A comparative study on the different log storage practices at four of New Zealand's log exporting Ports

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Abstract

The aim of this study is to provide the reader with an accurate picture of the current practices and procedures in place at four ports in New Zealand that are occupied by C3 Limited a port logistics company. Specifically, the storage and space utilisation of the log yards where exporting grades are held prior to being loaded onto the ship. The four ports are Marsden Point, the Port of Tauranga, Gisborne and the Nelson Port.

In order to compare the practices at the four different C3 Limited branches in New Zealand each location was visited. At these visits the procedures utilised by for the row allocation of logs, the physical differences between the ports, the port imposed procedures for area or volume allocation to suppliers and the Row Stacking Measure that is utilised by C3 Limited were explained. This was done through interviews. Interviews were carried out with a minimum of three participants at each location and always with the branch manager, operations supervisor and either a loader driver, yard foreman or port company representative. The information was then compared using tables and the findings highlighted for each location.

The following recommendations were made from the findings. The company should implement a uniform policy throughout its divisions with regard to the procedures used to allocate rows such as the very logical system in place at Marsden Point. Whilst the port imposed area or volume allocation methods are out of the control of C3 Limited to manipulate the focus must be shifted to increasing the throughput and efficiency of the systems in place to work within these constraints. The key benefits of implementing a companywide procedure is that it allows flexibility within the company to manipulate the workforce to required locations of employee shortage.

Introduction

With the volume of exports expected to increase in the coming years the ability of New Zealand port infrastructure and procedures to deal with these increases is vital to the nation's economic development. C3 Limited is a company that acts within 15 ports in Australasia and provides a marshalling service to suppliers exporting logs and other products from New Zealand. This report will focus on the marshalling procedures of C3 at four of these ports specifically the ports located at Marsden Point, Tauranga, Gisborne and Nelson comparing the current procedures and practices in place at the four locations and to determine if a set of recommendations is possible to implement a streamlined procedure across all ports.

Each port has a predetermined zone that it allows for the storage of logs prior to export, within this area either leased land or set volumes are allocated to suppliers for their log storage. As it is generally not an option for the surface area of the port to be increased this means that once the designated areas have been filled no more logs can be brought in even though more capacity is necessary to store the volumes required for export on the next incoming ship. Log storage for shipment comprises several aspects. The logs are stored in rows that are allocated by C3 employees in the appropriate areas. In each row all logs are from the same supplier, are of the same grade and are of the same length. With the use of a ticketing system the supplier can be ensured that the location and volume of each log is known both to them and C3 Limited when it comes to loading the ships to fill orders of set JAS[1] requirements for each exporter.

There are many contributing factors that determine the procedures in different ports such as the physical and structural limitations of the port infrastructure, the C3 Limited implemented row identifying or allocation system, the port imposed area or volume allocation to suppliers. In addition there is a general comparison called a Row Stacking Index which is a measure utilised by C3 Limited to compare the different storage practices.

Further considerations of this study are the key benefits that a streamlined system would be to increase efficiency and inter branch flexibility of employees through the national port company. This approach must however take into consideration the equally significant factors of the restrictions imposed by the different port companies as they are the land holders, the supplier is the lease holder or tenant and C3 Limited is the marshaller employed by the supplier to organise and maintain the inventory.

There is limited literature available on this area of forestry study and after a preliminary review of the University databases I found that there is currently no literature on storage density of felled logs. The following study and recommendations are therefore based on the information gathered through interviews and data analysis at each of the locations to determine the procedures and restrictions experienced by the regional branch of C3 Limited.

[1] JAS - Japanese Agricultural Standard

Methods

Study design

A mixed study design was established consisting of an exploratory, qualitative study using face to face interviews at each of the four ports. A selected data analysis of the Row Stacking Index (RSI) measures was also carried out and interviews with the branch managers, operations supervisors at the four locations and a representative from the port company at Marsden Point and Tauranga.

There was a change of approach early in the study design from a storage density comparison of the ports to a more general comparison of the four port procedures. This change occurred after the early data analysis when it was discovered that the initial assumption that the branches in each of the ports utilised the same or very similar procedures was found to be wrong. This is briefly explained.

The initial key measure that was to be used to compare the storage density of the ports was found to be misleading and also required some analysis to determine how this measure worked. This measure was the RSI calculation.

The results from this early analysis finding then turned the focus of the study to understanding the details of the key differences in the four ports namely the physical variances of the infrastructure, the differing procedures utilised by C3 Limited for row numbering and allocation in the yard, the port imposed procedures for area or volume allocation and finally the effects of the RSI measure on the comparison of the branches. This directed the further focus of the study, follow up interviews and comparative data analysis

Selection of the four ports in New Zealand.

The four ports were selected by fitting part or all of the following criteria:

- part of the C3 Company network
- large log export capacity
- variable geographical location

By researching the different capacities that the different ports in New Zealand hold and the associated plantation forestry regions it was established the ports that have the largest log exports which were Tauranga (Central North Island region), Marsden Point (Northland region) and Gisborne (East coast region) found from the Ministry of Primary Industries National exotic Forest Description. The geographic location was also considered as it was decided that a port in the South Island was required. This resulted in the Marsden Point, Port of Tauranga, Gisborne and Nelson Port being visited.

Participant Interviews

Face-to-face interviews with a minimum of three interviews were conducted at each port. These were with the branch manager, the operations supervisor and either a yard foreman, a driver or a port company representative.

An interview guide was written to develop consistent questions. The interview guide questions were designed in themes to determine the procedures implemented and the practices that occur at each port and to record participant suggestions. The guide is listed in the following:

- To understand the different methods that are utilised for storage,
- The area that is available to that port for log storage and how it is divided between suppliers
- Discuss any suggestions for improvement of storage density
- Gather the current storage density values gathered for the last two months
- Understand the reasoning for the current system that is in place

The Interviews took place in each of the four port areas on the following dates:

- Gisborne – 2-3/07/2013
- Marsden point – 4-5/07/2013
- Nelson – 19-20/08/2013
- Tauranga – 1/07/2013 and 29-30/08/2013

These dates were chosen so that time for travel to each of the locations could occur within a two month period as an allowable period of time after the visits to add to notes taken during the interviews and write summary and preliminary comparisons.

Follow up interviews

After the initial interviews at the four ports follow up phone calls were made to ensure that all the gathered information was correct and any uncertain areas of the procedures were clarified. These were also utilised to gather any information that was not available, such as port maps, at the time of the site visit.

Study Tools

The following were used to aid in the information collection procedure:

- Interview support material, the work plan for this study was given to each interviewee to read prior to the interview and a copy remained with the participant.
- Interview guides with a question per page so that the information given could be easily recorded in note form to be later written in full after the interview

- Data selected for analysis was the RSI spread sheet this was collected from the different ports containing the RSI values and measures up to the date of the interview.

Data Analysis

The data analysis was a multistep process and considerable data was analysed and compared across the four ports. The data analysis process is outlined through each stage.

The interview guide was utilised during the interviews to record information from each of the interviewees. Each question then had approximately a page of associated field notes and standard operating procedures for each interviewee and port to ensure that the procedures and methods were fully understood. The notes were then typed up by port and separated into the interview guide questions by topics where the information could then be complied into sections to compare the different ports against each other.

After the initial gathering of the RSI data at each of the ports a brief analysis of how the measure works was done to understand what the resulting value was defining. This was determined to not be a density measure (Kg/m^2) but was a statistical benchmark to compare the ports.

The interviewee notes were then entered into a comparative table to begin a content analysis of the information gathered from the face to face interviews and to identify common themes such as:

- Physical constraints
- Port imposed constraints
- Positives
- Disadvantages

The table separated the four ports into the listed categories but more specifically the aspects controlled by the C3 Limited branch at that port and the aspects that are controlled by the port companies.

