprietary technology to produce hydrophilic talc for true filler or coating applications in papermaking.

Appendix 3 provides information on talc quality for product originating from China. In the long term, this type of offshore product may provide some degree of competition to B.C. talc products. However, based on market intelligence and the experience of North American mineral pigment companies which have been trying to develop Chinese business relations, there will be persistent obstacles to significant market penetration in this region based on concerns with product quality, its uniformity, and reliability of delivery.

As shown in Chapter 2, the talc transportation cost from Montana to the West Coast of Canada appears to be in the range of Can $50-$70/tonne, based on Can $30-$40/tonne for rail freight from Montana to Vancouver or Prince George and an additional Can $20-$30/tonne for truck or rail from there to individual pulp or paper mills. This is based on information obtained from paper companies using talc in seven Western mills.

Figure 5-4
TALC OPERATING COSTS -
ECONOMIES OF SCALE *



* COSTS INCL. PROCESSING PERSONNEL,
CHEMICALS, ENERGY, FUEL & MINING
TEMANEX CONSULTING INC (198F5-4)

On the basis of our discussions, freight rates vary depending not only on distance but also on other considerations such as routing, mode of transport and whether talc needs to be reloaded, for example from rail to truck, before reaching its final destination. For example, the price of shipping talc from Montana to Prince George is Can $10-$20/tonne less than the cost of shipping to Vancouver and the difference is even greater between Interior and Coastal mills since talc is typically reloaded onto trucks before arriving at Coastal mills.

Table 5-3 gives estimates of freight costs for talc originating in BC and destined for Western markets. We assume that BC talc would originate in southwestern BC (near Hope) where both the current proposed talc operations (Pacific Talc and Highland Minerals) would be situated. Costs in Table 5-3 are preliminary. They were estimated on the basis of information in the Temanex database about the cost of shipping mineral pigments between a variety of existing origins and destinations.

TABLE 5-3
FREIGHT COSTS FOR BC TALC TO WESTERN MARKETS

DESTINATION	CAN $/MT
British Columbia	20-30
Alberta/Washington/Oregon	30-40
California	40-60

5.5 SUMMARY OF COMPETITIVE POSITION OF BC TALC

At this early stage of analysis, the principal cost advantage for BC producers will be the low freight costs compared to competing suppliers in Montana. For a talc operation with capacity of 100,000 tonnes per year, total cost per tonne is in the range of **$160-$210/tonne** as shown in Table 5-4. Capital costs make up 25%-35% of total costs, operating costs make up 45%-55%, and freight makes up the remaining 15%-25%.

TABLE 5-4

COST SUMMARY FOR BC TALC

DESCRIPTION	CAN $/TONNE
Operating Costs	90-95
Capital Related Costs	50-55
Freight	20-60
TOTAL	160-210

On the assumption that typical shipping costs from Montana to the West Coast are now in the order of Can $50-$70/tonne and that BC Talc would be shipped for Can $20-$60/tonne depending on the distance to markets, the cost advantage of BC producers may be negligible to California, but BC producers should have a cost advantage of about $30/tonne in BC and the US Pacific Northwest.

6 SUMMARY FORECAST 1993 TO 2003

Based on the discussion in the previous chapters, we have produced most likely, optimistic and pessimistic scenarios for conventional talc demand in Western North America. These are shown as trend lines in Figure 6-1. Table 6-1 shows end use market segment and geographical breakdown for the most likely scenario.

