Wood Supply – Northland and Auckland

Total wood supply for Northland and Auckland (Table 6) is highly variable, and subsequently pulp log supply (Table 7) is also variable. In reality, this potential supply will be smoothed.

Table 6 – Northland and Auckland wood supply.

	2013 - 2017	2018 - 2022	2023 - 2027	2028 - 2032	2033 - 2037	2038 - 2042
Far North	2,726,956	867,112	2,221,557	1,227,779	1,357,671	1,653,831
Whangarei	921,371	399,769	840,648	502,580	378,459	518,165
Kaipara	963,293	774,159	1,341,976	479,901	351,722	347,730
Auckland	441,570	404,255	1,316,583	1,183,937	732,387	503,082
Northland Total	**5,053,190**	**2,445,295**	**5,720,764**	**3,394,196**	**2,820,239**	**3,022,809**

Table 7 – Northland and Auckland pulp log supply at 25% of total.

	2013 - 2017	2018 - 2022	2023 - 2027	2028 - 2032	2033 - 2037	2038 - 2042
Far North	681,739	216,778	555,389	306,945	339,418	413,458
Whangarei	230,343	99,942	210,162	125,645	94,615	129,541
Kaipara	240,823	193,540	335,494	119,975	87,930	86,933
Auckland	110,393	101,064	329,146	295,984	183,097	125,771
Northland Total	**1,263,298**	**611,324**	**1,430,191**	**848,549**	**705,060**	**755,702**

A cross check of current export volumes and processing consumptions shows an excess of log supply in Northland, hence the export of chip and pulp logs from Northland to the CNI. Current export and consumption volume in Northland is around ~4.2 million tonnes per annum, versus a total supply of 5.05 million tonnes per annum.

Impact of HPMV 50MAX rules on trucking costs

In 2001, log transport costs were estimated at $13 to $14 per tonne for a transport distance of 100 km ($10 to $11 for 75 km). Since 2001 there have been increases in wages, and most significantly an increase in the cost of fuel. In 2001, oil prices were low, with Brent Crude at ~US$26 per barrel. This meant that diesel would have been around NZ $0.70 to $0.72 per litre. Currently Diesel prices are ~$1.42 per litre. Fuel and oil costs are the single largest cost item of operating a heavy truck, at around 30% of the total cost. The increase in fuel costs since 2001 are estimated to have increased truck transport costs by at least 25%, increasing the cost of a 100 km transport to $20 to $21 per km and a 75 km transport to $16 or $17 tonne.

In 2010 there were changes to the vehicle mass and dimension rules affecting heavy road transport vehicles. These changes are referred to as the HPMV (High Productivity Motor Vehicle) rules. These rules were introduced in order to increase the productivity of road freight transport; the consequence of the rules is heavier road freight vehicles with higher payloads.

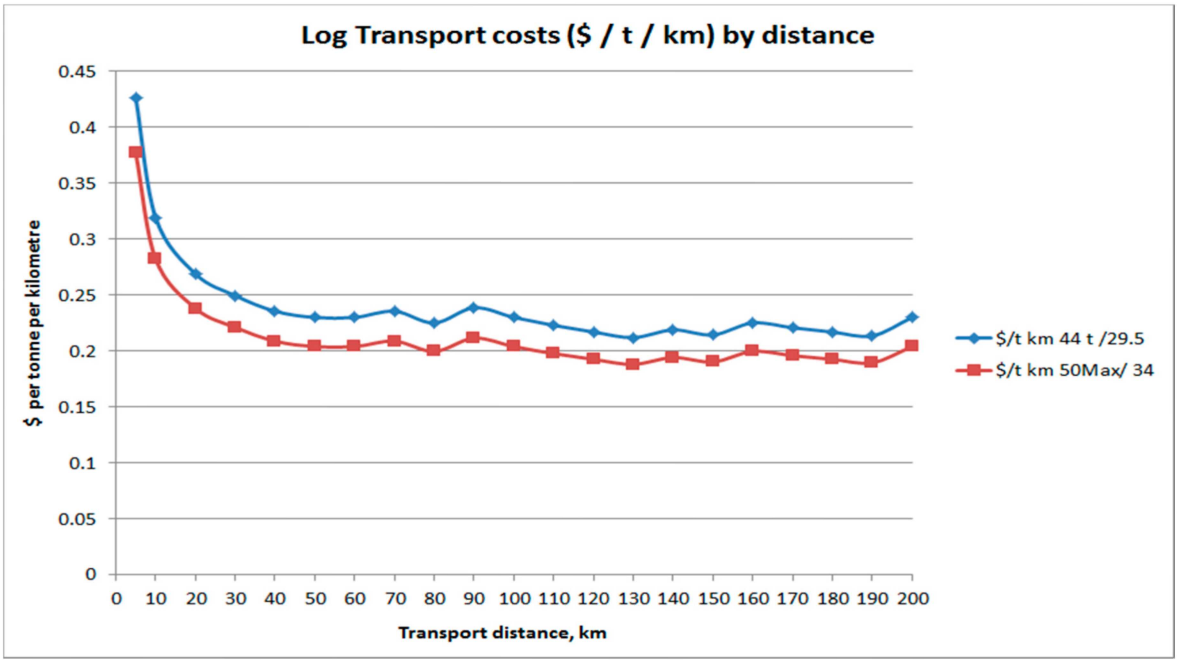
Initially the uptake of the HPMV option was slow, with bridge weight limit restrictions and the need for new truck / trailer axle configurations being the limiting factors. More recently there has been a marked increase in the number of HPMV trucks operating (NZTA, 2013), including log trucks.[13]

These trucks are commonly operating in a configuration referred to as 50MAX. The key parameters are a 23 m overall length and a maximum gross vehicle weight of 50 tonnes. This configuration has been found to work on bridges originally considered unable to take HPMVs. Many of the bridges that were considered unable to take the full weight of an HPMV truck are quite short spans, so are not supporting the full weight of a HPMV truck in the 50MAX configuration, as only part of the truck / trailer combination is on the bridge at any one time. This means that many rural roads are now able to take HPMVs in the 50MAX configuration. It is anticipated that the uptake of this option will continue. This should lead to a drop in the cost of transport, including logs.

Comparisons of the costs of log transport using a conventional 44 tonne 4 axle truck / 4 axle trailer versus a 50MAX 4 axle truck and 5 axle trailer are presented in Figures 11 and 12. These figures were derived using Scions Harvesting and Transport costing tool.

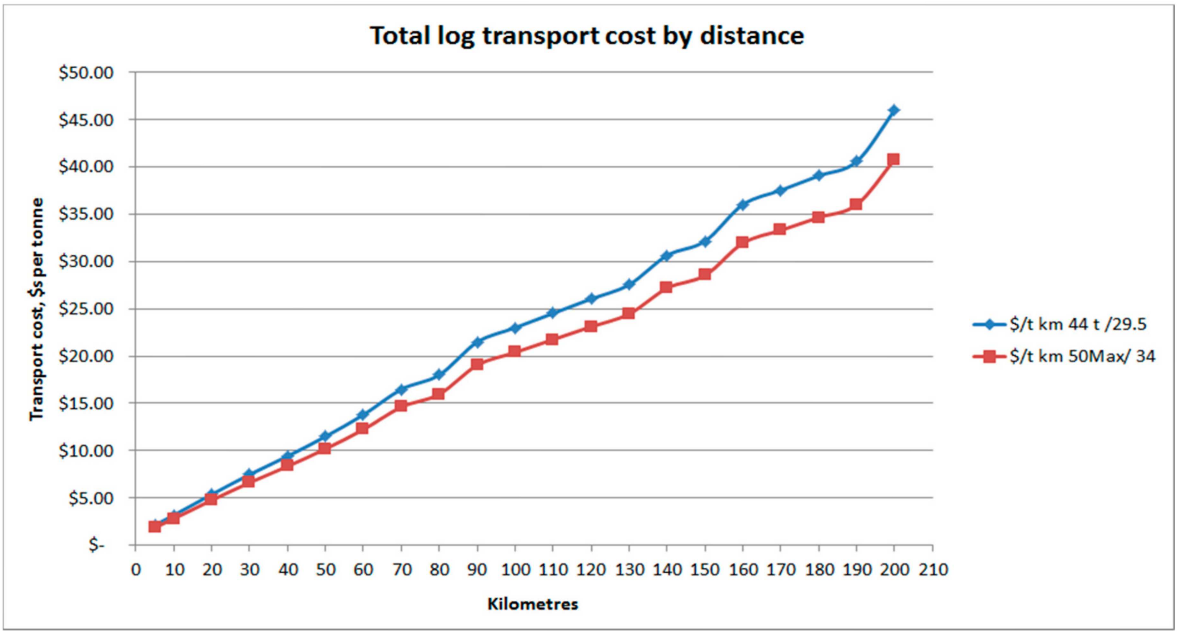
The 50MAX configuration gives a saving in transport costs of around 11%. This could reduce the impact of transport distance on the cost of pulp logs slightly. However, this cost reduction would only partly offset the increase in truck transport costs that have occurred in the last 10 to 15 years.