Following this analysis it was quickly established that a third table was required to compare the physical infrastructure restrictions of the different locations. The different rows of the comparative analytical tables were used to develop independent analysis with the addition of aspects to consider the wider picture. For each of the ports procedures the positives and negatives associated with each of the processes, that essentially have the same end goal, were established. These discoveries are described in detail in the findings section.

The gathered four ports RSI spread sheets were then further analysed to fully understand the background mathematics that are being utilised to determine the target percentage value. Once this had been established the standard operating procedure for the RSI measure was analysed to determine whether the given explanation of the procedure matched the calculations.

The values for each of the ports average percentage target to date were then also compared with the information gathered from the interviews and compared with whether the ports had fumigation occurring at them. These two factors were associated. For the fumigation process to occur a minimum gap of 1.0m must be present between rows therefore affecting the space between row requirements.

From this point the results were drafted together into a large table type system rating the different methods of storage ranked best to worst along with the connected restrictions associated with each method.

The methods were then compared to determine the procedures that could be implemented to create ease of movement whether promotional or inter port movement of the workforce when shortages occur within the company. This was then utilised to determine the recommendations for the study and an ideal procedure to be implemented as a systemic approach throughout the company.

Strengths and limitations of the study

One of the strengths of the study was the insider knowledge of the researcher. As I did my Engineering manual and professional hours with C3 Limited there was a pre-established knowledge of some of the port procedures and work processes. This was an important factor with interviewing the participants as they were much more willing to discuss procedures with someone who had worked within the company prior.

The limitation of this study was the inability to fully study the storage density measure and this is an area of Forestry Engineering Research that could be developed to understand the different costs and difficulties associated with storing and moving lower grade, smaller length logs.

Findings

The results are presented in four sections. Firstly a description of the four ports is presented followed by a key finding from each port. Then a summary of the information gathered from the interviews at each of the four ports Marsden Point, Tauranga Mount Maunganui, Gisborne and Napier is outlined in to determine the processes and limitations of the current systems in place.

The four themes of the study results are in sections relating to the physical differences at the four ports. The next three sections are the row allocation systems used, the restrictions imposed by the port companies in each region and the last section relates to the Row Stacking Index (RSI) comparisons and evaluations.

The main areas for comparison are the physical attributes and differences at each port, this is described in the first section, the row allocation system utilised by C3 Limited at the different ports and the regional port imposed supplier area or volume allocation systems that occur at each port.

Physical differences at the ports

The physical attributes of each location have been analysed and are presented in the following Table One. This outlines the key differences between locations both structurally and with respect to other factors beyond the control of C3 Limited. The key factors considered are the area for log storage on the port, the availability for suppliers to lease land or utilise common storage areas, the number of suppliers at each port, the number of berths and consequently the number of ships at the port at any time, whether the port volumes are affected by seasonal fluctuations, loads arriving by rail as well as trucks, the ship loading method used and finally, whether this is used because of loading restrictions on the port.

The single commonality for all four port operations for C3 Limited is the leased land and storage facility. As identified on Table One C3 Limited works with 10 of the 13 suppliers at Marsden Point Port and 8 of the 9 suppliers at the Tauranga Port and are the only marshaller in Gisborne and Nelson. C3 Limited as a company within the ports compared hold the majority of the contracts for log marshalling with suppliers.

This could be attributed to the check scalling and docket checking procedures in place at all ports that ensure that the quality of the service provided to the suppliers is consistent nationwide.

The log storage area varies remarkably by port as shown on Table One. It is important to consider however, as the regional variation for supply is dependent on many factors, it is best described by the national exotic forest description (MPI, 2013) Table 9.6: forest area by forest owner national size class as at April 2012(This table is shown in Appendix ten). The total Ha column it is shown that the regions with the largest areas of planted forest coincide with the ports that have the largest storage space. With an increased plantation area and consequently volume of exports serviced this explains why the Tauranga Port has the largest storage area and number of berths.

Location	Marsden Point	Tauranga	Gisborne	Nelson
Area for log storage on port (m^2)	207572	248010	143000	86710
Leased land and common storage	Yes	Yes	Yes	Yes
Number of suppliers	13, 10 work with C3	9, 8 with C3	4	3
Number of berths	2	3.5	1	1
Season fluctuations due to wood lot harvesting	Yes	No	Yes	No
Rail vs. no rail	No	Yes	No	No
Ship loading method	25% trucks always but often 50%	Bunks	Trucks	Bunks
Loading method restricted due to weight restrictions of port	No	Partially	Yes	No

Table one: Physical differences between locations

Table One identifies the physical differences between the locations. The key finding is that there is no consistent approach across the four port operations.

The next section of the findings analysis is of the independent factors associated with each of the four ports with the key finding identified at the end of each port analysis and a brief summary statement at the end of this section.

Marsden Point Port

The port at Marsden Point was purpose built in 2002 for log export (Deal, 2013) therefore there are no limiting restrictions on space and they have the ability to expand. Marsden Point is a developing community and the town is not located close to the port which is a large problem at other sites in New Zealand.

Due to the way Marsden Point Port has been designed within the total area there is 3ha in an outer yard that is not currently in use as this is for winter volumes. This port services an area that deals with a lot of seasonal logging which causes large changes in volumes. This is due to the larger number of smaller suppliers that only work in the warmer months and Marsden Point Port puts no restrictions on the quantity or regularity of suppliers exporting volumes.

Another key difference with Marsden Point Port is the method utilised for the loading of ships. Trucks are used to load straight onto the ship, off the trailer, instead of first pre berthing and then loading into bunks as explained in the following Figure One.

Figure 1: Bunks and pre berthing example

Bunks are used to help the wire ropes that are used by the cranes to be placed around the loads to place them on the ships. The loader places the load into the bunk then it is checked to account for the logs and therefore the volume being placed on the ship. It is then lifted into the hold. Pre berthing as can be seen in the right hand corner of Figure One. This is done when wood from areas far from the berth are required. The wood is moved to the berth and then loaded onto the ship.

A key finding is that Marsden Point Port practice of using trucks instead of bunks for wood that needs to be moved from yards away from ship side reduces the costs associated with double handling.

The Port of Tauranga

The Port of Tauranga is the closest to the Central North Island Forests and the central processing yard located at Kaingaroa that also has direct rail access to the port. This is the only port with rail access. The Port of Tauranga has the largest area and deals with the largest volumes in New Zealand.

There are currently 3.5 berths utilised for log ships. The half berth is due to the fact that the fourth berth used for mixed hull boats that take raw log exports and value added products such as timber or other exported items. Smaller loaders have to be used at the Port of Tauranga due to loading restrictions. At the Mount log marshalling yard logs are pre berthed however there has been the utilisation of some trucks recently.

This port provides a unique challenge as the notice of a ships arrival tends to be between 3-4 hours prior. In addition, ship scheduling is done on a first in first served basis so the next ship to arrive can be different to the ship planed for (Whitworth, 2013). This causes a delay as wood cannot be pre berthed until it is confirmed which exact ship will be arriving. As the yard is so large there is an area set aside specifically for pre berthing. As soon as the ship is confirmed the logs are moved from there allocated storage areas to "ship side". This is done in the Port of Tauranga with loaders and also with shuttle trucks from the outer yard located across a main road.

The key findings are the factors to consider with the Tauranga Port that they must react to the constantly changing environments and the technology utilised so as to ensure that the organisation required for this task can manage these increases with efficiency. These procedures ensure that the required information is easy to locate and the database is always up to date. This is important as at the Mount yard due to the large volumes they do not have time to wait for the system to be updated.

Gisborne Port

Gisborne Port have utilised a satellite yard located a ten minute drive from the port. This satellite yard has the ability to fully service the trucks. Therefore trucks coming in to Gisborne from that direction can be a viable option for storage. This port is the only port in this comparison to have a full off site scalling and storage facility.