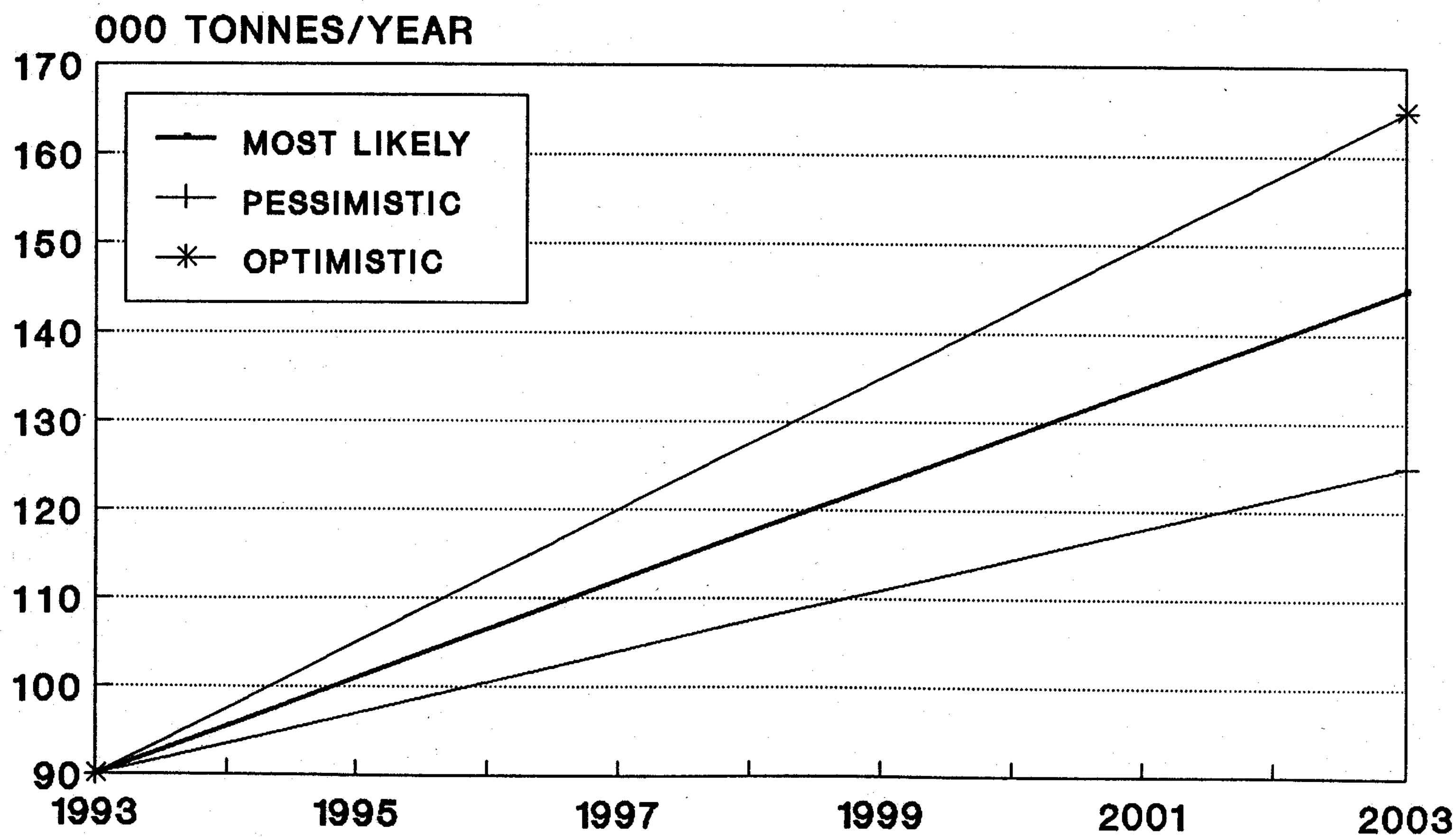
TABLE 6-1

WESTERN NORTH AMERICA EXTENDER AND FILLER TALC FORECASTS (CONVENTIONAL, HYDROPHOBIC TALC - IN 000 TONNES/YEAR)

END USE	1993	2003
END USE		
Pulp & Paper - Conventional (pitch/stickies control)	28	65
Paint	35	45
Other (adhesives, tires)	27	35
Total	90	145
GEOGRAPHICAL (ESTIMATES ROUNDED OFF)		
British Columbia	15	20
Alberta+	10	15
Washington+	15	20
Oregon+	15	20
California*	30	45
Other*	10	25
Total	90	145

+ Mostly pulp & paper * Mostly paints and other industrial products

Figure 6-1
W. N. AMERICA CONVENTIONAL* EXTENDER & FILLER TALC CONSUMPTION FORECAST**



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*HYDROPHOBIC
**TREND LINE

Figure 6-2 shows one possible scenario for hydrophilic talc potential. The following assumptions are made:

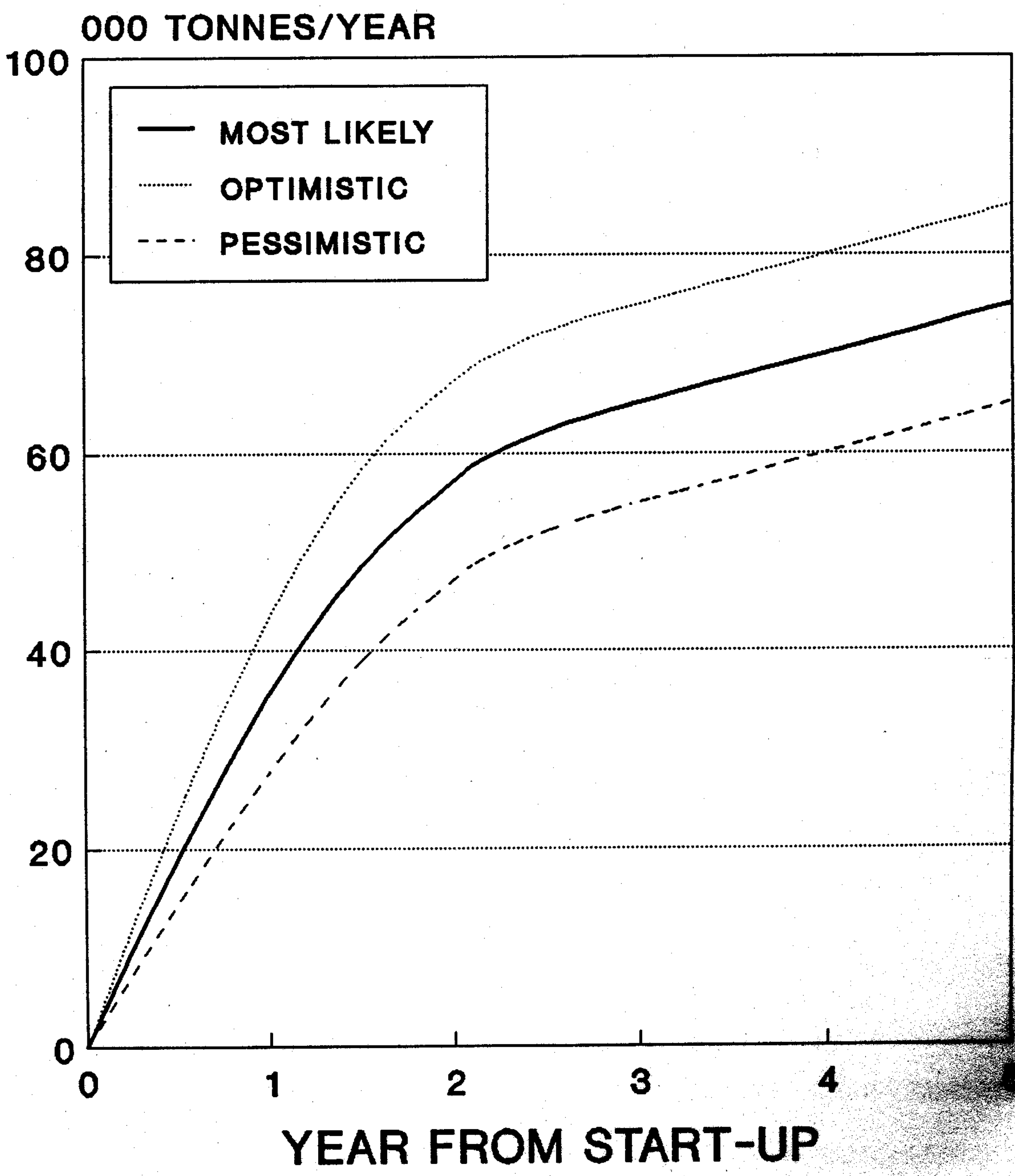
a) A 10-12% penetration in the Western North American paper filler and coating market. This assumption, at first glance, looks conservative. After all, a single regional pigment supplier (i.e. with no other local competitor) should be looking at a potential market penetration of about 30% or more of the available market. In reality, we must remember that calcium carbonate has a rather unshakeable hold as the pigment of choice for fine papers (see section 4.1). We estimate that calcium carbonate will account for at least 50% of total papermaking mineral pigment in the year 2003. Therefore, since hydrophilic talc is only likely to penetrate the remaining 50% share of the regional paper pigments market, the effective penetration will be a reasonable 20-25%. This is about what would be expected from a regional producer and a new pigment product, rather than the more conservative 10-12% that would be calculated based on the total papermaking pigments regional market size;

b) Commercial plant start-up occurs during the period 1995 to 1999;

c) The regional pigment supplier faces the technical and selling challenges of a new product introduction professionally, and furthermore has adequate financial, technical and marketing resources to accomplish the objective of successful market penetration.

In summary, there is a significant potential for British Columbia talc development to supply the Western North American market. As stated earlier, one B.C. producer will have a much stronger chance of success and much more favourable economies of scale than two competing suppliers each trying to carve up about a half share of the market.

Figure 6-2
HYDROPHILIC TALC PENETRATION SCENARIOS IN PAPER FILLER/COATING APPLICATIONS



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APPENDIX 1

"AN INDEX TO DETERMINE THE RELATIVE VALUE OF PAPERS"

Temanex Consulting has developed an index to determine the relative value of papers, based on performance. Company president, George Ionides, explains, using MFC as an example.

Know what your paper is really worth

DURING THE LAST 10-15 years, there has been a significant increase in the number of alternative pulp, papermaking pigment and paper products competing in the same or similar end-use markets. This has been the result of on-going technological and market evolution, both in the production and in the end-use of paper products. Nowhere has this been more evident than in printing or graphic papers.

In market pulps, the dominant share of northern softwood kraft has been eroded by competing products in the last 10-20 years. First, in the 1960s and 1970s, came southern softwood, northern and southern hardwood, and eucalyptus kraft pulps. The 1980s and 1990s saw the introduction of hardwood and softwood bleached CTMP market pulps. In papermaking pigments, ground calcium carbonate and talc in Europe and precipitated calcium carbonate (PCC) in North America continue to gain market share against the dominant kaolin in both woodfree and, in the future, mechanical printing papers. In the 1960s and early 1970s, the mechanical printing papers spectrum in North America consisted of newsprint and LWC at the low- and high-quality ends, with a small component of directory paper between them. However, during the last 10-15 years, an impressive array of new and improved products was introduced to this market. This included dozens of grades of unfilled or very lightly filled machine-finished (MF) grades such as rotonews and MF high brightness (heatset web) offset, as well as supercalendered A grade (SCA) and B grade (SCB) and, since 1986, machine-finished coated (MFC) from Finland.