Figure 11 – Impact of 50MAX trucks on transport costs ($/t/km).



[13] NZTA (2013). http://www.nzta.govt.nz/about/media/releases/3086/news.html .

Figure 12 – Impact of 50MAX on log transport costs ($ per tonne).



Supply and demand summary

Hawkes Bay

The Pan Pac mill is estimated to take in up to 600,000 tonnes per annum of wood fibre. Currently in Hawkes Bay the wood fibre supply from pulp logs is estimated at 435,000 tonnes and chip from sawmilling operations at 306,000 tonnes per annum. There is an estimated excess supply of pulp grade wood fibre of around 140,000 green tonnes per annum (p.a.), which is in line with the chip export volume for 2013 via the port at Napier (153,000 t p.a.).

The presence of the existing chip export market indicates that there is a viable alternative market to the Pan Pac pulp mill for pulp grade wood fibre.

Pulp log supply in Hawkes Bay increases slightly over time and by 2020 it is estimated that pulp log supply will be around 164,000 m^3 per annum greater than it was in 2013.

Central North Island

The CHHPP mills combined are estimated to take up to ~3.67 million tonnes of wood per annum. The current pulp log supply for the CNI was estimated at 1.9 million tonnes per annum (MPI, 2009). However based on total harvest volume this estimate is likely to be less than the current harvest of pulp logs; which when estimated from other log volumes could be as high as 2.6 to 3.2 million tonnes per annum. Sawmill chip supply is estimated at 1.0 to 1.15 million tonnes p. a. Total pulp grade wood supply in the CNI is estimated at 4.1 million tonnes p.a.

CHHPP indicate that [ ] per annum of sawmill chip is being brought into the CNI from Northland. Further there is import of pulp grade logs from Northland [ ] and Taranaki [ ] by CHHPP. This gives a total pulp grade wood supply of 4.37 million tonnes p.a. These figures still indicate a shortfall in pulp grade wood supply for the CNI as there are other users of this material in the CNI, notably Whakatane Board mills (65,000 tonnes p.a.), Winstone Pulp International (WPI) at Karioi (500,000 tonnes p.a.), Norske Skog Tasman (Kawerau) ~290,000 tonnes p.a..

Total estimated pulp grade wood demand in the CNI is around 4.463 million tonnes per annum, with demand exceeding local supply. This explains the lack of chip export via Tauranga and the import of pulp grade wood fibre from Northland and Taranaki by CHHPP.

Clearly the mills are getting their wood fibre from somewhere, but as we do not have figures from Winstone Pulp International, Norske Skog Tasman and Whakatane Board Mills on where all their feedstock is coming from, it is hard to estimate what other imports to the region there might be. It is possible that WPI is importing pulp log and sawmill chip from the southern North Island, although they have significant chip supply from forests adjacent to the mill and their sawmill near Karioi.

MPI estimate that pulp log supply in the CNI will expand substantially over the next 10 years, with the MPI estimate being 2.93 million tonnes per annum of pulp logs being available by 2023.

National trends

In the WoodScape study[14] some trends in log harvest and exports were identified. New Zealand generally processes most of the very high quality logs (pruned and S1) and the low quality logs (pulp) on-shore. The logs that are exported are the intermediate quality saw logs (A and K grades). Anecdotally there was a movement of what would have traditionally been called pulp logs into KIS grade for export. These are straight, small diameter logs with large knots. The high level of wood demand from China has been driving higher log prices for these intermediate and lower grade logs. This has put pressure on the New Zealand sawmilling industry and impacted on pulp grade wood supply in some regions (CNI and Nelson / Marlborough).

The WoodScape model and analysis also showed that pulp mills are highly sensitive to feedstock costs (Table 8). The WoodScape model uses Return On Capital Employed (ROCE) to compare wood processing options and to test the sensitivity of these options to differing inputs, such as fibre costs. As fibre costs increase with transport distance, pulp mills are looking to obtain the bulk of their fibre supply from as short a transport distance as possible.

[14] M. Jack, P. Hall, A. Goodison, L. Barry - WoodScape Study Summary Report (February 2013) http://www.woodco.org.nz/strategic-plans/woodscape

Table 8 – Impact of a 5% cost increase in fibre cost on example pulp mills.

Mill Type & Scale	**Kraft 1.6 M tonnes in**	**BCTMP 0.66 M tonnes in**
Wood cost, $ / green tonne	$53	$53
Wood as a % of costs	43%	31%
ROCE Base case	9.7%	1.0%
ROCE with wood cost +5%	6.6%	0.3%
Change in ROCE	-3.1	-0.7
% change in ROCE	-32%	-70%

Part Two: Pulp Production, Properties and Applications

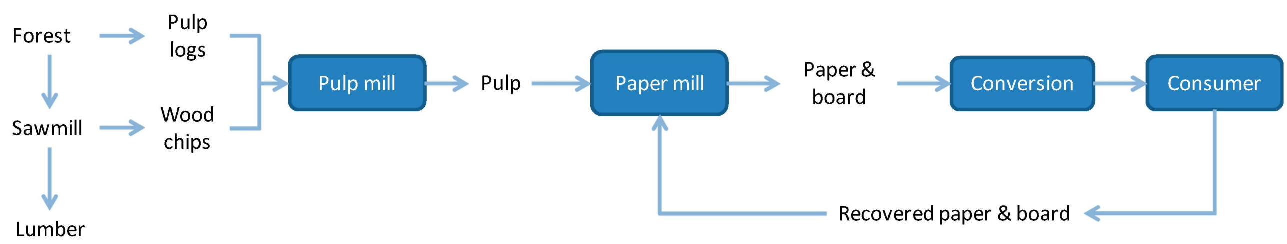
Global pulp and paper industry

At a very high level, the pulp and paper industry involves the following (Figure 13):

- Pulp logs and wood chips from either the forest or primary solid wood processing (e.g. sawmilling) are delivered to a pulp mill and broken down into individual wood fibres (a pulp)
- Pulp is then converted into various types of paper and paperboard at a paper mill.
- Paper and paperboard are further processed, or converted into various types of paper products, e.g. corrugated boxes, tissue or copy paper, ready for use by the consumer
- After use, paper and board products can be recovered and returned to the paper mill where they are recycled to make further products.

Pulp manufacture and papermaking can either be carried out at the same site (integrated mill) or at separate sites. In the latter case, the pulp sold to paper and board manufacturers is referred to as 'market' pulp.

Figure 13 – Overview of pulp and paper industry.

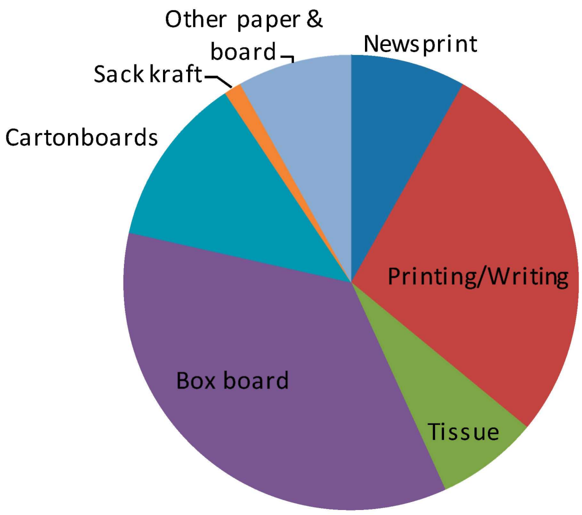


The global pulp and paper industry is large, with worldwide paper and board production in 2011 estimated at 398 million air dried tonnes.[15] Production of pulp in the same year was estimated to be 185 million tonnes[16]. Recycling of recovered paper explains why paper and board production exceeds pulp production, with worldwide recovery of paper and board in 2011 estimated to be 223 million tonnes.

The main grades of paper and board are shown in Figure 14. Within each of these main grades there are a wide range of different products. Global production of packaging boards (corrugating materials and boxboards) and tissue papers are continuing to increase (+2% and +1% per annum respectively), whilst communication grades are declining, including newsprint (-2% per annum) and printing and writing papers (-1% per annum).

[15] Pulp and paper products are normally reported on an air dried basis, containing ~10% moisture, whereas logs are reported on a green basis, ie. containing 50 – 60 % moisture. In this report we have stuck to the accepted basis for reporting weights in the respective sections.
[16] Composed of chemical pulps (71%), semichemical pulps (3%) mechanical pulps (17%) and the balance (9%) as non-wood pulps. These different pulp types are described below.