Other ports have the option of using outer yards that are close to the port. From this satellite yard the logs are then shuttled into the port and straight to the cranes. Bunks are not used in Gisborne due to loading restrictions and therefore the planning of ship loading must be done around the flow of shuttle trucks moving around the yard to unload new loads and to move loads to shipside all at the same time. This can cause some traffic issues. It is important that a good wood flow throughout the port occurs (Davey, 2013) to reduce delays caused by road blocks.

A key finding is that the Gisborne Port full off site scalling and storage facility is located in the path to the port and it is not a detour to store logs at this location. It is therefore not increasing the trucking costs for the supplier however as the loads must then be shuttled into the port to be loaded onto the ship an analysis of the associated costs of this would be crucial as to whether this system might be implemented elsewhere.

Nelson Port

Nelson Port is located at the top of the South Island and along with Picton exports the wood from the Marlborough Nelson regions dependent on the supplier. Due to the space limitations at the

Nelson Port they utilise lots of outer yards around and adjacent to the port area. Whilst these yards are available to be used the aim is to keep the majority of the wood in the closer yards. This is due to the additional costs associated with the movement between the outer yards and the inner yard. To do this shuttle trucks are required which are hired. An additional cost is the workforce to chain and unchain the loads. The loads have to be chained as the outer yards require movement over public roads. As the shipping schedule is usually predictable there are not often problems with storage however when it does change it results in full utilisation of all yards approximately four times a year (Reuben, 2013).

The finding from Nelson Port is that a smaller port area faces different challenges and crossing public roads is the safety requirement here.

Having identified the comparative infrastructural differences in the four ports it is important to consider the factors that are controlled by the procedures in place at the different C3 Limited branches. The next section of data analysis considers the effects of row allocation can be the difference between fully utilising the available space and increasing the efficiency of movement throughout the port.

Row allocation system

To keep track of the volumes and individual logs stored in the port area a row allocation system is in place. As the loads are placed into rows the associated volumes are updated and allocated to that row on the database. Using these values the loading of the ship can be planned to ensure that the correct volumes are leaving the port for each supplier and the supplier can know how much wood they currently have for shipping. In this way it is crucial that the loader drivers in the yard know exactly what is in each row and where it is located so they can place any additional loads into the correct row.

Initially it was assumed that a similar method was utilised at each port as they are all managed by the same company. It was quickly established that this was not the case. A description of the row allocation method at each port follows.

Marsden Point Port

The row allocation method utilised at Marsden Point is based on a physical location of the row. This is done by the yard being separated into blocks that are labelled alphabetically and marks painted at 2.0 m intervals down the centre (Nerra, 2013). The row is then given a name that is the block it is located in and the distance from the middle road the row is located as depicted in the following Figure Two.

Figure 2: Marsden Point yard layout, see bigger version in Appendix one

So to find C160 the driver knows that they must enter the yard and drive approximately 160m to find the row where the load has been allocated. The markings also help with measuring the distance between rows and an example of these markings is shown in Figure Two.

Finding: The benefits of this row allocation method is the fact that the row name provides a physical location of the row and means that the system is easy for drivers from other ports or new drivers to manipulate the yard. The regular interval markings are highly frequent at the Marsden Point yard and maintenance is required for the upkeep however larger spacing's could work in the same manner.

Figure 3: indication of the markings in place at Marsden Point

Port of Tauranga

The row allocation method utilised at the Port of Tauranga is similar to that in Marsden Point however the rows are numbered numerically instead of as a measure from the main road. This is done on a fully computerised system where ticket checking scalling and yard planning is all done with the aid of computer software. The blocks are labelled either alphabetically or by a historic name such as the "horse paddock". Features such as the water side, rail side or middle road are utilised to determine which side of the block the row is located on. From there the rows are in numerical order from north to south. For example C19WS will be the 19th row from the north end on the water side of C block (Smylie, 2013). A full copy for one supplier is shown in Appendix three.

KI	ROAD		RAIL	A	ROAD		RAIL
KI 4.0	D10			A 12.0	HP05		
KI 2.9	C33			A 11.0	HP07		
KI 3.8	F10RS	FUMO		A 10.0	E10W		
KI 3.6				A 9.0			
KI 3.0				A 8.0	4BW26		K30MR
KIS				A 7.9			
KIS 6.0	ASK	FUMO		A 7.7			
KIS 5.8	F13MR			A 7.3	5SHDR8		
KIS 4.8				A 6.6	BT4		
KIS 3.8	n/s			A 6.0			
KIS 3.6	ASK			A 5.8	F19RS	FUMO	
KIS 3.0				A 5.4	K10MR		
U1				A 5.1	F21MR		
U1 7.3	8BR4			A 5.0	K4RS	THEN E4WS	
U1 7.7				A 4.9			
U1 5.8	E11MR	FUMO		A 4.5			
U1 5.4	F9RS			A 4.2			

Figure 4: example of the TPTF yard plan, full version in Appendix three

Finding: The system is easy for out of port workers and new workers to pick up however, the scale of the yard can make locating the number difficult. This also means that there are multiple yard foremen working at one time to ensure that the rows are labelled correctly. The yard foremen must also ensure that the loader drivers and the locations where the truck drivers check the plan have an up to date copy of the yard plan. A copy of a section of the yard plan is shown in Figure Four above and tells the reader the current location of the different grades for that supplier.

Gisborne Port

As the operations supervisor at C3 Limited's yard in Gisborne previously worked at the Port of Tauranga, Mount Maunganui log yard the row allocation resembles that of the Mount yard. The only key difference is that as there is a sea wall and therefore they number from the wall outwards. The blocks are given a letter and then numbered numerically. As the yard has recently been tar sealed there is currently no markings on the yard and this allows for the middle road to be shifted allowing for the high stacking of rows (Davey, 2013).

Finding: The finding for the Gisborne Port is the middle road that gets moved is indicated on the yard map of the Gisborne port in Appendix four. The key disadvantage of the ability to move the middle road is that a certain width must be maintained to ensure that there is no safety implications associated with the change.

Nelson Port

The Nelson log yard has a system for row allocation that is essentially random. The row “name” does not correspond to its location in any way and is instead chosen off a sheet of numbers as the next one to be allocated of which an example is shown in Appendix six. This occurs by the loader driver radioing to find out the next number and then calling that row by the new number in that yard. This can be done in Nelson as it is made up of many sub yards however within each of these areas the number on the row does not link to its location (Reuben, 2013).

The yard plan carried by the drivers acts as a map of where exactly in the yard the row is located with an x to indicate if the row has had its tickets checked and two x’s (e.g. xx) if the row has been high stacked and had its tickets checked twice. An example of the yard plan for one of the sub yards is shown in Appendices seven and eight. This method requires the drivers to “just know” where the rows are located and would be difficult for new workers to learn. Currently this is not a problem faced by C3 Limited at the Nelson Port as they do not tend to get in out of port workers due to the large casual staff pool available to them. As there are usually only two loader drivers working at any time they act as the yard foreman and it’s up to them to plan the layout of the yard and the location of where the rows are located.

The finding for the Nelson Port is that this system is based on a predominantly manual system whereas that has been updated in the other three ports with the Mount Log yard utilising all the technology available most efficiently.

In summary the overall key finding for this section is the systems utilised by Marsden Point, Tauranga and Gisborne are easy for out of port and new workers to pick up. The scale of the yard can make locating the number of the rows difficult in the Tauranga yard and the safety aspects of moving the middle road in Gisborne have safety constraints at different ports. The logical nature of the Marsden Point yard allow for rows to be located with ease when workers are new to the branch. The Nelson system is predominantly manual and the software programs utilised on a regular basis at the Port of Tauranga are not implemented company wide.