Many of the products in a given market compete, at least in some end-use sectors, with one another. For example, market bleached CTMPs are used in tissue/towel products as partial substitutes for bleached kraft pulps. PCC is used in uncoated woodfree papers to displace kaolin. SCA competes with LWC in inserts, catalogs and some magazines. On the other hand, there are grades in a given product spectrum which clearly cannot be substituted. For example, it is inconceivable to use uncoated woodfrees or LWC for newspapers, but both newsprint and LWC can be used to print inserts, depending on the sensitivity of the paper end-user to the print quality and differences in cost between these two grades.

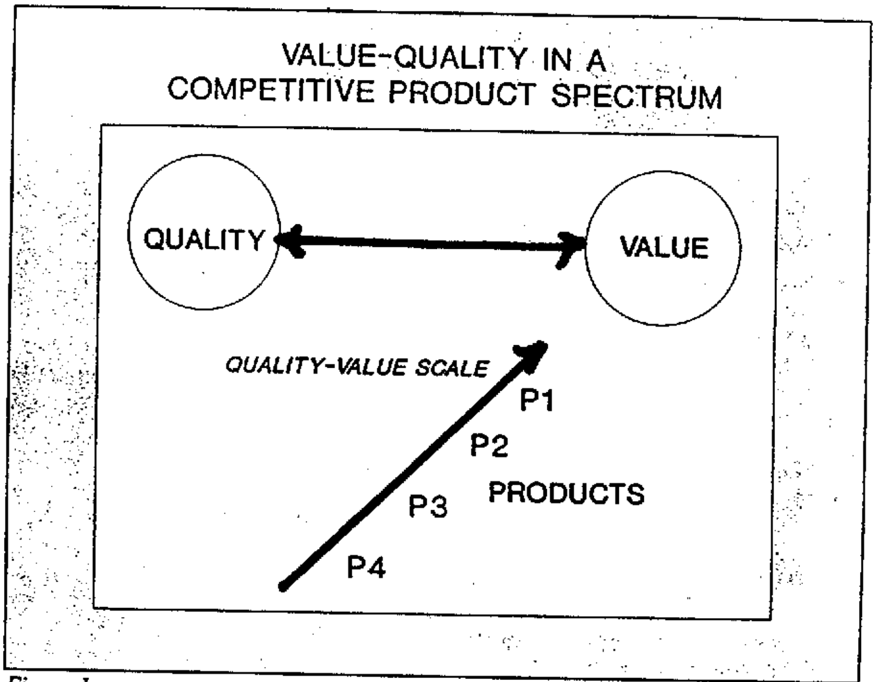

Figure 1

Know where your paper stands

The key question in attempting to bring rationality to such a market segment is: "How does the position of a given product relative to other, competing and non-competing grades in the same grade spectrum become defined?" The answer to this question has been clouded with confusion in the past. Furthermore, the increasing number of alternative products, and competitive pressures for technological innovation to improve profitability, make it imperative to have a rational way of defining product value. Work carried out at Temanex Consulting during the last few years, first with printing papers and, more recently, with market pulps and papermaking pigments, has defined a rational approach to definition of product value and therefore price position in a given market. The philosophy throughout this work has been to relate product value to product performance in its end use. Although the raw material composition of a paper (pulps and pigments) will no doubt have an effect on performance, it should not be the primary determinant of product value and positioning in a competitive spectrum. The general approach and some of its benefits are described below.

What makes a valuable product?

In an unrestricted and unregulated market, the relative price of similar, competing products is normally defined according to the perceived quality and value of each of these products in relation to the others (see Figure 1). This value perception, and the resulting price relation, have not been rationally defined either for paper products themselves or for the major raw materials (pulps and pigments) used to make paper. It is well known, for example, that brighter pulps and