Figure 14. Estimated global paper and board production by grade for 2011.[17]



Products from the pulp and paper industry are demanded not for their own sake, but rather for the services they provide. For example, instead of demanding newsprint per se, consumers actually demand something that provides the morning news, or an undamaged apple rather than the corrugated box it was packed in. Therefore, trends within these end uses will determine the demand for paper and the pulps it is produced from, e.g. the move from printed to electronic communication is leading to a decline in newsprint production.

Pulp and paper manufacturers operate in a highly competitive global market. Many of their products are commodities and, in common with other commodities, the prices fluctuate depending on market forces.[18]

Different grades of paper and paperboard have different end-use performance requirements, so the properties of the constituent pulps are chosen to meet the desired final product requirement and to minimise cost.

New Zealand pulp and paper industry

Pulp manufacture in New Zealand is based on a sustainably-managed plantation forest resource, largely derived from *Pinus radiata.* Minor amounts of other softwoods such as Douglas fir and small amount Eucalypt is also used for pulp production[19]. New Zealand is a significant global pulp manufacturer, ranking as the 18th largest pulp producer in the world.

[17] Estimates from: Australia and New Zealand Pulp and Paper Industry Guide – Appita (2013).
[18] This can be seen in Figure 20 below.
[19] This is currently used solely for neutral sulfite semichemical pulp production. Up until very recently, a small amount of bleached eucalyptus kraft pulp was produced in New Zealand.

The New Zealand pulp and paper industry is principally driven by exports, with direct exports of pulp, paper and board accounting for approximately half of all the pulp produced. In 2012 pulp production totalled 1.5 M air dried tonnes, with 57 % of this being exported, principally as chemical pulps (Table 9). Packaging grades are the main paper and board exports.

New Zealand, as a softwood pulp manufacturer, competes against softwood pulps produced in countries such as Chile, North America and Scandinavia. Pulps produced from softwoods have different properties to those derived from hardwoods, meaning that the NZ industry is not competing directly with eucalypt pulps from countries such as Brazil.

New Zealand also imports significant volumes of paper grades not manufactured locally, particularly of printing and writing paper papers. There are also significant imports of packaging grades.

Approximately 500,000 tonnes of used paper is recovered each year, with an estimated 230,000 tonnes utilised domestically, largely in board production, with the balance exported to Asia where it finds a ready market.

Table 9 – Estimates of New Zealand production, exports and imports of pulp, paper and board for 2012 ('000 tonnes). Sources: Appita and NZ Forest Owners Assn[20] and in parentheses MPI[21]

	Production	Exports	Imports
Total pulp	1,500 (1,555)	850 (796)	(21)
Chemical pulp	800	675	
Mechanical pulp	710	175	
Paper and board	853 (859)	367 (382)	(456)
Newsprint	265 (297)		?
Other	588 (563)	367	420
Recovered paper	~500	230	

Tables 10 and 11 provide some publically-available estimates of New Zealand pulp production and paper and board production for 2012.

[20] Australia and New Zealand Pulp and Paper Industry Guide – Appita (2013).
New Zealand Plantation Forest Industry Facts & Figures, 2012/13 Edition. NZ Forest Owners Association and Ministry of Primary Industries.
[21] Annual Pulp Paper and Paperboard Statistics: Ministry of Primary Industries (Exports exclude newsprint).

Table 10 – Estimates of pulp production in New Zealand for 2012 ('000 tonnes).[22]

Company	Site	Wood		Output	Used	Market	Comments
Carter Holt Harvey Pulp, Paper & Packaging	Kinleith mill	Pine, Eucalypt	Bleached & unbleached kraft, NSSC	475	200	275	Eucalypt only used in NSSC pulp
	Tasman mill	Pine & eucalypt	Bleached & unbleached kraft	290		290	Eucalypt BKP has recently ceased
Whakatane Mill Ltd (Reynolds Packaging)	Whakatane	Pine	SGW	40	40		
Norske Skog Tasman	Kawerau	Pine	TMP	280	280		
Winstone Pulp International Ltd	Karioi	Pine	BCTMP	190		190	
Pan Pac Forest Products Ltd	Whirinaki	Pine	TMP BCTMP	85 200		85 200	

Table 11 – Estimates of paper and paperboard production in New Zealand for 2012 ('000 tonnes).[23]

Company	Site	Output	Grade & status
Carter Holt Harvey Pulp, Paper & Packaging	Kinleith	325	Corrugating materials – liners and mediums[24]
	Penrose	85	Recycled corrugating medium
Whakatane Mill Ltd	Whakatane	115	Coated carton board
Norske Skog Tasman	Kawerau	260	Capacity since reduced to 150 tpa
SCA Hygiene Australasia	Kawerau	45	Tissue products
		830	

22 Australia and New Zealand Pulp and Paper Industry Guide – Appita (2013).
23 See preceding footnote.
24 Corrugated boxes consist of a fluted corrugated medium (medium) glued between two flat linerboards (liners).

Pulping processes

Pulps can be produced by a number of different processes. In this section of the report, we will briefly summarise the different pulping processes that are used, focussing particularly on those which are produced in New Zealand.

The basic aim of all pulping processes is to convert the wood into individual fibres in a form that renders them suitable for papermaking. Separation of the fibres can be done either using mechanical energy (mechanical pulping), or by heating wood chips with chemicals to degrade and dissolve out the wood components (principally the lignin) which hold the fibres together (chemical pulping), or by combinations of these methods.[25]

Mechanical pulping

In practice, there are two major ways to produce mechanical pulps on an industrial scale:

- By pressing wood logs against a revolving pulpstone (grinding)
- By disintegrating wood chips between rotating discs of a device called a refiner (refining)

The resulting mechanical pulps are produced in high yield, >95% of the input wood. As a consequence of this high yield, mechanical pulps contain all the same components as the wood raw material, in about the same ratios as the starting wood.

In both cases, significant amounts of electrical energy are required to produce pulps of a suitable quality, up to as high as 3.5 MWh/metric tonne pulp for mechanical pulp in top quality magazine grades. Consequently, electricity is one of the major costs in the production of mechanical pulps.

Groundwood pulps

Traditionally, mechanical pulping used grindstones to grind the fibres off the surfaces of wood billets at either atmospheric or elevated pressure, stone groundwood (SGW), or pressure groundwood (PGW) respectively. Such processes have now largely been replaced by refiner pulps because of their high energy requirement and the high level of damage done to the fibre. Small amounts of SGW are still produced by Whakatane Mill Ltd for use in the internal plies of their board products.

Refiner mechanical pulps

Today mechanical pulping is normally carried out in refiners, in which wood chips are centrally fed between two parallel circular plates with grooved surfaces, one of which is rotating. As the chips are forced from the centre towards the circumference the groves roll the fibres from the chip surface. The separated fibres then pass along the grooves towards the circumference and exit the refiner. The process is called refiner mechanical pulping (RMP).

In a modification of the RMP process, the wood chips are preheated with pressurised steam prior to refining and then refined at pressure. This modifies both the energy required and the resultant fibre properties, producing a pulp that is stronger and contains much lower levels of rejects than

[25] Chemical pulps do require some mechanical refining to render them suitable for paper manufacture. This is normally applied immediately prior to the paper machine, so is normally considered as part of the papermaking process.

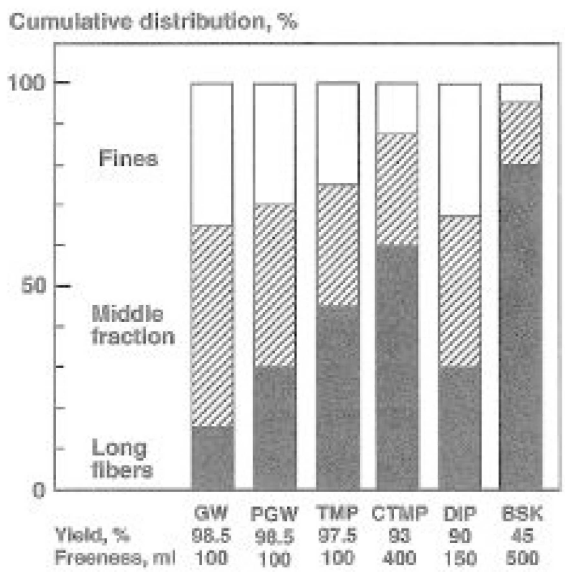
when the chips are atmospherically refined. This is called thermomechanical pulping (TMP). Pulp yields are typically 95 – 98%. This process is used both at Norske Skog's newsprint mill at Kawerau and at Pan Pac's mill at Whirinaki.

It is also possible to impregnate the chips with small amounts of a solution of sodium sulfite prior to thermomechanical pulping. This is known as chemithermomechanical pulping (CTMP). Adding the sulfite prior to preheating dissolves some of the lignin, thereby reducing the yield and also increasing the brightness of the resulting pulp. The pulp strength is increased due to more fibres per unit weight and increased fibre bonding potential. Yield is typically 90 to 92 %.