Restrictions imposed by the Port Companies

Each port is run by a port company such as Northport at Marsden Point, Port of Tauranga in Tauranga/ Mount, Eastland Port in Gisborne and Port Nelson in Nelson. These companies act as the land owner with the suppliers the lease holders. C3 Limited is the company employed to marshal[2] the product by the supplier however they must work within the ports restrictions. At some ports there are multiple marshaller's acting in the same area but for different suppliers. The port is therefore charged with allocating the different suppliers a volume or area that they are able to utilise whilst waiting for their ship to arrive. Each port has a different method and for each company it is outlined in the following discussion.

For Marsden Point the area allocation to suppliers is indicated on the yard map as seen in Appendix one. The yellow area indicates the area marshalled by another marshalling company and is leased area held by one of the main suppliers. The blue area is held by one of C3 Limited's customers and is the other permanent lease area at this port. The light green area indicates common storage area and is divided between the other suppliers, the majority of which are C3 Limited's clients, and is divided based on the weekly cartin information given to the port by C3 Limited weekly. It is also based on the supplier's predictions for the upcoming months. The map does not show the two outer yards that are also utilised by common storage suppliers.

This method allows the marshallers to work with the suppliers on the volumes that are currently present and can then restrict volumes if nearing capacity. Northport Port Company only step in when "space becomes a problem" as the port begins to reach capacity (Burgess, 2013). To reduce the likelihood of this occurring the port provide bookends[3] for all roadside rows and import the steel directly to reduce the costs associated with building the large steel structures. They also do not restrict the number of suppliers at the port and therefore there are large numbers, 13, compared to other ports.

Finding: At Marsden Point the port authorities do not restrict the number of suppliers at the port and therefore there are large numbers, 13, compared to other ports.

The Port of Tauranga limits the number of suppliers to nine. Of these suppliers eight are with C3 Limited and either lease land independently or as part of a group arrangement. The leases are for a term of three years. The suppliers that lease an area as a group work with C3 Limited to determine the area allocations within this area with little interference from the port until the port reaches capacity or there is a "surge" in wood. A surge is when there is a change in shipping schedule and the area allocated to the supplier is consequently full with wood still entering the port. This surge is allocated space in the general storage area that is monitored by the Port of Tauranga company and

[2] A log marshaller is employed to ensure that the location of the logs is known and take wood from the initial entry onto the port to shipside to be exported

[3] A book end is a steel structure, similar in shape to a book bookend, used to square the logs and allow for more storage on the same amount of area

the supplier can only be given space in this area if the throughput of wood, the time between when the wood arrives and leaves on ship, is high (quick) for that supplier (Whitworth, 2013).

The key finding for the Port of Tauranga main disadvantages of this area allocation system is the length of the term for the supplier to commit to and that the Port of Tauranga is actively restricting the number of suppliers making it difficult for new suppliers as they have to sell to current suppliers to get there wood on ships.

Due to the fact that the wood must be pre berthed in Tauranga there is an area shipside that the wood gets moved to once a ship has been confirmed. This is often only three to four hours' notice. The following Figure Five shows the main yard that is divided between suppliers at the Tauranga as well as the area allocated for pre berthing which is directly beside the ship. Bookends are not highly utilised in the main yard as can be seen in Figure Five below however they are used in the outer yards.

Figure 5: the Mount log yard controlled by the Port of Tauranga

Finding: The Port of Tauranga supplies these for the supplier to purchase off them using a rental payment system. The rail can also be seen in this Figure Five and it arrives regularly throughout the day (Whitworth, 2013).

At the Gisborne Port run by the Eastland Port Company there are four major suppliers of which one has permanently leased land. This lease is the result of a historical contract that has been brought and sold between suppliers in the past (Carter, 2013). The other three suppliers utilise the rest of the area with an allocation based on the average volume that has been present on the port over the previous quarter.

Finding: The finding for Gisborne is the benefits of this system are that it is very current but it does affect seasonal logging as the volume allocation reflects that of the volumes present in the past. For example if a supplier has high volumes in the summer months and then lower in the winter the following summer volume allocation will be based on the low winter volumes, as this is the most recent past quarter, instead of what was required in the previous summer. This results in a disadvantage to seasonal logging and forces the supplier to aim for a more stable wood flow.

The Nelson Port volume allocation is based on the capacity of the main inner yard and is divided between the three suppliers. The allocations are based on the cartin[4] provided to the port by C3 Limited and are compared to the throughput of the volume by the different suppliers. There is currently a supplier that has ships less frequently so the wood is stored in an outer yard to allow for more room for the more frequent suppliers in the inner yard (Reuben, 2013). The planed volume allocation is less than that of capacity so they can then adjust accordingly if there is a change in shipping schedule and a surge in wood.

Key finding: The finding is the Port of Nelson is influenced by changes in the shipping schedule at the Picton Port as a supplier may decide to re-route the ship to Picton if they feel the volumes there need to be exported more urgently than those in Nelson.

In summary the overall key finding for this section is that Marsden Point the port authorities do not restrict the number of suppliers at the port and therefore there are large numbers, 13, compared to other ports which are limited by the port companies. The key disadvantage to the lease method utilised at the Port of Tauranga is the length of the term however this ensures that the supplier, marshaller and port company know the exact area restrictions that they must work within. Conversely, the method for volume allocation utilised at the Gisborne Port is so current that the effects of seasonal logging are felt by suppliers and forces a more even wood flow from the forest to the port to be exported.

[4] Cartin is the volume of wood that is present on the port as calculated when the logs are scaled upon entry to the port. Example in Appendix nine.

RSI comparisons and evaluations

RSI stands for the Row Stacking Index and is a measure that is used at all of C3 Limited's ports to provide a benchmark comparison between the highly varied ports. It is used to report the storage performance and act as an unbiased sampling method according to the standard operating procedure (SOP) released internally.

To perform this calculation the explanation document requires that a row of logs meets the following criteria:

- A 24 and 28 average SED[5] with a length of 3.8 to 4.0m
- if possible a row that is located on a hard or sealed surface
- the chosen row must be located between two closed rows, this means that the two rows on either side are full to capacity
- the measures must start at the book-end or the beginning of the stack and measure the height of the stack and the maximum distance between logs in the chosen and adjacent row.
- measure the distance between rows at a height of 1.4m (the same as DBH[6])
- measure height and this distance at every ten meters along the length of the row till the end
- if the stack starts with a sloping end the first measures are first taken at the mid-point of the sloping face
- the use of book ends and high stacking is recorded

Figure 6: clockwise from the left: the locations of measures for the RSI calculations, An example of a bookend, rows being filled by a machine the stack on the right has been high stacked compared to the left that has been filled with a loader.

[5] Small end diameter
[6] Diameter at Breast height, a common measure in the forestry sector at 1.4m height off the ground

The data is then entered into a spread sheet the uses the following formulas to calculate the target RSI and the RSI:

$$Target = (average\ height) \times 0.75$$

$$RSI = \frac{Average\ height}{Average\ distance\ between\ rows}$$

The RSI calculation suggests a linear relationship between the average height and the distance between rows. For example if a row has an average height of 6 m to reach 100% of the target the average distance between rows must be as follows

$$Target = 6.0(m)\ \times 0.75$$
$$Target = 4.5$$
$$RSI = Target = 4.5 = \frac{6.0(m)}{x}$$
$$x(average\ distance\ between\ rows) = 1.3\ (m)$$

Regardless of the entered average height upon working back through the equation the multiple of 0.75 in the target causes a goal distance between rows of 1.33m. Where the spread sheet shows the row over target is the rows with an average distance between them of less than 1.33m. An example of the resulting graph from the Mount Maunganui log marshalling is shown below.