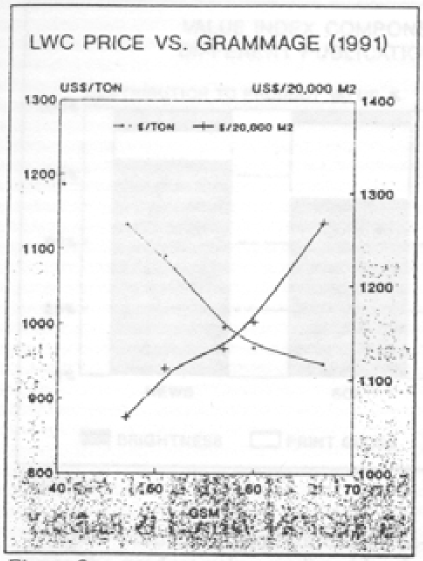

Figure 2

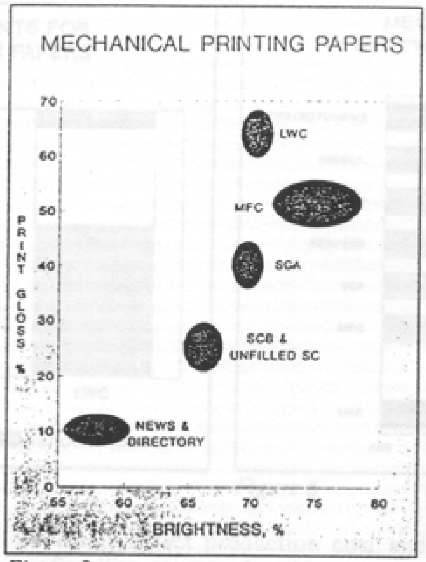

Figure 3

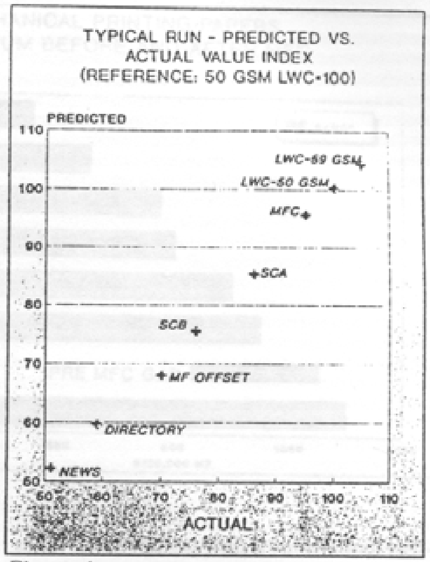

Figure 4

papers will command a higher price than less bright ones. Also, stronger pulps will normally cost more than equivalent brightness but lower-strength pulp grades. However, what combination of product quality or performance parameters sets the actual product value relative to other products?

A prerequisite to rationalizing price-quality relationships is that there should be an underlying connection among competing grades. This relation essentially defines the grade spectrum boundaries. A well known spectrum which Temanex has studied in depth and which is used as the working example in the following analysis is the mechanical printing papers spectrum. These are highly cost-effective (in terms of cost per unit area), relatively lightweight printing papers. They include newsprint, uncoated groundwoods (directory, improved newsprint and SC) and coated groundwoods (LWC and MFC). The underlying connection among them is that their primary end-use and demand growth is driven by advertising expenditures and advertisers' needs. Other printing papers, e.g. uncoated woodfree business papers, such as

VALUE AS % OF 50-g/m² LWC	
Grade	Value index
59-g/m² LWC	105
50-g/m² LWC (reference)	100
MFC	95
SCA	86
SCB	76
MF offset	70
Directory	59
Newsprint	51

copier, envelope, and so on, are too remote in their end uses from mechanical printing papers and cannot be considered as part of the same spectrum.

Ascertaining true value

In attempting to rationalize value-quality relationships among mechanical printing papers, it is important first to define the true value/price of a product. Cost per unit area is used as the true product value parameter. This is the most meaningful definition, as opposed to the more commonly used (for convenience) cost/ton, since paper products are produced and consumed by area rather then weight. For example, only 75 tons of a 45-g/m² paper are needed to print the same number of catalogs as 100 tons of a 60 g/m² paper. In the mathematical analysis, dollars/20,000 m² has been used as the product value parameter. This is convenient, since 20,000 m² equals one ton for a paper of 50 g/m² weight. However, price and value index change over time, both in real and nominal currency terms. Therefore, the value of individual products will be expressed as a percentage of a 50-g/m² LWC. Table 1 shows the position of some key grades in the spectrum relative to 50-g/m² LWC. Figure 2 shows the price ($/ton) and value ($/20,000 m²) for LWC in 1991.

The second step is to relate the product value to desirable and measurable product performance parameters. For mechanical printing papers, the major performance requirements are printability and runnability. Printability is quantified as brightness and print gloss. Print gloss becomes increasingly important as the quality and value of a product increase. Figure 3 shows the location of some major grades in the spectrum.

As shown in Figure 5, runnability makes a much smaller relative contribution to the product value compared to print ability. But this does not mean that it is not an important quality requirement. Good runnability is a primary performance requirement for all these products. It was found to be necessary to include a quantitative runnability parameter in the value model in order to strengthen the model's capabilities to define value quantitatively. Defining runnability by a quantitative, measurable parameter, however, presents a much greater challenge. The number of paper breaks per 100 rolls run is the most natural parameter to use conceptually, but it is only definable with large statistical uncertainty and is therefore of little use here. Reinforcing kraft pulp content has been used as the most convenient parameter to quantify runnability. Furthermore, to eliminate confusion when stronger mechanical pulps are used in a given grade (e.g. TMP rather than groundwood in newsprint), it was found to be necessary to normalize the reinforcing chemical pulp content to the traditional, dominant mechanical pulp, i.e. northern softwood stone groundwood.