Mechanical pulps can be made brighter (whiter) by including a bleaching stage incorporating chemicals such as hydrogen peroxide. In the case of CTMP pulp, the pulp is then referred to as a bleached chemithermomechanical pulp (BCTMP). In such bleaching stages the chemicals react with light-absorbing groups in the pulp, but leave the other pulp components, particularly the lignin, largely intact. BCTMP yields are typically 85-90%. This BCTMP process is used both at the Winstone Pulp International mill at Karioi and, since the recent upgrade, in Pan Pac's mill at Whirinaki.

The harsh mechanical treatments used in mechanical pulping processes all cause varying levels of fibre damage and fibre breakage, impacting on the proportion of long fibres, fragmented fibres and fines in the pulp. Figure 15 shows that for a common softwood raw material (Norway spruce in this case), the proportion of intact fibres increases in the order stone groundwood (GW) <TMP < CTMP < bleached kraft (BSK). These pulp fractions have different properties, so the properties of a given mechanical pulp is dependent on both the quantity and quality of the different fibre fractions.

Figure 15. Pulp fraction distributions for various pulps all produced from a common Norway spruce feed. GW = stone groundwood; DIP = de-inked mechanical pulp; BSK = bleached kraft pulp.[26]



[26] Source: J Sundholm – Mechanical Pulping Fafpet Oy, Finland (1999) p.21.

Chemical (kraft) pulping
In chemical pulping, wood chips are heated with chemicals in an aqueous solution. The objective here is to break down the lignin into smaller pieces, which then become soluble in the pulping liquor and leave behind most of the hemicelluloses and cellulose in the form of insoluble pulp fibres.

In the kraft process, the most common chemical pulping method, pulping is carried out by using an aqueous solution of sodium hydroxide and sodium sulfide at elevated temperatures. Following cooking, the pulp fibres and pulping liquor containing the dissolved wood components and spent pulping chemicals are separated. The pulp yield is typically between 45 and 55%, depending on the intended end use. In addition to solubilising most of the lignin, a good portion of the hemicelluloses are also degraded and dissolved in the pulping liquor.

A number of different kraft pulp grades are produced. Unbleached grades for packaging applications are pulped to a higher yield and contain more lignin than pulps that are subsequently going to be bleached and made into white papers. Unbleached kraft pulps (UKP) contain mainly cellulose, but are quite dark due to the presence of the residual lignin.

While unbleached kraft pulps are quite dark, they can be bleached to a high brightness. Such pulps are referred to as bleached kraft pulps (BKP). Bleaching of chemical pulps differs from bleaching of mechanical pulps in that the process is typically carried out in a series of steps, with the aim of first removing the lignin still remaining in the pulp and then finally bleaching any remaining light-absorbing groups in the pulp. This produces pulps having brightnesses higher than those achievable by bleaching mechanical pulps and also means that the pulps are stable to light (e.g. does not yellow in sunlight as is the case with newsprint). In both New Zealand kraft mills, lignin removal is carried out using alkaline oxygen and then with chlorine dioxide, and final brightening principally with additional chlorine dioxide.

A key feature of the kraft pulping process is that the spent cooking liquor can be evaporated and then burnt in a recovery furnace to produce heat. The spent pulping chemicals are also recovered from the residue from combustion via a “recausticising” process. This ability to recover most of the process energy by combustion of the dissolved wood components, plus recycle the cooking chemicals, is critical to the economics of the kraft process. However, these additional unit operations add considerably to the complexity of the process and the capital cost of the mill.

Neutral sulfite semichemical (NSSC) pulping
There are also pulping processes which use combinations of chemical and mechanical stages to produce pulps from wood chips. Essentially the wood chips are digested with chemicals to remove some of the lignin, and then the remainder of the pulping action is supplied mechanically, mostly in disc refiners. Such semichemical pulps encompass the intermediate range of pulp yields between mechanical and chemical pulping, typically between 55 and 85%[27] and tend to have properties intermediate between those of pure mechanical and chemical pulps.

[27] In practice there is some overlap with high yield kraft pulps at the lower end and with chemimechanical processes at the high end.

In New Zealand, semichemical pulp is produced at CHH's Kinleith mill from eucalypt wood by using a cooking liquor containing sodium sulfite plus sodium carbonate followed by disc refining. This is commonly referred to as the NSSC process and produces a pulp ideally suited to for the centre fluting medium in corrugated container board.

Recycled fibre

Recycled paper is another important fibre resource for paper and board manufacture, globally and also in New Zealand.

In New Zealand the overall collection rate for used paper and board is estimated at about 59% of consumption (~ 500,000 tonnes per annum), with about half of this being recycled domestically and the balance being exported.

How recovered paper is treated prior to re-manufacture is defined by the intended end use, and can involve simple slushing of the used paper or board in water for some grades, but may also include deinking, screening and cleaning and refining (e.g. for printing grades).

In New Zealand, recycled fibre is an important component of some corrugated board products, including linerboard grades produced at Kinleith and medium produced at Penrose.

Key differences between mechanical and kraft pulping processes

The key differences between mechanical and kraft pulping processes are:

- The processes used, and therefore the equipment required for many of the unit operations in the mills are quite distinct. This means that pulp mills cannot easily switch their processes from TMP/CTMP through to kraft, or vice versa, as this would require major capital investment and take a number of years to complete.
- Mechanical pulps are typically produced in considerably higher yields, normally >85% for softwoods, versus kraft pulps which are normally produced in yields of between 40 and 60%. As discussed above, the actual yield will depend on the exact mechanical process used and the processing conditions. This means that raw material costs per tonne of product are lower for mechanical pulps as more of the raw material is converted into the product.
- Mechanical pulping processes are less complicated than kraft processes, and have lower capital costs, particularly with a kraft mill requiring extra steps to recover the cooking chemicals and burn the solubilised pulp components for energy recovery. This means that a mechanical BCTMP mill has a smaller economic scale than a kraft mill, so could be built and operated in areas that would not support a kraft mill.
- Mechanical pulping processes consume large amounts of electricity. However, the cost of this energy needs to be balanced against the additional costs of purchasing chemicals.

Pulp properties and price

The different types of pulps that are produced in New Zealand have different properties and differing costs. In this section of the report, we will briefly summarise the properties of the different types of pulps that are produced in New Zealand and show that different pulp types have different costs.

Hardwood vs softwood pulps

The properties of pulps made from wood depend on the properties of the in the initial wood, and in particular whether it is a hardwood or a softwood. Hardwoods such as Eucalypts and other deciduous broad leaf trees such as birch and poplar yield fibres which are typically 0.5 to 2 mm long with relatively thick walls. These characteristics enable the fibres to retain most of their tubular shape during processing and enhance paper properties such as bulk, opacity and formation uniformity. However hardwood pulps lack the strength potential of softwood fibres.

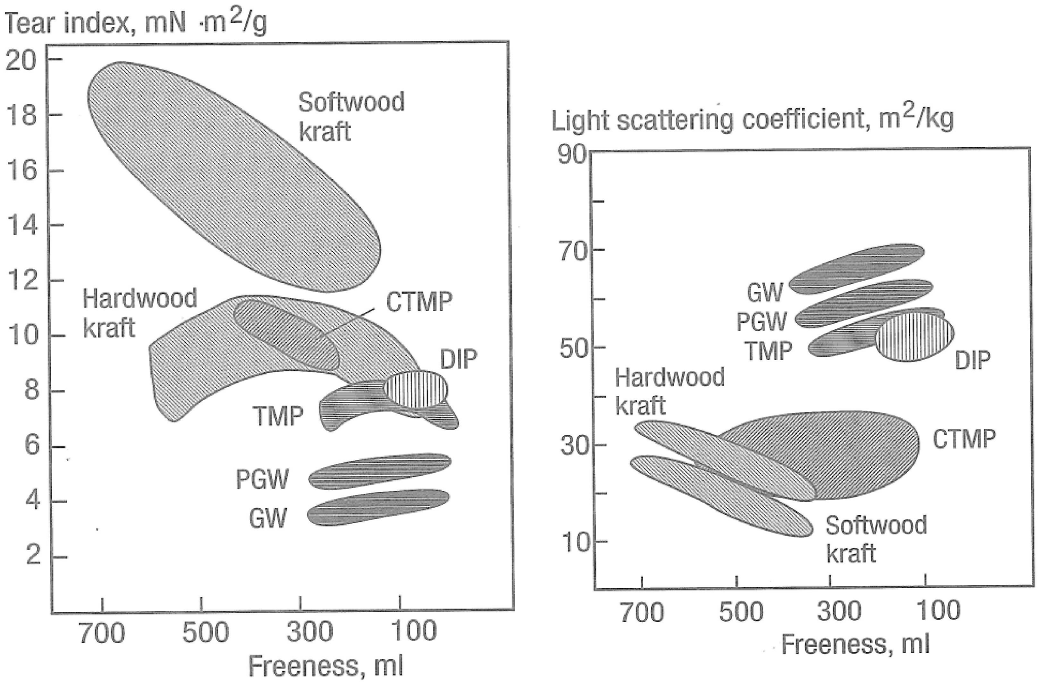
Softwoods are coniferous needle and cone-bearing trees such as radiata pine and Douglas fir and yield fibres which are typically 3 to 5 mm in length with relatively thin walls. Refining collapses, flattens and fibrillates softwood kraft fibres, enhancing fibre to fibre bonding to produce papers of high strength and density. As a result softwood kraft pulps tend to be used in packaging papers and as a reinforcing fibre in printing and writing grades, whereas hardwoods are normally preferred for printing and writing grades, where their higher bulk, opacity and uniformity afford a high quality printing surface. Hardwood fibre is also preferred for tissue, because it confers softness to the paper, although some softwood is often added for strength.