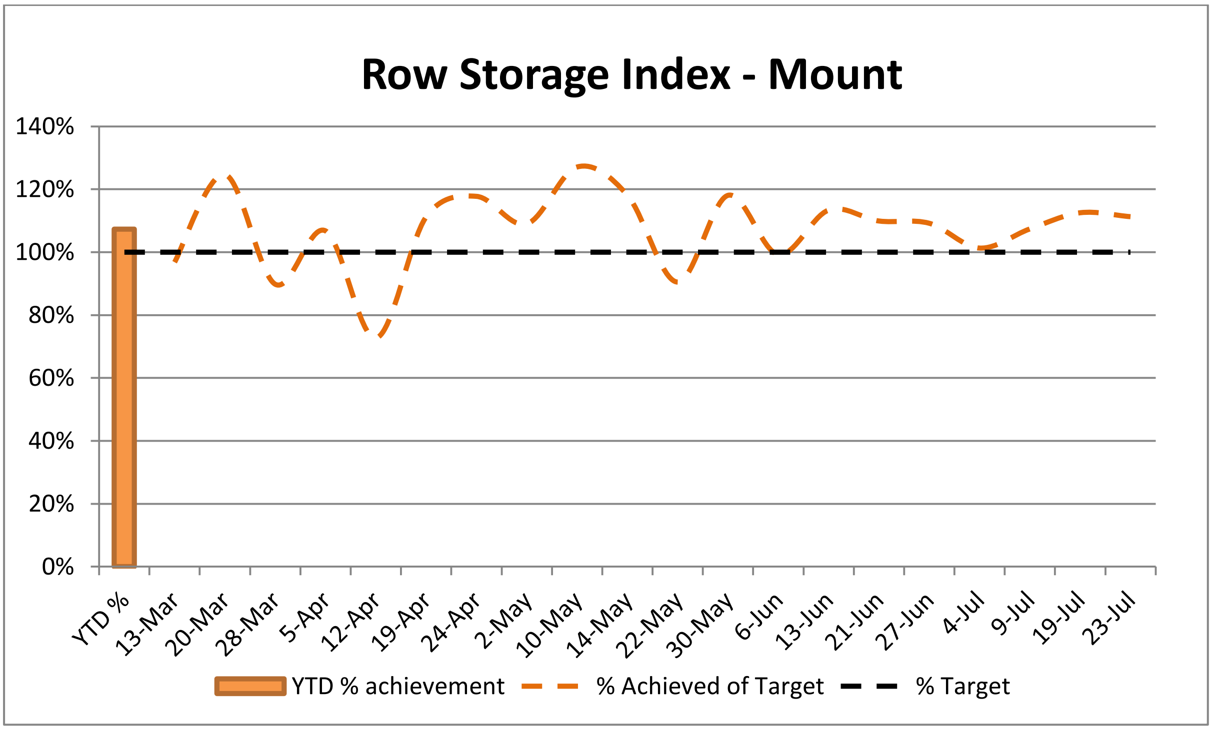

Figure 7: Example of the RSI graph produced by the calculation spread sheet

This shows that for the majority the rows are spaced less than 1.33m apart however this gives no indication of the height that the rows are stacked to, whether the row has been high stacked or whether it has a book end at the beginning of the row. Due to the SOP this measure does ensure that rows of similar grade (SED of 24 and 28 average) and lengths of either 3.8m or 4.0m are used.

This measure has limitations as for fumigation a minimum of 1.0 m is requested although getting a direct statement of this has not been possible. This is so the fumigation company can safely tarpaulin the rows and if this gap is not maintained the logs will not be fumigated and therefore will not leave the port.

With a minimum distance of 1.0 m and a target of 1.33m the difference between the stacking on target and too close is marginal. The benefits of all rows stacked within this 0.33m range could have negative impacts with the fumigation company known to cut logs, reducing value, to ensure this minimum gap of 1.0m is present. This impact to the dissatisfaction of suppliers (Smylie, 2013).

Rows are also kept at this width at non fumigation ports to allow for check scalling and ticket checking which is also part of C3 Limited's auditing process. The RSI calculations given by the four ports in this study show the percentage target reached, on average, summarised in the following Table Two.

It is important to note that the frequencies of recording the appropriate data vary for each port and the dates the rows have been measured also vary. Table Two indicates for the current measures to date the average percentage achievement. Where the percentage value is over 100% the port has managed to maintain the space between rows of less than 1.33m. The fumigation port column shows the ports that must have a gap of greater than 1.0m between rows as required for this procedure to occur as for the other ports this size gap is technically not a necessity.

Port	Year to date percentage achievement	Fumigation port
Marsden Point	94%	Yes
Mount	107%	Yes
Gisborne	77%	No
Nelson	113%	No

Table two: RSI average comparisons for the four ports

The finding here is that the RSI calculation method identifies how well the space, a key limiting factor at the ports, is being utilised. By the target width between rows set at 1.33m the only way to be above target is to decrease the row width. The key disadvantage of this however is that the rows can be no smaller then 1.0m in width to allow for ticket checking and check scalling to occur as well as fumigation in both Tauranga and Marsden Point ports.

The SOP to this procedure states that the method is used to measure the storage density and continues that it is used to compare things that the marshaller can control such as the height of rows and the distance between rows.

While this procedure does compare the height and distance between rows, density is defined as kg/m2 and the values produced are not a density measure. The resulting RSI value signifies the relationship between the average distance and height. Whilst the target reached tells how close to the proposed ideal width of 1.33m the average distance is regardless of the height of the row.

Finding: The key finding for this section is that to accurately determine the density of the rows a formula would have to be developed using the measured JAS volume over the surface area that the wood is stored on.

As the space on the port will forever be a hugely limiting factor it is important to consider a different means of increasing the storage capacity. Rather than going in the vertical direction, which has serious safety limitations, and moving the rows closer together which has quality implications, as without the auditing process the supplier cannot be ensured of the location of each log at any time.

This measure has limitations as although it identifies how well the space, a key limiting factor at the ports, is being utilised it does not give a storage density measure as suggested by the SOP. As the target width between rows is set at 1.33m the only way to be above target is to decrease the row width. The key disadvantage of this is that the rows can be no smaller then 1.0m in width to allow for three factors the ticket checking and check scalling to occur as well as fumigation in both Tauranga and Marsden Point ports. To accurately determine the density of the rows a formula would have to be developed using the measured JAS volume over the surface area that the wood is stored on.

Recommendations

The implementation of the row allocation method based on the physical location of the rows as occurs in Marsden Point Port should be utilised throughout the four ports as the obvious benefits of reduced time in finding the rows and the logical nature of the system means that workers can easily familiarise themselves with the yard.

To do this, marks of some type would need to be placed throughout the yards at all ports at even intervals that can then be used to gauge the location of the row. This would replace the numerical system in place in Tauranga and Gisborne which currently has the key disadvantage of becoming out of sequence. The Marsden Point row allocation method is superior to the method utilised in Nelson of completely random number allocation to rows.

The ability of Gisborne to move middle road and account for high stacking is ideal but hard to apply elsewhere. Other ports have competing marshallers and other port users using the same areas and other port infrastructure built around the designated road ways. Moving roadways also incurs additional safety concerns. As the port area increases so does the traffic around these roads increasing the requirements for visibility around corners and bends.

Most ports use a computerised system for some or all of the row allocation, yard planning, docket checking and row volumes. Some of these mainstream procedures at the Port of Tauranga are not implemented in the other ports such as electronic docket checking and a computer generated yard plan. The technology available needs to be implemented companywide to improve efficiency and reduce error. This could be done by sending a team of workers from Tauranga, who know the systems well to teach the other branches along with a member from the IT department who can update and implement the required software.

While it is not possible for C3 Limited to change the ports volume allocation systems they can look at the effects of double handling the wood to pre berth instead of trucking straight to the cranes as implemented in Marsden Point Port up to 50% of the time. By increasing the efficiency of the yard the turnaround of ships can be increased and the space previously used to pre berth can be used for storing the logs for the next ship.

Tar sealing the storage areas increases efficiency, however this is up to the port companies, this has been shown to greatly increase the storage capability of the yards. In addition, convincing the port companies and or the suppliers to invest in bookends is paramount to increasing capacity. The benefits of tar sealing can be seen at the Gisborne yard who have noticed much tidier rows and more control over the rollout of logs from the beak of the loader when unloading trucks. The benefits of bookends are that they square the ends of the rows allowing for more volume to be stored over the same area therefore increasing the capacity of the row.