The equation relating the relative product values in the table to the corresponding runnability and printability parameters is:

Relative Value Index = 0.75*(% brightness) + 0.67*(% print gloss) + 0.18*(% kraft content).

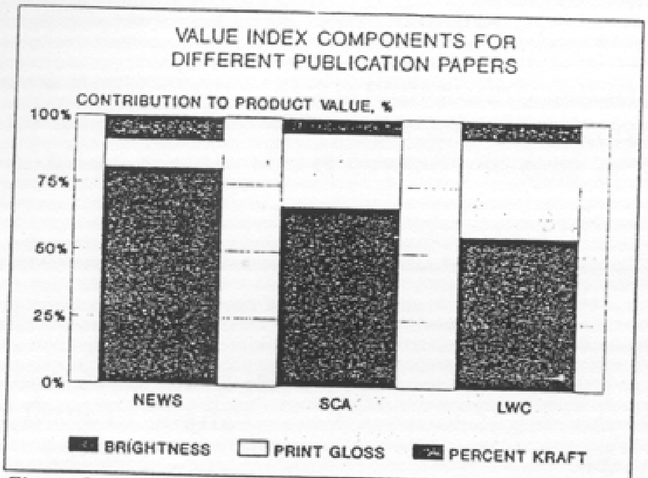

Figure 5

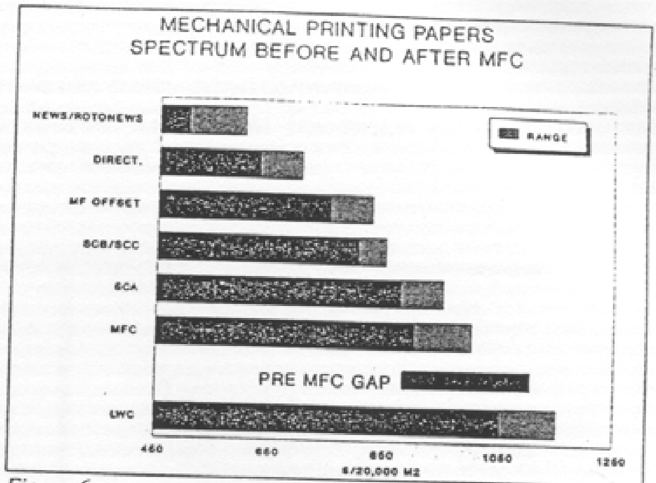

Figure 6

Figure 4 shows the good correlation between the product value predicted by the model and actual market value. Clearly, the model provides a precise definition of product value in the spectrum of woodcontaining publication papers from newsprint to LWC. It can be used in a variety of strategic decisions, in particular with regard to comparing profitability of alternative grades and defining the correct competitive positioning of new grades. A working example, using the development and positioning of MFC in the spectrum during the last 5-6 years, is outlined later in this article. It should be noted that implicit in the model is the assumption of spectrum continuity, as opposed to discrete grade positioning of a few notable grades. Defining grade quality and value into discrete boxes (e.g. the outdated North American classification of coated papers as Nos. 1-5 using brightness as the primary and gloss as the secondary determinant) is an anachronism in today's diverse, competitive markets.

Figure 5 shows the relative contribution of the measurable printability and runnability parameters to product value for major products in the mechanical printing papers spectrum. As a general observation, the higher the product quality and value, the greater the importance of print gloss becomes. Also, as mentioned above, although the runnability parameter as defined in this model appears to make a small contribution to product value, it is really more an indication of a necessary prerequisite to the product's acceptance by the market. This does not mean product value should be improved by increasing reinforcing kraft content, which would adversely affect production cost and profitability, among other things.

Positioning MFC: A practical example

MFC, as it is known and used in North America and Europe, was developed in Finland in the mid-1980s. Prior to its development and introduction to these markets, there was a relatively large gap between the value ($/20,000 m^2) of LWC and the next grade in line, namely SCA. This gap was of the order of 15-20% of the LWC value, i.e. almost 30-40% of the full range of the values of mechanical printing papers (i.e. the value gap from newsprint to LWC; see Figure 6). Clearly, there was a strong incentive to fill the gap with a new grade, in this case MFC.

When MFC first arrived in North America in 1986-87, with a brightness of 72-74% and a relatively low paper and print gloss, its price was initially positioned roughly halfway between LWC and SCA, at about 7% below LWC. Since then, continuing brightness and print gloss improvements, and appreciation of some of MFC's special positive attributes, have resulted in a price which, at a given grammage, is only about 4-5% lower than LWC, and is at about the level predicted by the Temanex value index equation. Nevertheless, as MFC quality continues to improve, its value can be expected to continue approaching that of LWC, thereby once again creating a large gap between SCA and LWC. Based on on-going evaluation of opportunities in the spectrum of mechanical printing grades, it is believed that a lightly-coated (2-3 g/m^2 pigmented coating per side) grade, similar to some Japanese coated groundwood grades, will be the next generation MFC-type grade to enter the spectrum with a value about halfway between SCA and LWC. It is also felt that this will be a highly profitable grade for the producer, based on its projected value (price) and production cost.