Mechanical vs chemical pulps

Figure 16 compares the differences in strength and light scattering between mechanical pulps from a common softwood, Norway spruce, against kraft and standard deinked pulp also prepared from the same wood source. This illustrates that with softwood:

- pulp strength increases in the order GW < TMP < CTMP < kraft. The principal factors contributing to the higher kraft pulp strength are their higher fibre length, lower level of fibre damage and the higher fibre-to-fibre bonding strength of refined kraft fibres.
- light scattering follows the opposite trend, ie. that mechanical pulps have a higher light-scattering ability.

Figure 16. Comparison of the tear strength and light scattering ability of mechanical and kraft pulps. Freeness is a common measure of the ability to drain water from a pulp. GW = stone groundwood; DIP = de-inked pulp; BSK = bleached (softwood) kraft.[28]



A second critical difference is that while mechanical pulps can be produced at reasonable brightnesses, particularly if they are bleached, it is not possible to reach the high brightnesses that can be routinely achieved by bleached kraft pulps.

Unbleached kraft pulps, typically are considerably darker than mechanical pulps. The colour of the unbleached pulps depends on the amount of lignin in the pulp, with kraft pulps of lower lignin content having a higher brightness.

As bleaching of kraft pulps adds significantly to the cost of production, unbleached pulps are used where the high strength of kraft pulp is required, but where a high brightness is not required, e.g. in linerboard and fibre cement pulp.

Furthermore, mechanical pulps yellow on exposure to light, e.g. when a newspaper is left out in the sun, meaning that papers containing mechanical pulps are not suitable for longer-term or permanent storage. This yellowing can be attributed to the lignin which still remains in the mechanical pulps.

[28] Source: J Sundholm – Mechanical Pulping Fafpet Oy, Finland (1999) p.20.

Table 12. Comparison of softwood mechanical and kraft pulps.

Mechanical pulps	Kraft pulps
High pulp yield, typically >95%	Lower yield, typically 40 – 60%
Refining leads to fibre breakage and fibre damage	Fibres longer and less damaged
	Stronger fibres
Fibres less collapsed and fibrillated, leading to weaker interfibre bonding and bulkier sheets	Refined fibres collapsed and fibrillated leading to strong interfibre bonding and high sheet density
Higher light-scattering power	Poorer light-scattering
Brightness adequate for many applications	Unbleached pulps dark Bleached pulps have highest brightness
Pulps yellow on exposure to light	Bleached pulps have highest & stable brightness
Generally lower cost	

Neutral sulfite semichemical pulps

Hardwood NSSC pulps at about 75% yield exhibit exceptional stiffness at a relatively low cost, making them ideally suited to the centre fluted layer in corrugated container board. A high brightness or good optical properties are not required for such grades.

Recycled fibre

The properties of recycled papers depend on the source of the recovered paper. For example, the pulps isolated from recovered newsprint will have different properties to those from recovered corrugated containers, or mixed office waste because different fibres are used in the manufacture of the original products. Cleanliness, or the level of non-fibre components such as ink, fillers and plastics, is also a major issue for recovered fibre.

In many cases the use of recovered paper is limited to the grade from which the paper came – for example for newsprint and printing grades – while some packaging grades can utilise old newsprint and printing papers as well as returned packaging. Consequently, sorting into categories (e.g. white vs brown, newsprint, corrugated boxes) maximises the value of recovered paper and board in subsequent recycling.

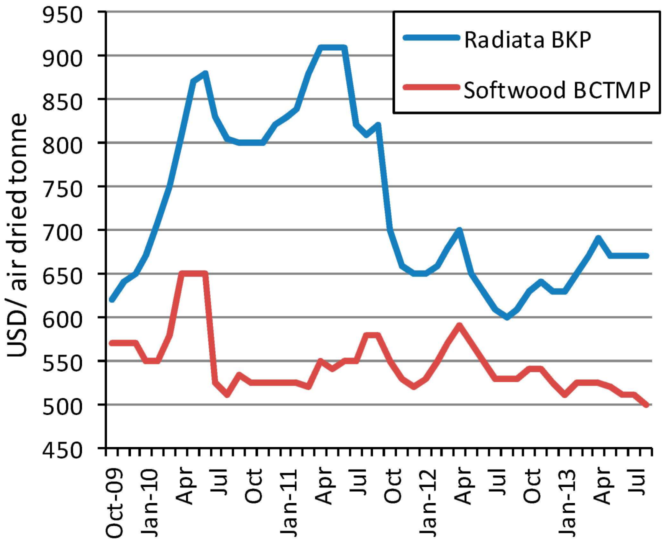
The original quality of the fibre is gradually degraded each time the fibre is re-processed, particularly after the first recycle, meaning that the performance of a board made from recycled fibre is lower than that of its virgin equivalent and drops gradually with each re-process. Consequently to maintain adequate product strength, there is often a need to add a small amount of virgin fibre to a recycled furnish.

Pulp prices

As has been indicated above, the different pulp types have different prices. This is illustrated in Figure 17, which compares the list prices in China for radiata pine bleached kraft pulp and a benchmark softwood BCTMP.

[

]



Key points:

- Consistent with other commodities, the prices of these pulps vary significantly with time.
- While factors such as the GFC affected the prices for all grades, the differentials between the different pulp grades change with time, indicative of different price drivers (e.g. supply and demand) within each of the grades.
- Radiata pine bleached kraft pulp commands a significant price premium over softwood BCTMP, but the level of this premium can vary quite widely.
- By way of comparison, recovered paper sells at a significant discount to these virgin grades, with the average Australian price across all grades for recovered paper in January 2014 estimated to be AUD 157 per tonne.[29]

[29] Pulp and Paper Edge No. 106, Industry Edge Incorporated. March 2014.

Applications of pulp grades

Mechanical pulps

Mechanical pulps are mainly used for the production of mechanical printing papers. These are printing papers which require good opacity and printability at low basis weight, but only a limited strength and durability, and which furthermore need to be comparatively cheap. The main grades are newsprint, as well as uncoated and coated grades which are typically used in magazines and advertising fliers.

Other applications for mechanical pulps are in various board grades, wallpaper, soft tissue and absorbent and moulded products. Folding boxboard, widely used to package food and other consumer goods, is typically a three-layer board which has been traditionally manufactured with SGW in the middle layer. A fast-growing application for CTMP has been in liquid packaging board, which is increasingly been made as a three-layer sheet with a well washed BCTMP in the middle layer of the three-layer sheet. CTMP is also used as fluff pulp in certain absorbent products.

Kraft pulps

The higher-cost kraft pulps tend to be used in applications either where a high and stable brightness is required, or where high strength is needed (particularly for softwood pulps).

Applications where a high paper or board strength is required include in liners for corrugating packaging (especially in demanding applications such as for packaging of horticultural products in coolstores) and sack paper for bags to package products such as cement or milk powder.

Softwood kraft pulps are also commonly added as a reinforcing component in both mechanical and recycled products and in hardwood printing papers (e.g. copy paper) to improve the strength of the paper sheet to acceptable levels.

The other main use of bleached kraft pulps is in printing papers where a high and stable brightness is required for archival purposes. Copy paper is for example normally manufactured from a blend of softwood and hardwood kraft pulp.

The high brightness of BKP means that it can be used as an outer layer on a board product to give a surface capable of high-impact printing, and in speciality boards to package high-end products such as cosmetics, where the high brightness of the packaging is used to emphasise the product image.

Tissue papers, a class of lightweight papers, particularly at the higher ends of the market, are made primarily using bleached kraft pulps, although de-inked recycled pulp and mechanical pulps may also be used.

Bleached kraft pulps are also used for fluff pulps in adsorbent grades such as used in diapers and sanitary pads.

Unbleached softwood kraft pulp of high coarseness is also used as a reinforcement and processing aid in the production of fibre-reinforced cement building products. This speciality softwood kraft pulp is produced at the Tasman Mill.

NSSC pulps

The eucalypt NSSC pulp produced at CHH's Kinleith mill is all used internally to produce fluting medium, for use in the centre fluted layer in corrugated container board, taking advantage of the high compressive strength at moderate cost which can be achieved using pulps of this type.