Finally to accurately determine the density of the rows a formula would have to be developed using the measured JAS volume over the surface area that the wood is stored on would require further research.

Conclusions

The findings from the information gathered at the four different ports in New Zealand show that even though ports all are marshalled by C3 Limited they all have varying procedures in place to allocate rows and therefore yard layouts, supplier area or volume allocation and space utilisation methods. Although some of these factors such as the supplier area or volume allocation are determined by the specific port companies the variables and procedures put in place by C3 Limited within these frameworks all vary significantly.

Within C3 Limited there is a culture of providing workers with the opportunity to work in other ports and promotions within the company to different locations. As this culture is deeply engrained in C3 Limited it could be assumed that the ease of moving between ports would be increased if all the C3 Limited port branches utilised the same yard layout and row allocation methods.

To develop this kind of flexibility within the company has many advantages such as allowing the company to remain competitive within changing markets (Russell & Taylor, 2000). To do this would involve implementing a streamlined procedure for the yard and row allocation throughout the ports nationwide to ensure that the flexibility of movement of employees between locations can be fully utilised. The best system to be put in place would utilise the most successful procedures at each of the ports to ensure a clear and logical system. The current system that does this best is that of Marsden Point Port and the benefits of the technology utilised in Tauranga are also high with regard to increasing the efficiencies at the port.

As the Row Stacking Index is not a storage density measure but a space utilisation comparison the development of a storage density equation should be investigated if this is what is to be compared between ports. This would utilise the information gathered through scalling the logs and comparing the JAS volume over the square meter area covered by that row. A factor comparing the heights of the rows and also the effects on density that different grades have would also aid in developing a clear picture of the storage capabilities of each port.

As the space on the port will forever be a hugely limiting factor it is important to consider a different means of increasing the capacity rather than going in the vertical direction which has serious safety limitations and moving the rows closer together which has quality implications.

This requires a shift in focus from storage capacity of the ports to the efficiency of the throughput volumes. If the logs can be loaded onto the ship with decreased handling, increased efficiency and reduced time spent on port then the capacity of the port to deal with the imminent increase in export volumes would become available. This would also ensure that limits on stacked heights of rows would not be exceeded ensuring that safety remains of paramount importance.

The key aspects to be considered for future research highlighted by this study are the development of a density equation to be utilised at all ports, a comparison of the volume turn around at the different ports compared to the frequency of ships, number of berths and the area available for storage. To quantify the benefits, if any, of utilising trucks to load ships instead of bunks if permanently implemented. This would make the area allocated for pre berthing unnecessary reducing costs associated with double handling of loads, already placed on shuttle trucks, and increasing space for log storage. The last area indicated by this research for further study would be to determine the associated costs with satellite yards that have the ability to fully service trucks and whether they are beneficial or a last resort option.

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Appendix

Appendix one: Marsden yard map (inner yard)

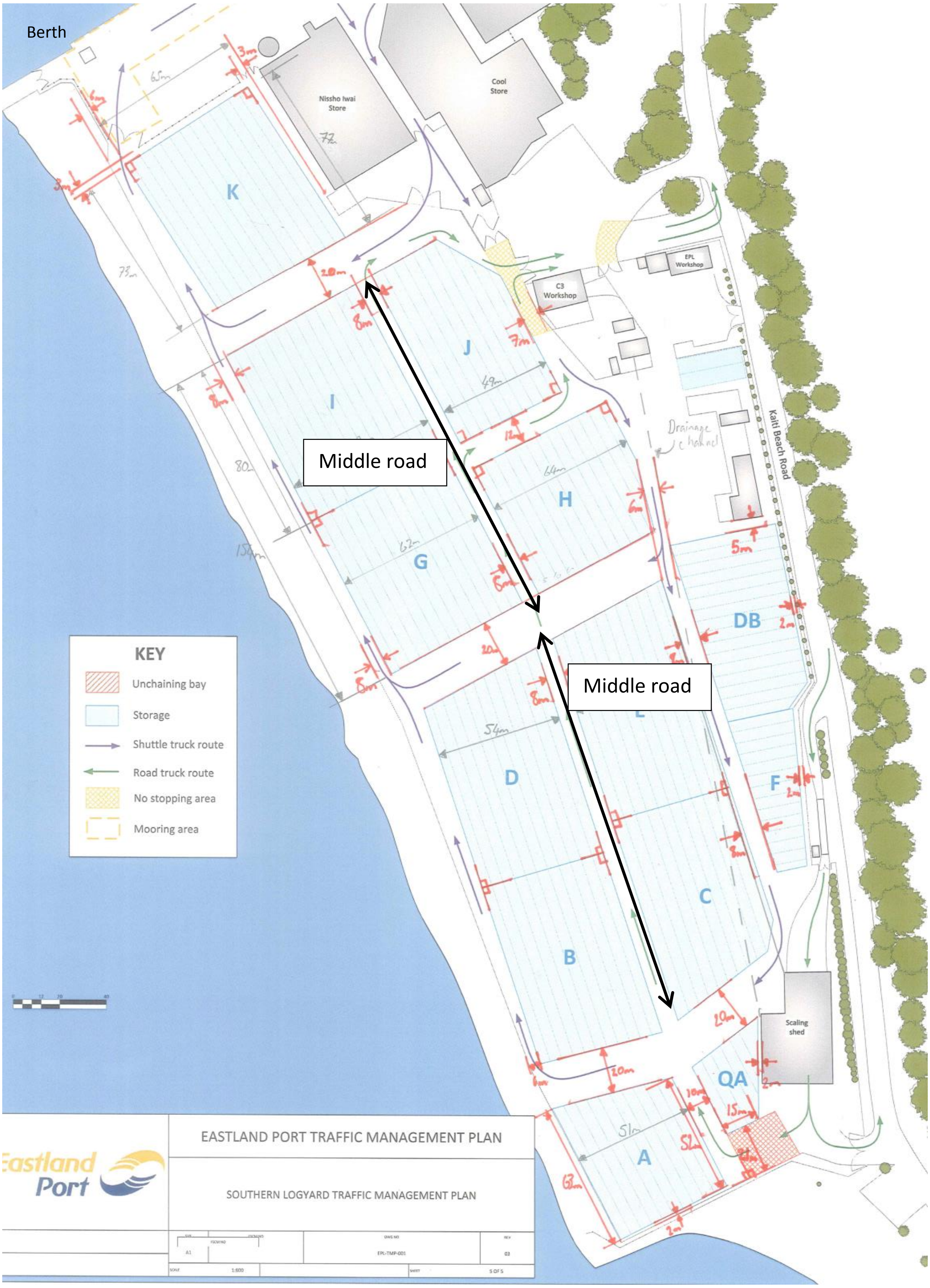
Appendix two: Mount log yard map (Inner yards)

Appendix three: Mount yard plan detailing the location of the current rows for the different grades for the TPTF supplier

KI	ROAD		RAIL
KI 4.0	D10		
KI 2.9	C33		
KI 3.8	F10RS	FUMO	
KI 3.6			
KI 3.0			
KIS			
KIS 6.0	ASK	FUMO	
KIS 5.8	F13MR		
KIS 4.8			
KIS 3.8	n/s		
KIS 3.6	ASK		
KIS 3.0			
U1			
U1 7.3	8BR4		
U1 7.7			
U1 5.8	E11MR	FUMO	
U1 5.4	F9RS		
U1 5.1	11BR13	REQ 80JAS	
U1 4.8			
U1 4.0			
U1 3.8	C22		
U1 3.6	D23		
U2			
U2 7.3	F24RS		
U2 3.8	ASK		
U2 3.6	D18		
PA			
PA 3.9	E6WS		
PA 5.9			
PB			
PB 5.9	BT5	FUMO	
PB 5.1	H/P09	FUMO	
PB 3.9	F16RS	FUMO	
PB 3.6	F6RS	FUMO	
PB 2.9		FUMO	
PB30			
PB30 3.8	F10MR	FUMO	
PB40			
PB40 5.1			
PB40 2.9			
PB40 3.6			
PT	NON	FSC	
PT 5.9	TBD	TBD	
PT 2.9	TBD	TBD	
PT 5.1	TBD	TBD	
PT 3.9	TBD	TBD	

