

**THT Process Analysis and  
Recommendations for  
THT improvement**

by

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## **Executive Summary**

The non-adherence to agreed Train Handling Times (THT) can cause fines of up to R250 000 for XCSA. Train resources are under pressure and the THT process is unstable. Several factors are contributing to the THT not achieving the target of 12 hours. This document explains the study undertaken to establish the causes for poor THT performance and provides time study results, as well as recommendations to improve THT's for Boschmans Colliery.

Stockpile management, shift changes, Minnaar authorisation and front-end loader availability have the biggest impact on the THT.

Based on discussions with the out loading supervisor, it was determined that the optimal distance between the stockpile and rail is 15 meters. At this optimal distance, at least two front-end loaders are necessary to load the train within the target of 12 hours. For any distance, further than 15 meters, the number of front-end loaders increases significantly.

Shift changes have a big effect on the THT and can cause delays of up to 90 minutes during the export trains loading cycles. If shift changes are managed more optimally, the 90 minute delays can be reduced significantly.

It was found that the access procedures at Minnaar siding is not what it is supposed to be. On train BM177, Sheltam waited a total of 100 minutes to gain access to Minnaar siding, due to Spoornet officials not responding.

Front-end loaders form a critical part of the THT. If FEL's are not available, the target of 12 hours cannot be met. It is therefore critical to ensure that FEL's and FEL drivers are available when the export train arrives.

Other factors contributing to long THT include driver availability, co-ordination, shunting, Spoornet schedules, train watering and reporting systems.

It is believed that if the recommended actions are successfully implemented, the THT target of 12 hours could be met.

# Table of Contents

## Chapter 1

Introduction.....	1
1.1 Background.....	1
1.2 Project Objectives.....	2
1.3 Project Aim.....	2
1.4 Project Scope.....	2
1.5 Deliverables.....	2
1.6 Approach.....	3

## Chapter 2

Literature Study.....	4
2.1 Introduction.....	4
2.2 Supply Chain Management.....	4
2.2.1 Supply chain Visibility.....	4
2.2.2 Inventory Management.....	5
2.3 Production scheduling.....	6
2.3.1 Materials requirements planning.....	6
2.4 Critical Path Method.....	6
2.5 Resource Leveling.....	7
2.6 Conclusion.....	8

## Chapter 3

Environmental Analysis.....	9
3.1 Stakeholders.....	9
3.2 THT – Process.....	10
3.3 Roles and Responsibilities.....	12
3.4 Results and Interpretation.....	12
3.5 Gantt chart for Boschmans Train Activities:.....	13
3.6 Distribution of THT.....	13
3.7 Causes for long THT's.....	14
3.7.1. Stockpile Management.....	14
3.7.2. Front End Loaders (FEL's).....	15
3.7.3. Drivers.....	15
3.7.4. Train Handling.....	15
3.7.5. Co-ordination.....	16

**Chapter 4**

Recommendations..... **18**

- 5.1. Stockpile Management ..... 18
- 5.2. Front End Loaders ..... 19
- 5.3. Drivers..... 19
- 5.4. Shift Changes ..... 20
- 5.5. Minnaar authorization ..... 20
- 5.6. Watering..... 20
- 5.7. Spoornet schedules ..... 21
- 5.8. Communication ..... 21
- 5.9. Reporting ..... 21

**Chapter 5**

Conclusion..... **22**

**Chapter 6**

References ..... **23**

**Appendix A..... 24**

- Loading Cycle for various distances ..... 24

**Appendix B..... 25**

- THT distribution with parallel activities..... 25

**Appendix C..... 26**

- Process Diagram ..... 26

**Appendix D..... 27**

- Time study Results ..... 27

**Appendix E..... 30**

- Complete Gantt Chart..... 30

**Appendix F ..... 31**

- Time study data of the loading cycle of one FEL (load to load):..... 31

## List of Figures

Figure 1: THT Process.....	11
Figure 2: Gant chart for the critical path.....	13
Figure 3: THT distribution without parallel activities.....	13
Figure 4: Fishbone diagram indicating key reasons for THT delays.....	14
Figure 5: Concept view of the proposed “Loading” and “Buffer” stockpile arrangement.....	19
Figure 6: THT distribution with parallel activities.....	25
Figure 7: Mapped Train loading activity process diagram .....	26
Figure 8: Detailed Gantt chart, showing all parallel activities.....	30
Figure 9: Stockpile Distance.....	31

## List of Tables

Table 1: Stakeholder List .....	9
Table 2: Responsibility Matrix .....	12
Table 3: Impact of distance and FEL’s on the time required to load an export train.....	15
Table 4: Loading Cycle .....	24
Table 5: Time study .....	27
Table 6: Detailed loading cycles .....	31