Recovered fibre

Globally, recovered fibre is used within most paper grades, including printing and writing, packaging and tissue grades, with the use of recovered fibre in paper and board manufacturing exceeding that virgin fibre production. It is also used as one layer within a multi-layer board, with, for example, a middle layer of recycled fibre and a top layer of virgin bleached or unbleached kraft fibre.

The properties of products made from recycled fibre are generally inferior to those made from the equivalent virgin pulp, but are adequate for many but not all applications. In particular virgin pulp may be preferred due to its higher strength, higher brightness, and higher cleanliness.

In New Zealand, the main uses for recycled fibre are for the production of recycled medium for use in corrugated packaging at the CHH Penrose mill, and for the production of linerboard at the Kinleith mill. In addition, recycled fibre is or has been used for the manufacture of moulded pulp products, e.g. egg cartons, for some tissue grades and for some boxboard grades at the Whakatane mill.

Evolution in paper grades

The on-going pressure to reduce costs, coupled with innovations and improvements in pulping and papermaking and changes in end-user requirements have led to an evolution over time in the pulp grades used in various products. For example:

- In the early years of this century, the Norske newsprint mill at Kawerau installed a TMP pulp plant, which allowed them to reduce the amount of purchased kraft pulp that formerly needed to be added to add strength to the furnish for newsprint production.
- Fluff pulp, which forms the absorbent medium in disposable diapers, feminine care products and hospital pads, was traditionally sourced from long-fibre chemical pulps. However, less expensive chemimechanical pulp grades have taken a significant share of this market.
- Globally, increasing amounts of recovered fibre are being used to replace virgin chemical and mechanical pulps across many paper and board grades.

The potential for a new pulp mill in New Zealand

The recent WoodScape study[30] indicated that, of the existing pulp and paper processes, a greenfield "world scale" kraft mill offered better returns on capital invested than both newsprint and BCTMP. It should be emphasised that this analysis was undertaken at a given point in time (ie. using the exchange rate, product price and wood price at that time), assuming the mills were being

[30] M. Jack, P. Hall, A. Goodison, L. Barry - WoodScape Study Summary Report (February 2013) http://www.woodco.org.nz/strategic-plans/woodscape

built from scratch at a new site. Clearly this does not reflect the profitability of an existing operation or building on a brownfield (existing) site.

To understand what building such a new kraft mill in New Zealand might mean, the proposed market bleached eucalyptus kraft pulp mill that Gunns proposed to build at Bell Bay in Tasmania provides an indication of what such a world-scale mill could look like. This mill was planned to produce 1.1 million tonnes per year of air-dry bleached kraft pulp, cost approximately AUD 2.3 billion and consume 4.5 million tonnes of wood per annum. Smaller-scale mills produce poorer returns.

Assuming that such a hypothetical mill were to use pulp logs and sawmill chips, the volumes required would necessitate the mill be located in the CNI and consume in excess of the estimated current total pulp log plus sawmill chip supply in the region (4.1 million tonnes per annum). Consequently, such a new mill would likely require closure of both the existing kraft mills at Kinleith (2.1 million tonnes wood per year) and at Kawerau (1.4 million tonnes wood per year), as well as other plants. As discussed previously, such a kraft mill would be very sensitive to the delivered wood cost, ie. the distance the logs and chips would need to be transported to the mill, as feedstock costs are a large portion (42-43%) of the operating costs.[31]

Other options to make use of the potential additional pulp logs and sawmill chip for on-shore wood processing include future wood-to-biofuel or wood-to-biochemical processes which are under rapid development in New Zealand and other parts of the world. The economic scale of such operations may be smaller than that now required for a world-scale kraft mill. Other options would be as additional investment to increased capacity at existing wood sites or another wood processing investment outside the pulp and paper industry, e.g. pellets.

[31] For example, see Table 8 for an estimate of the impact on a slightly smaller kraft mill.

Glossary

Tonne = 1 metric tonne
Cubic metre = m^3

Abbreviations

BCTMP	Bleached chemithermomechanical pulp
BEK	Bleached eucalypt kraft (pulp)
BKP	Bleached kraft pulp
BSK	Bleached softwood kraft (pulp)
CNI	Central North Island
CTMP	Chemithermomechanical pulp
DIP	De-inked pulp
GW	Groundwood
HB	Hawkes Bay
HPMV	High productivity motor vehicle
MPI	Ministry of Primary Industries
MAF	Ministry of Agriculture and Forestry
NBSK	Northern bleached softwood kraft
NEFD	National exotic forest description
NSSC	Neutral sulfite semichemical
PGW	Pressure groundwood
SGW	Stone groundwood
TMP	Thermomechanical pulp
UKP	Unbleached kraft pulp

Conversion factors

1m^3 of log = 0.96 tonnes
1 tonne of log = 1.042 m^3
1 m^3 of solid log, when chipped = 2.5 m^3 = 0.96 tonnes
1m^3 of chip = 0.384 tonnes

Note in the MPI export statistics softwood chip exports are reported in bone dry units (BDU)
1 BDU = 2400 lbs = 1.0866 tonnes = 2.6 green tonnes = 6.5 m^3

Appendices

Appendix 1: Data for CNI and Hawkes Bay total wood and pulp log supply (Figs 1,2)

Potential harvest volumes for the CNI and HB regions

	Total recoverable volume					
	2013 to 2017	**2018 to 2022**	**2023 to 2027**	**2028 to 2032**	**2033 to 2037**	**2038 to 2042**
CNI	9,092,471	10,791,190	16,162,775	15,158,308	10,807,718	9,780,110
Hawkes Bay	1,724,169	1,416,469	6,375,197	2,940,303	2,410,921	2,218,492
East Coast	2,762,553	2,457,145	5,902,656	3,249,328	1,227,041	2,322,477

	Pulp Log supply					
	2013 to 2017	**2018 to 2022**	**2023 to 2027**	**2028 to 2032**	**2033 to 2037**	**2038 to 2042**
CNI pulp 20%	1,818,494	2,158,238	3,232,555	3,031,662	2,161,544	1,956,022
CNI pulp 25%	2,273,118	2,697,797	4,040,694	3,789,577	2,701,930	2,445,027
CNI pulp 30%	2,727,600	3,237,357	4,848,832	4,547,492	3,242,315	2,934,033
Hawkes Bay Pulp 20%	344,834	283,294	1,275,039	588,061	482,184	443,698
Hawkes Bay Pulp 25%	431,042	354,117	1,593,799	735,076	602,730	554,623
East Coast	552,511	491,429	1,180,531	649,866	245,408	464,495

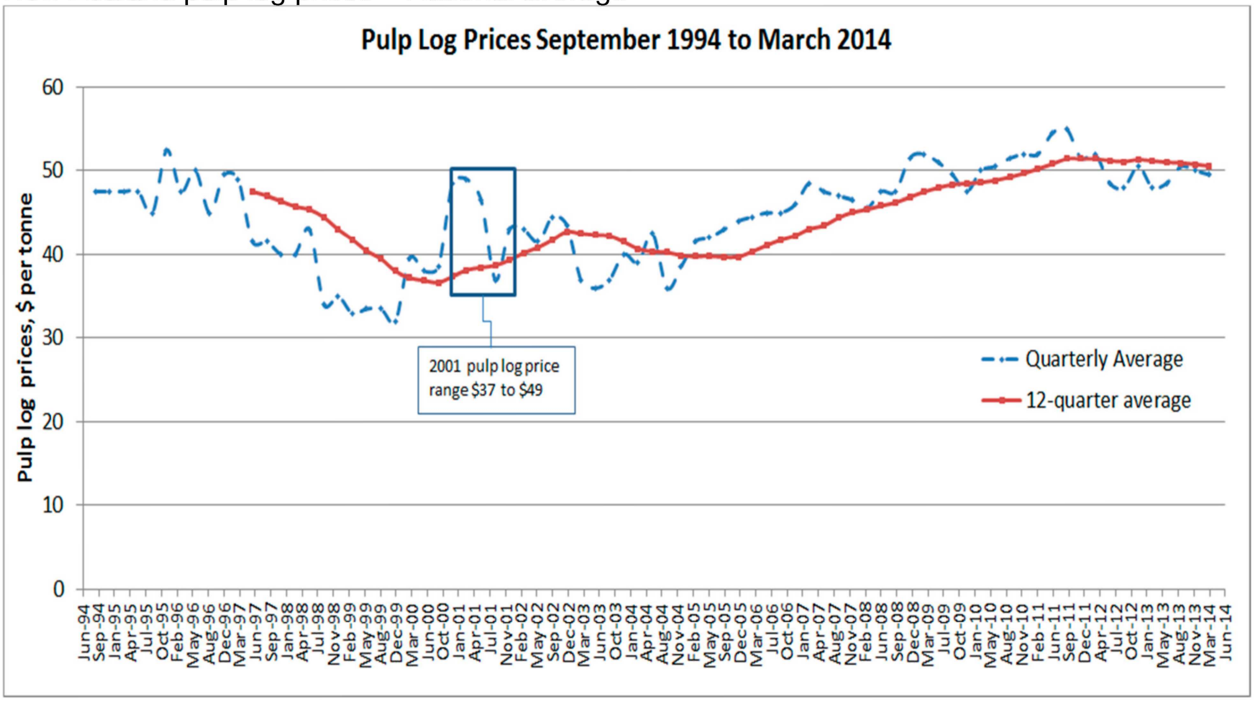
Appendix 2: Pulp log volume potentially available for Hawkes Bay and CNI (Figs 3,4)

Pulp log volume (m^3 per annum) potentially available for Hawkes Bay and CNI- split non-declining yield (MAF Forest Industry & Wood Availability Forecasts, 2009).