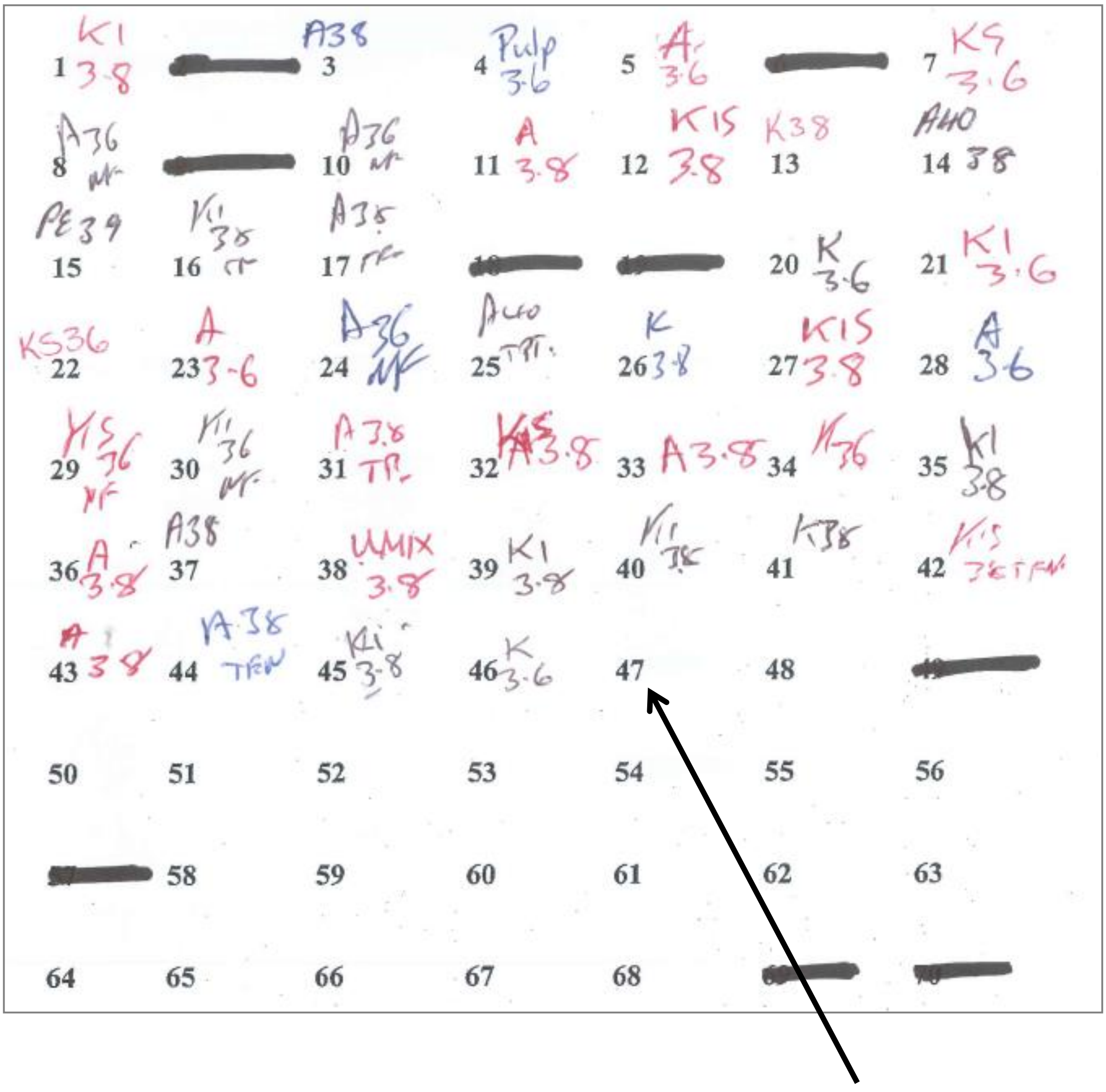
A	ROAD		RAIL
A 12.0	HP05		
A 11.0	HP07		
A 10.0	E10W		
A 9.0			
A 8.0	4BW26		K30MR
A 7.9			
A 7.7			
A 7.3	5SHDR8		
A 6.6	BT4		
A 6.0			
A 5.8	F19RS	FUMO	
A 5.4	K10MR		
A 5.1	F21MR		
A 5.0	K4RS	THEN E4WS	
A 4.9			
A 4.5			
A 4.2			
A 4.0	D3		
A 3.8	C16	FUMO	
A 3.6	D6		
A 3.0			
A40			
A40 3.9	E1WS	FUMO	
A40 8.0			
A40 6.0		FUMO	
A40 5.8	N/S	FUMO	
POP			
CF+3.9			
D/FIR			
CF 5.9	K13MR		
CF 3.9	D33		
CF 11.9			
D/FIR			
KIS 3.9	D21		
D/FIR			
T0 11.9	K14RS	FUMO	
TO 5.9	K27MR	FUMO	
TO 3.9	E12M	FUMO	
AO			
AO 12.0			
AO 11.0			
AO 4.0			
AO 3.6			
UMIX			
UMIX 5.8	10BERTH	144JAS	
UMIX 3.8	D12		

Appendix four: Gisborne yard map (main yard)



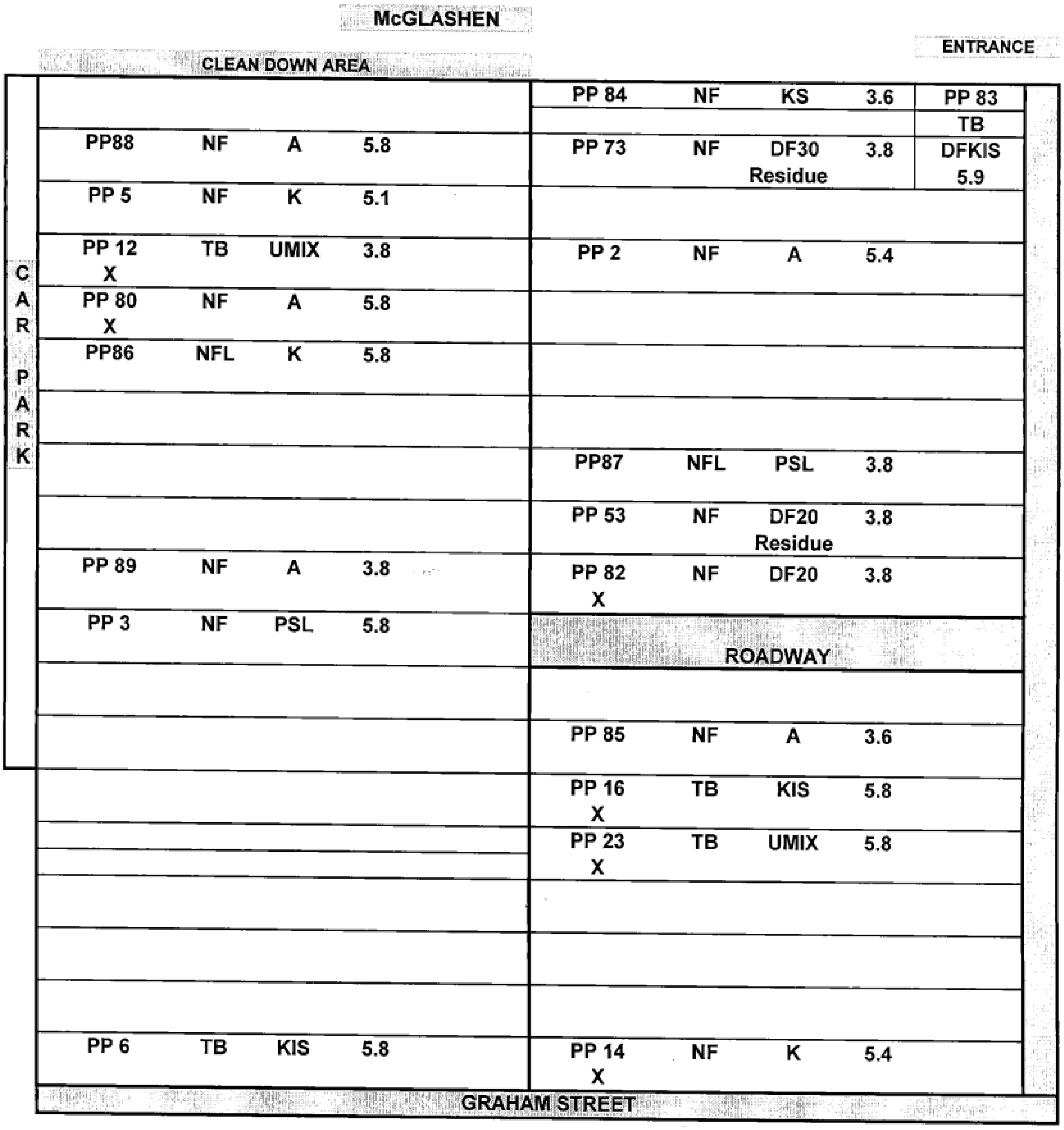
Appendix five: Nelson yard map (inner yards)