## List of Abbreviations

XCSA	Xstrata Coal South Africa
THT	Train Handling Times
FEL	Front End Loader

# Chapter 1

## Introduction

### 1.1 Background

Xstrata is a global diversified mining group, listed on the London and Swiss stock exchanges. Xstrata's businesses maintain a significant position in seven major international commodity markets: copper, coking coal, thermal coal, ferrochrome, nickel, vanadium and zinc. Xstrata employs around 56000 people including contractors. Xstrata Coal is the largest exporter of thermal coal and a major producer of premium quality hard coking coal and semi-soft coal. Xstrata Coal has interests in over 30 operational coal mines in Australia, South Africa and Columbia.

ProjectWay was tasked by Xstrata Coal South Africa (XCSA) to investigate THT's at the Boschmans Coal processing plant in the Tweefontein Division. THT is defined as the total time from collection of 100 empty trucks, by Sheltam at Minnaar siding, until delivery of the 100 fully loaded trucks at Minnaar siding (Sheltam is contracted to XCSA to operate the transport process between Minnaar Station and the colliery where coal loading takes place). The THT starts when the empty train is delivered by Spoornet and power is cut at Minnaar siding. Data taken by XCSA operations over the last 6 months indicated an increase in THT's at Boschmans. The information showed that the THT's exceed the target of 12 hours, but also indicated an irregular trend. The distribution of values along the average also indicated potential inconsistencies or unstableness within the operations.

The importance of meeting THT targets is to ensure compliance to agreed Spoornet timeframes. Non-adherence may lead to penalties (up to +/-R250 000), which Spoornet can claim for late delivery of loaded trucks.

This document provides an overview of the results and recommendations obtained during the study to investigate Train Handling Times (THT's) at Boschmans Colliery. The document is structured as follows:

- Project Objectives and Background
- Approach

- Stakeholders and Resources
- Breakdown of THT Activities
- Time study results
- Processing and Interpretation of the information
- Conclusion

## **1.2 Project Objectives**

The study was undertaken to determine:

- the key parameters and activities that determine THT durations;
- variations in THT's;
- causes of variations, and
- potential improvement actions

## **1.3 Project Aim**

The aim of this project is to establish the main reasons for the THT durations not being in the target of 12 hours. Specific attention will be given to the complete THT process, from where the train is collected at Minnaar siding until it is delivered back at Minnaar siding.

## **1.4 Project Scope**

The Scope of work proposed in this proposal is as follow:

- Gathering Information
- Analysing the information
- Report
- Presentation to management

## **1.5 Deliverables**

- Fully mapped THT process
- Document with problems experienced during train loading as well as recommendations to rectify the problems.



## 1.6 Approach

The following approach will be followed during the investigation:

- 3.1. Conduct interviews with all the relevant stakeholders
- 3.2. Study the current process (complete process) in terms of:
  - 3.2.1. Shunting times
  - 3.2.2. Loading times
  - 3.2.3. Traveling times from Plant to Minnaar Siding
  - 3.2.4. Arrival Times
  - 3.2.5. Handover procedure, access and durations
  - 3.2.6. Specific Parameters
    - Communication from Minnaar Siding to Boschmans Colliery and Sheltam
    - Traveling time from Boschmans Colliery to Hibbert and onwards to Minnaar siding
    - Availability of locomotives
    - Availability of loaders and size of loaders
    - Stockpile management
  - 3.2.7. Resource availability
    - Loader capacity
    - Coordination
    - Locomotives
  - 3.2.8. Logistics and scheduling
  - 3.2.9. Hand over process
  - 3.2.10. Communication
  - 3.2.11. Co-ordination of activities and time of day
- 3.3. Perform a time study of Front End Loaders, and Locomotive operations
- 3.4. Review the management/co-ordination function
- 3.5. Analyse all information
- 3.6. Report on findings and make recommendations

## Chapter 2

### Literature Study

#### 2.1 Introduction

Customer satisfaction is one of the key aspects for the success of a company. If a company promises certain amount of products or a specific delivery time and cannot deliver, the customer will not be satisfied. Production planning is critical when it comes to satisfying customers. Resource availability needs to be planned, throughout the whole process, from the start of the process until the end when delivery is made. Good relationships with customers can ensure that the customer will come back to do business with you again and to create a sustainable business. There are various techniques available to assist a manager in planning resources with the aim to meet customer demand and to maintain good customer relationships. Resource levelling and identifying the critical path are examples of such techniques. It is always important to identify the critical path and then to establish the constraint in the process. Supply chain management, supply chain visibility and inventory management will also help XCSA with better stockpile management and production control.