What does the future hold?

The product value index ($/20,000 m^2) represents the true value of publication papers both for the consumer and the producer. For woodcontaining publication papers, it was shown to be closely related to measurable product performance parameters representing printability and runnability - brightness and print gloss for print ability and reinforcing kraft content for runnability. There are two important, implicit underlying assumptions on which the philosophy of this approach is based. Both of these assumptions, to a large extent, represent fundamental departures from traditional product quality and value classification schemes. A first is that there should be no discrete boundaries in a competitive product spectrum delineating product groupings, but rather a continuous product spectrum with an infinite number of possibilities for grade quality-value positioning. A second implicit assumption of the model is that the primary determinant of product value is product performance in its market and end uses, rather than its raw material composition. This approach is now being extended to define the value of market pulps and papermaking pigments.

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APPENDIX 2

MONTANA TALC QUALITY SPECIFICATIONS

The Montana Talc Company

Compacted Nicron 100

For Pitch, Stickies and Gunk Control

Compacted Nicron 100 is a high-purity, asbestos-free, platy Montana talc. The high purity and ultra-fine grinding make Compacted Nicron 100 ideal for pitch control. Compacted Nicron 100 is available in bulk or 50 lb. bags. 1/92

Physical Properties

Surface Area [m^2/g (N_2 BET)]	16 ± 1
Bulk Density (lbs/ft^3)	
Loose	45
Tapped	60
Dry Brightness	85 ± 2
Oil Absorption, g/100g talc	40
Specific Gravity	2.8
Moisture	1.0 - 3.0%
Valley Abrasion	20 mg max
Acid Solubles as %CaO	0.4 max
pH	9.0

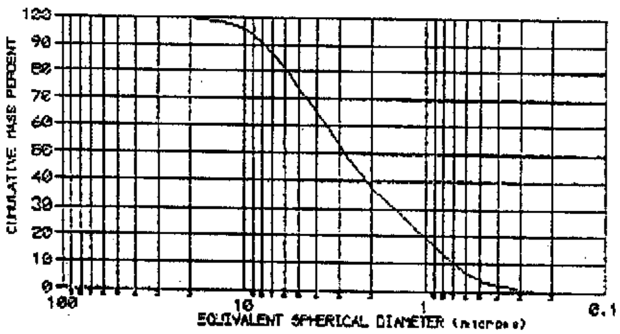
Chemical Analysis

MgO	31%
SiO_2	62%
CaO	0.5%
Al_2O_3	trace
Fe_2O_3	<1%
L.O.I.	6%

Mineral Analysis

Talc	99%
Dolomite	<1%
Chlorite	<1%
Quartz	<1%
Asbestos	None

*Particle Size Distribution



minus 44 µm	(325 mesh)	100%
minus 20 µm		100%
minus 10 µm		89%
minus 5 µm		70%
minus 2 µm		42%
minus 1 µm		28%
minus 0.5 µm		14%
minus 0.2 µm		6%
median particle size		2.8µm

*As measured by Micrometrics Sedgraph 5000

Date herein are based on most recent testing and are offered in good faith as being typical of normal production.

The Montana Talc Company • 28769 Sappington Road • Three Forks, MT 59752 • (406) 285-3286 • FAX: 406-285-3530

TYPICAL DATA SHEET

Cyprus Industrial Minerals Company

Talc Division
555 South Flower Street • Los Angeles, California 90071 • Telephone (213) 489-3700

MISTRON VAPOR

MISTRON VAPOR is a high purity, asbestos-free, natural magnesium silicate pigment. The surfaces of its ultra-fine, platy particles have a strong affinity for many types of organic molecules and, conversely, a strong hydrophobicity. However, in aqueous systems excellent wetting may be achieved by use of proper surface active agents.

Major uses of MISTRON VAPOR are as a white reinforcing filler and processing aid in elastomers and plastics, as a rheological control agent in liquid resins, plastisols, adhesives, and as a scavenger of unwanted organic matter from water slurries, for example the control of undesirable pitch build-up during paper production.

CHEMICAL ANALYSIS

	Percent		Parts Per Million
MgO	31	Pb	not detected
SiO_2	62	Sb	not detected
CaO	1	As	not detected
Al_2O_3	trace	Cd	0.5
K_2O	—	Hg	0.02
Fe_2O_3	1	Se	4
TiO_2	—	Ba (water soluble)	1.5
Loss on Ignition:			
CO_2 } Chemically H_2O } Combined	5½		