Appendix Six: Nelson number allocation example

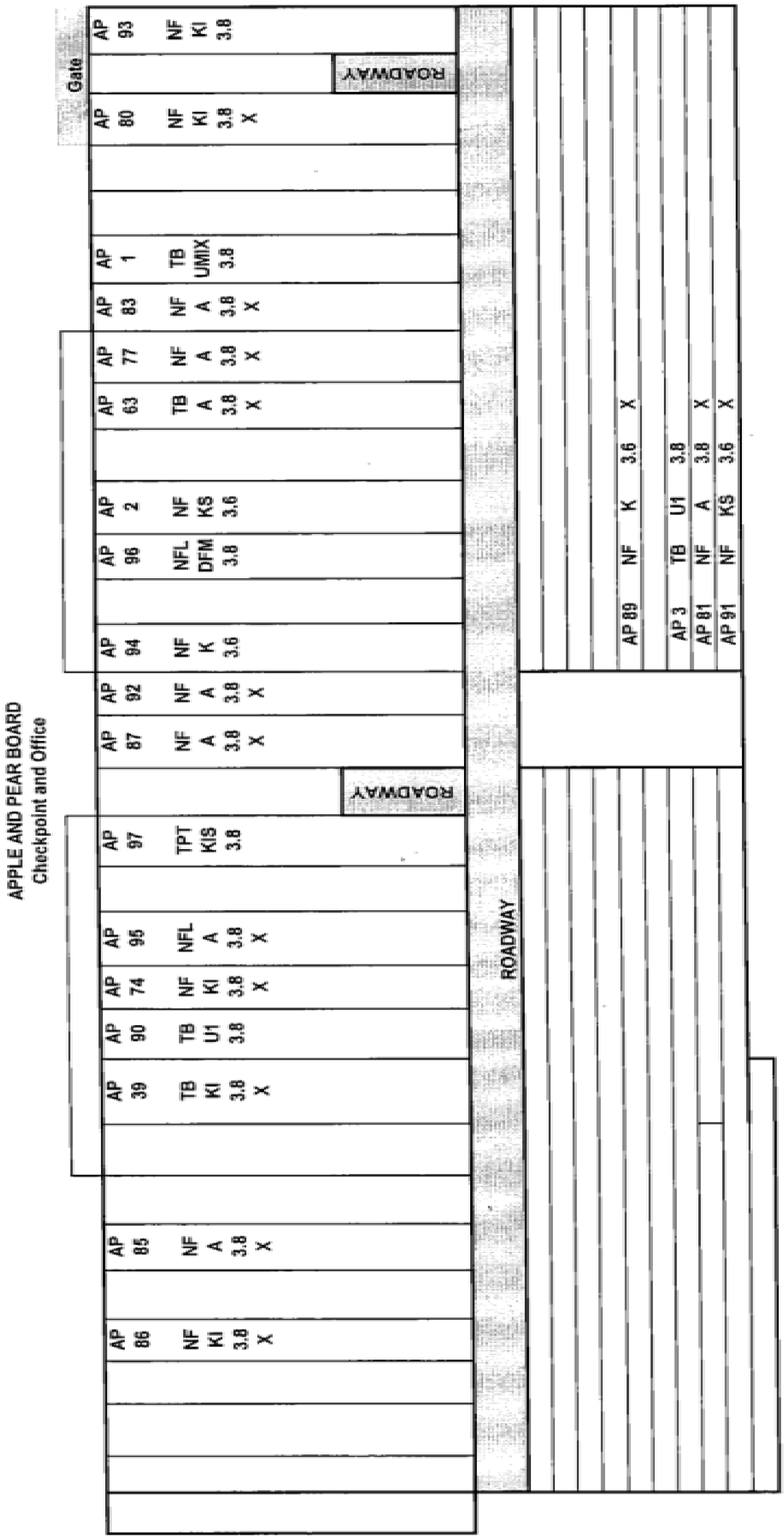


*This shows that the next number to be allocated to this supplier will be 47

Appendix seven: Nelson yard plan detailing pictorial representation of row locations in McGlashens yard



Appendix eight: Nelson yard plan detailing pictorial representation of row locations in AP yard



Appendix nine: Example of weekly cart in summary by supplier for the Mount Log yard

Cartin - Supplier Summary

	Supplier	Loads	Pieces	Volume
Branch	**TRG** **Tauranga**			
ANR	Asian Natural Resources Ltd	255	8,369	4,884.982
DNS	DNS Forest Products	237	11,227	4,107.886
E1	Ernslaw One	124	4,550	2,947.695
NZFM	New Zealand Forest Managers	206	10,805	5,481.461
RNZ	Rayonier New Zealand	316	15,953	5,801.872
TENC	Tenco Ltd	373	13,692	7,337.575
TPTF	TPT Forests	2,184	92,059	46,579.109
	Totals for Tauranga	**3,695**	**156,655**	**77,140.580**

Appendix ten: NEFD table (MPI, 2013)

TABLE 9.6: FOREST AREA BY FOREST OWNER NATIONAL SIZE CLASS, AS AT 1 APRIL 2012

	NATIONAL SIZE CLASS						
WOOD SUPPLY REGION	<40 HA	40–99 HA	100–499 HA	500–999 HA	1000–9999 HA	10 000+ HA	TOTAL HA
Northland	42 129	8 231	13 902	8 961	47 020	82 316	202 559
Central North Island	50 111	6 728	18 456	8 087	47 677	421 038	552 097
East Coast	16 606	3 001	11 742	4 417	32 225	86 298	154 289
Hawke's Bay	21 600	3 650	8 273	2 007	11 139	82 917	129 586
Southern North Island	44 527	13 418	31 808	9 031	25 840	41 452	166 076
Nelson and Marlborough	24 503	10 633	19 775	7 961	21 271	84 442	168 585
West Coast	2 761	412	515	617	4 682	23 479	32 466
Canterbury	32 618	5 113	13 653	3 762	18 172	36 737	110 055
Otago and Southland	43 010	9 118	16 858	4 160	21 509	109 133	203 788
New Zealand total	**277 865**	**60 304**	**134 982**	**49 003**	**229 535**	**967 812**	**1 719 501**