	Hawkes Bay	CNI
2005	286,000	
2006	403,000	1,555,000
2007	395,000	1,514,000
2008	433,000	1,547,000
2009	436,000	1,578,000
2010	431,000	1,591,000
2011	427,000	1,686,000
2012	446,000	1,898,000
2013	435,000	1,900,000
2014	414,000	1,928,000
2015	410,000	2,036,000
2016	407,000	2,239,000
2017	452,000	2,245,000
2018	493,000	2,292,000
2019	544,000	2,450,000
2020	599,000	2,730,000
2021	638,000	2,898,000
2022	616,000	2,946,000
2023	622,000	2,931,000
2024	617,000	2,968,000
2025	608,000	3,000,000
2026	632,000	3,020,000
2027	610,000	3,044,000
2028	583,000	3,040,000
2029	612,000	3,052,000
2030	583,000	3,074,000
2031	560,000	3,051,000
2032	575,000	3,065,000
2033	602,000	3,091,000
2034	628,000	3,119,000
2035	565,000	2,789,000
2036	508,000	2,515,000
2037	459,000	2,512,000
2038	444,000	2,507,000
2039	463,000	2,490,000
2040	467,000	2,522,000

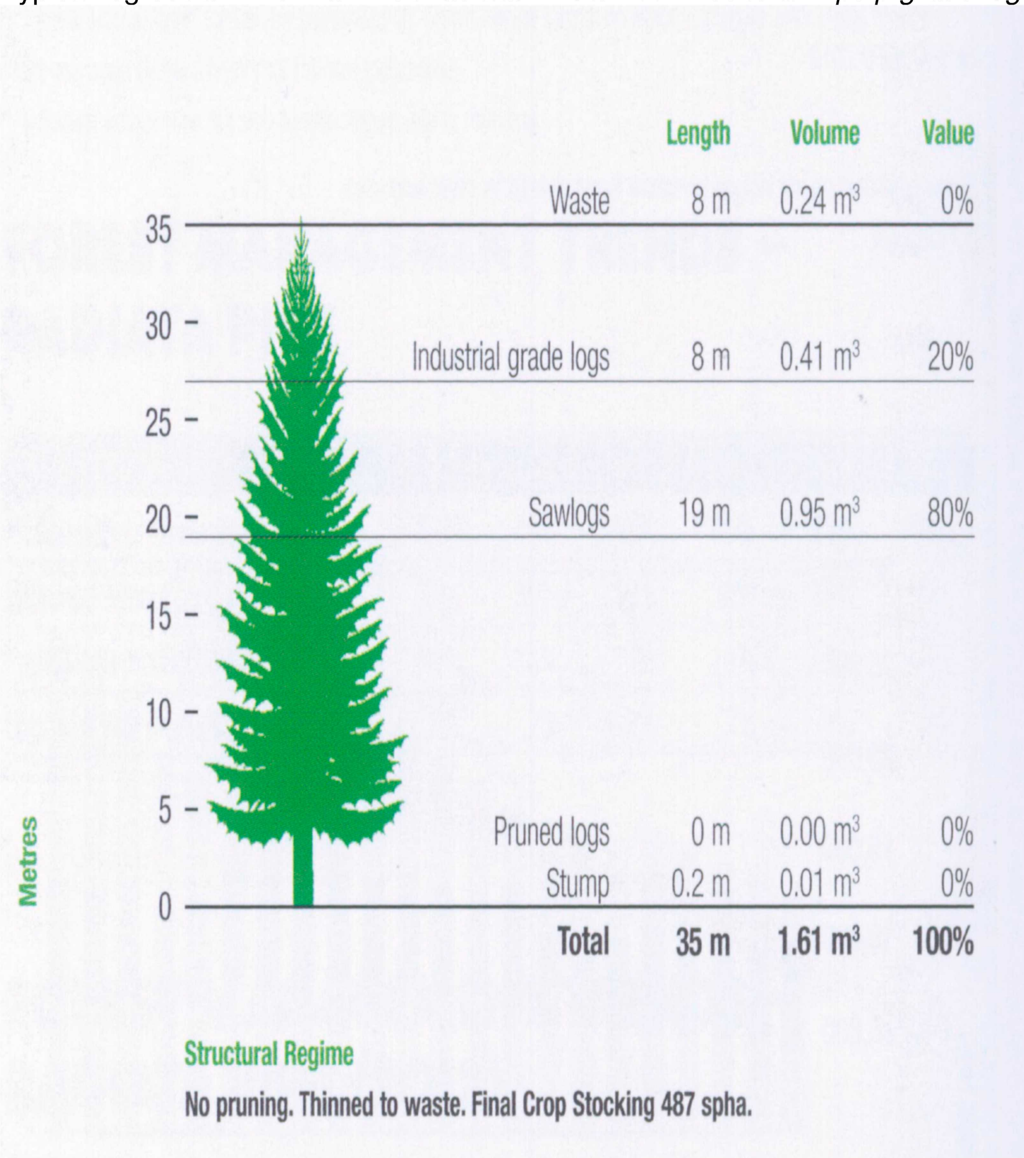
Appendix 3: New Zealand pulp log prices

New Zealand pulp log prices – National average



Appendix 4: Typical log out-turn from a *P. radiata stem*

Typical log out-turn from a *Pinus radiata – note 20% industrial = pulp grade logs*



Source = New Zealand Plantation Forest Industry Facts and Figures; New Zealand Forest Owners Association

Appendix 5: Road wander factors

Road wander factors (actual road distance versus straight line distance)

Wairoa to Napier	1.74
Napier to Taupo	1.23
Taupo to Kawerau	1.55
Rotorua to Tauranga	1.31
Napier to Masterton	1.18

APPENDIX B: BRUCE MANLEY LETTER

New Zealand School of Forestry

College of Engineering
Tel: +64 3 364 2122
Fax: + 64 3 364 2124
Email: bruce.manley@canterbury.ac.nz

UNIVERSITY OF CANTERBURY
Te Whare Wānanga o Waitaha
CHRISTCHURCH NEW ZEALAND

May 14 2014

Mr Grant David
Chapman Tripp
PO Box 993
Wellington 6140

Dear Mr David

Commerce Commission application by Oji Oceania Management (NZ)