MINERAL ANALYSIS

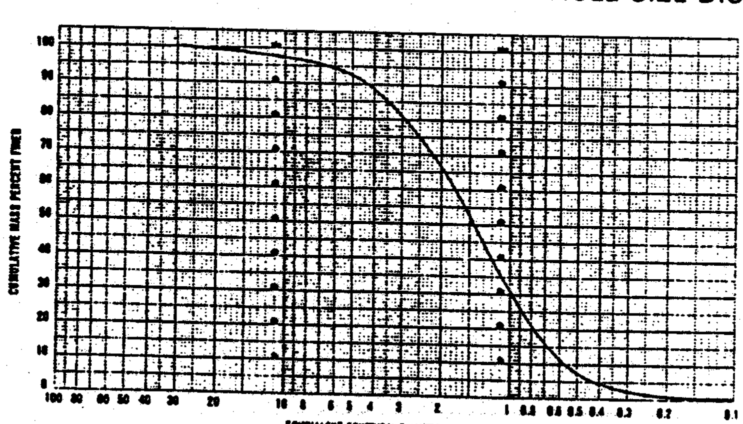
	Percent
Talc ($3MgO$-$4SiO_2$-H_2O)	98
Chlorite ($5MgO$-Al_2O_3-$3SiO_2$-$4H_2O$)	—
Dolomite ([CaMg] CO_3)	2
Quartz	1
Asbestos-type minerals	not detected

PHYSICAL PROPERTIES

Brightness, % (relative to MgO):	
General Electric	85+
Luminous (green filter)	88+
Apparent Density, lb/ft³:	
Loose (Scott Volumeter)	6
Tapped (Numinco)	13
COMPACTED	50
Specific gravity	2.8
Acid Solubles, % (as CaO)	1

Oil absorption, g/100g talc:	
Spatula rub-out ASTM D281	46
Gardner-Coleman ASTM D1483	80
Surface area, m²/g (N_2BET)	17
Hegman fineness of grind	5½-6
Adsorbed moisture, %	0.2
pH (1:5 dilution)	9
Refractive index	1.6
Valley abrasion, mg max.	20

PARTICLE SIZE DISTRIBUTION



% minus 200 mesh, 74 μm		100
% minus 325 mesh, 44 μm		100
% minus	20 μm	100
% minus	10 μm	97
% minus	5 μm	92
% minus	2 μm	65
% minus	1 μm	30
% minus	0.5 μm	7
Median particle size, μm		1½

Data presented are representative of most recent testing and are offered in good faith as being typical of normal production.

CYPRUS

APPENDIX 3

CHINESE TALC QUALITY

TALC

Origin 产地	Classification 类别	Grade 品位	Whiteness 白度	Fineness (mesh) 细度	Typical chemical composition (%) 化学成分	
					SiO_2	MgO
Pingdu, Shandong 山东平度	Powder	1	85	325	58	30
		2	80	325	53	30
		3	70	300	41	29
	Lump	1	85		58	30
		2	80		53	30
		3	70		41	29
	Granular	1	80		55	30
Qixia, Shandong 山东栖霞	Lump	Special	93		61	31
		1	90		61	30
		2	85		60	30
		3	49		61	30
	Granular	1	90		61	30
		2	84		60	29
		3	49		60	29

Origin 产地	Classification 类别	Grade 品位	Whiteness 白度（≥）	Fineness (mesh) 细度	Size (cm) 规格	Typical chemical composition (%) 化学成分	
						SiO_2	MgO
Haiyang, Shandong 山东海阳	Lump	1	85		2	40-60	30
		2	80		2	40-60	30
		3	75			40-60	30
		4	70			40-60	30
	Powder	Special	90	325			
		1	85	325			
		2	80	325			
		3a	75	300			
		3b	70	300			
		4b	60	200			
Guilin, Guangxi 广西桂林	Medical powder		90	325		60	30
	Industrial powder		80	325		60	30
	Lump	1	85			60	30
		2	80-82			58	28

Origin 产地	Classification 类别	Grade 品位	Whiteness 白度	Fineness (mesh) 细度	Percentage retained(≤) 筛余	Typical chemical composition (%) 化学成分 SiO_2	MgO
Yiexian, Shandong 山东掖县	Powder for ceramic	Special	86	325	2	61	31
		1	85	325	2	60	31
	Powder for textile	Special	90	325	0.4		
		1	85	325	2		
		2	80	325	2		
	Powder for papermaking	Special	90	325	1		
		1	85	325	2		
		2	80	325	2		
		3	75	200	2		
	Powder for medicine		85	325	2		
	Powder for cosmetic	Special	90	325	2		
	Lump	Special	90			60	30
		1	85			58	30

Origin 产地	Classification 类别	Grade 品位	Whiteness 白度	Fineness (mesh) 细度	Typical chemical composition (%) 化学成分	
					SiO_2	MgO
Yingkou, Liaoning 辽宁营口	Lump	1	90		60	30
		2	90		58	30
		3	85		56	30
	Granular	1	85		57	30
		2	85		54	30
		3	75		50	30
	Powder	1	90	325	60	30
		2	90	325	58	30
		2	90	200	58	30
		2	90	157	58	30
		2	90	100	58	30
		3	85	325	56	30
		3	85	200	56	30
		4	75	325	50	30
		4	75	200	50	30