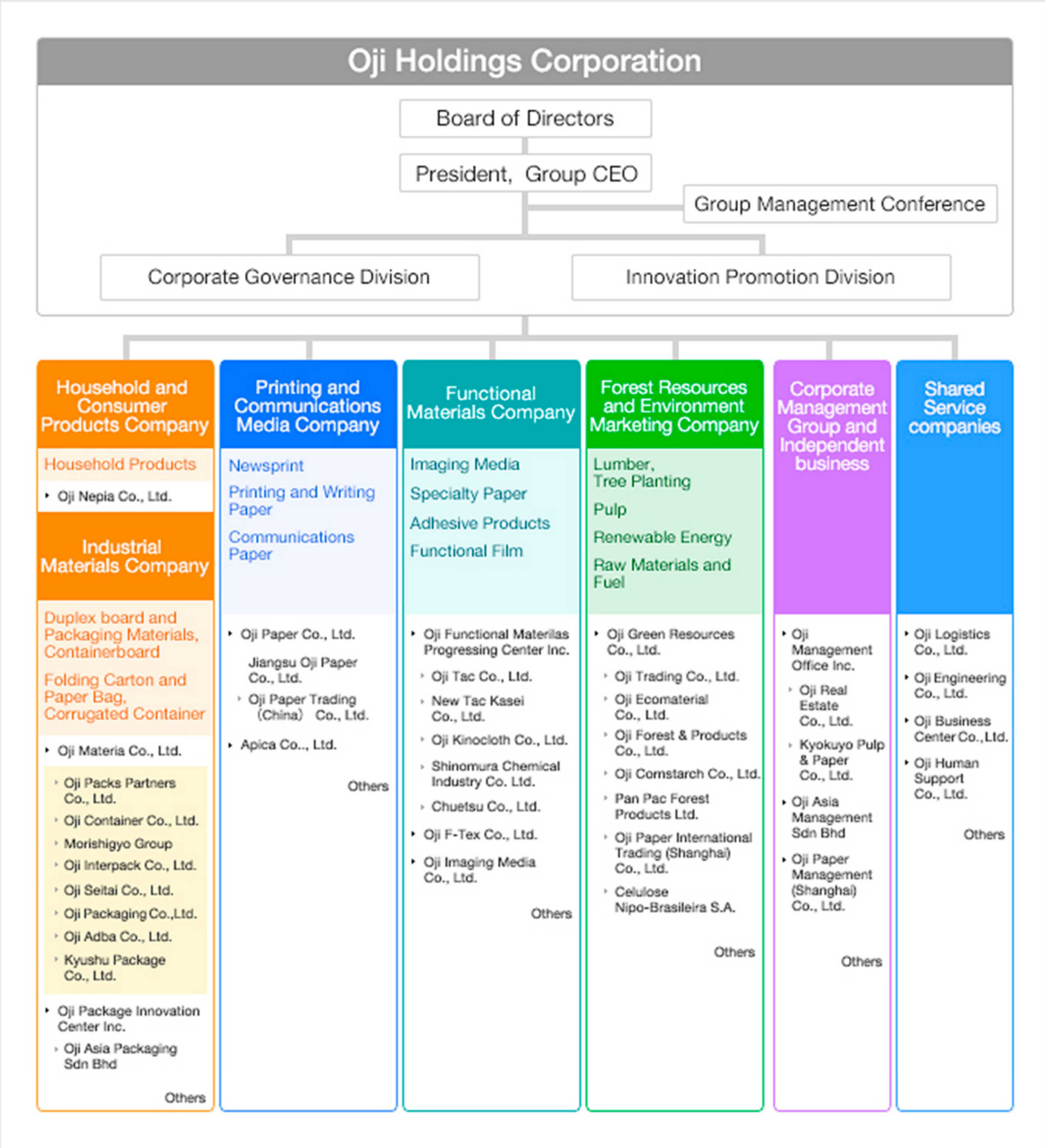
I am Professor of Forest Management at the School of Forestry. I hold a BForSc(Hons) from the University of Canterbury, a BBS(Accountancy) from Massey University and a PhD from the University of Washington. I am a Fellow of the New Zealand Institute of Forestry.

I have been a forestry researcher since 1976. I have specialised in the development of modelling systems and their application for wood flow forecasting, financial evaluation, forest valuation and forest sector analysis. From 2005 to 2010 I was contracted by the Ministry of Agriculture and Forestry (MAF) to prepare Wood Availability Forecasts for each of the wood supply regions in New Zealand. These forecasts were prepared using base data provided by forestry companies and consultants. The underlying area information was extracted from the National Exotic Forest Description (NEFD). Results were reviewed by stakeholders in each region.

I have been engaged by Chapman Tripp as an expert to review the application and the Scion Report that has been used as background to it. I can confirm that the statements they contain regarding wood availability and wood flows to mills are valid. They are based on the MAF regional wood availability forecasts that I prepared with appropriate recognition of events that have occurred since the forecasts were prepared.

Bruce Manley
Professor & Head of School

APPENDIX C: STRUCTURE CHART FOR OJI COMPANIES RELEVANT TO TRANSACTION

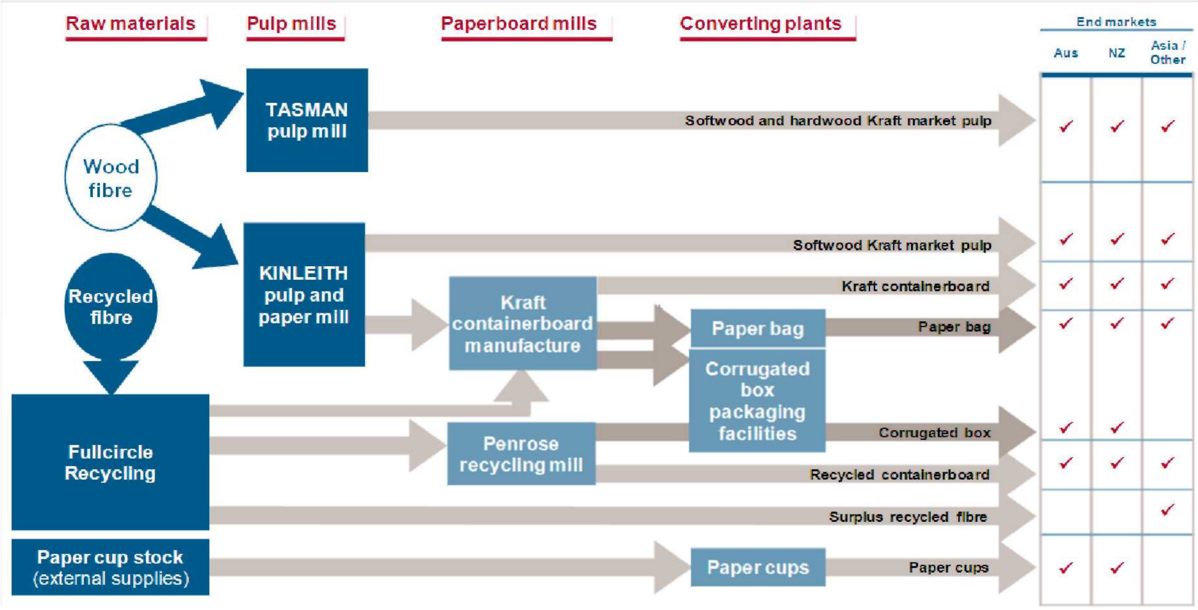


APPENDIX D: SHAREHOLDERS OF INCJ [CONFIDENTIAL]

APPENDIX E: STRUCTURE CHART FOR RANK AND CHH COMPANIES RELEVANT TO THE TRANSACTION [CONFIDENTIAL]

APPENDIX F: CHH'S NEW ZEALAND BUSINESS OPERATIONS

	Pulp & Paper			Packaging
Facilities	 **Kinleith mill**	 **Tasman mill**	 **Penrose mill**	 **8 converting plants**
Key products	▪ Radiata bleached market kraft pulp ▪ Kraft containerboard	▪ Radiata bleached market kraft pulp ▪ Unbleached softwood fibre cement pulp ▪ Low coarseness kraft pulp	▪ Recycled containerboard ▪ Recycled fibre	▪ Corrugated boxes ▪ Paper bags ▪ Paper cups ▪ Specialty board
End uses	▪ Printing and writing paper ▪ Tissue ▪ Containerboard products	▪ Printing and writing paper ▪ Tissue ▪ Paperboard products ▪ Fibre cement building products, (eg house cladding) and other building purposes	▪ containerboard products	▪ Corrugated boxes: horticulture, agricultural and primary produce and other manufactured products ▪ Paper bags: hygiene grade products such as dairy and industrial products such as cement ▪ Paper cups: coffee, food service markets and quick service restaurants ▪ Specialty board: heavy duty packaging, frozen and chilled packaging, point of sale displays, cornerboards and bulk bins
Supporting businesses		**Lodestar** ▪ Shipping and transport		**Fullcircle** ▪ 14 recycled fibre collection facilities


Raw materials
Pulp mills
Paperboard mills
Converting plants
End markets
Aus
NZ
Asia / Other
Wood fibre
Recycled fibre
TASMAN pulp mill
KINLEITH pulp and paper mill
Kraft containerboard manufacture
Paper bag
Corrugated box packaging facilities
Penrose recycling mill
Fullcircle Recycling
Paper cup stock (external supplies)
Paper cups
Softwood and hardwood Kraft market pulp
Softwood Kraft market pulp
Kraft containerboard
Paper bag
Corrugated box
Recycled containerboard
Surplus recycled fibre
Paper cups

APPENDIX G: CHH BUSINESS MANAGEMENT ACCOUNTS (FOR COMPANIES BEING DIVESTED) [CONFIDENTIAL]

APPENDIX H: APPITA ARTICLE ENTITLED "TECHNOLOGY OF PULPING AND PAPER-MAKING IN AUSTRALIA AND NEW ZEALAND" [CONFIDENTIAL]:

APPENDIX I: SOURCES OF PAN PAC'S FIBRE SUPPLY 2012-14 [CONFIDENTIAL]

APPENDIX J: CHH'S QUARTERLY PRICING SCHEDULES FOR UN-CONTRACTED WOOD FIBRE [CONFIDENTIAL]

APPENDIX K: MAF WOOD AVAILABILITY FORECASTS [ATTACHED SEPARATELY]

APPENDIX L: PAN PAC TRANSPORT COSTS TABLE [CONFIDENTIAL]

APPENDIX M: CCH TRANSPORT COST TABLE [CONFIDENTIAL]

APPENDIX N: SHARE SALE AGREEMENT [CONFIDENTIAL]

APPENDIX O: TRANSFER AGREEMENT [CONFIDENTIAL]