#### 2.2 Supply Chain Management

The topic of this project is to analyze and improve the THT process, it is thus necessary to look at supply chain as a whole and previous methods used to optimize supply chains. According to wikipedia supply, chain management (SCM) is the process of planning, implementing, and controlling the operations of the supply chain as efficiently as possible. Supply Chain Management spans all movement and storage of raw materials, work-in-process inventory, and finished goods from point-of-origin to point-of-consumption.

It is a system of coupled logistics networks between the original vendors and the final customer. Supply chain management will be discussed by looking at supply chain visibility and how it can influence inventory management.

##### 2.2.1 Supply chain Visibility

According to the Supplier selection and management report of November 2004, supply chain visibility is the ability to be alerted to exceptions in supply chain execution (sense), and enable action based on this information (respond), they define visibility as follow: “visibility is

a sense and respond system for the supply chain based on what is important in the business". Visibility has an influence on inventory management, which is part of supply chain management and a growing concern for the supply management community. With good supply chain visibility, comes good forecasting, reduced inventory and minimal backlogs. Raw materials can be ordered and delivered on time, which will optimize the production and keep customers happy. Better visibility will also improve the return on inventory assets and increase inventory turns.

Visibility solutions were discussed in the Supplier Selection and Management Report of November 2004 and are listed below:

- The status of in-transit goods needs to be identified, exceptions proactively managed and the costs of expediting shipment needs to be minimized to ensure logistics efficiency and to minimize the cost of inventory.
- Excess inventories needs to be avoided; the methods for doing this will be discussed in this chapter under inventory management.
- Time-sensitive orders needs to be managed; this requires keeping a close watch on supplier delivery performance and measuring supplier variability on inbound shipments.

### **2.2.2 Inventory Management**

"Regardless of which strategies are selected, proactive inventory management policies will make a difference in your operations," Cox (2005) remarked and was quoted in the Inventory Management Report of January 2005. Inventory management is a crucial part of production planning and supply chain management; the availability of inventory will influence the planning processes, inventory should be managed is such a way that the probability of back orders are eliminated while still keeping inventory levels to the minimum. Several policies can be employed to help with the reduction of inventory and still satisfy demand. These policies address different aspects of inventory management such as reduction of active inventory, purchasing of active inventory, the transfer of inventory and relying on third parties and suppliers for the successful management of inventory. These aspects of inventory management were discussed under various resolutions recommended in the Inventory Management Report of January 2005. According to the report the following resolutions can be made to reduce inventory and inventory cost:

- Base safety stock on customer service. The appropriate number of product classes needs to be established and dividing lines needs to be set between these classes. The level of safety stock needs to be updated to establish the service levels necessary to achieve the financial goals of the business.
- Use routine demand forecasting. Forecast error can lead to overstocking or backorders and must be eliminated, this can be done by using manually edited arithmetic forecasting models. Inventory levels needs to be kept close to only that required to support desired customer service levels.
- Forecast events. A one-time demand needs to be taken into account whether it is part of the sales history, or the future, it should either be edited from history or incorporated into routine demand forecast.

## **2.3 Production scheduling**

### **2.3.1 Materials requirements planning**

Material requirements planning (MRP) is a production scheduling approach that helps with the planning of the right amount of materials at the right time. A MRP system is a set of procedures, and policies that is used on a master production schedule for each item being produced. Segerstedt (2006) describes the process of MRP as follows; a master production schedule is created for each end item, delivery times and order quantities is then specified from a forecasted demand and the master production schedule is netted to downstream items through bills of materials. Demand is send through to available inventory and the decision is made if a new planned order should be created or an old open order should be rescheduled with a new delivery date. Material requirements planning will definitely help XCSA to deliver the right amount of coal at the right time to Spoornet.

## **2.4 Critical Path Method**

According to wikipedia, the Critical Path Method, abbreviated CPM, or critical path analysis, is a mathematically based algorithm for scheduling a set of project activities. It is an important tool for effective project management.

Wikipedia states that the essential technique for using CPM is, to construct a model of the project that includes the following:

1. A list of all activities required to complete the project (also known as Work breakdown structure),
2. The time (duration) that each activity will take to completion, and
3. The dependencies between the activities.

Further wikipedia states that using these values, CPM calculates the longest path of planned activities to the end of the project, and the earliest and latest that each activity can start and finish without making the project longer.

This process determines which activities are "critical" (i.e., on the longest path) and which have "total float" (i.e., can be delayed without making the project longer).

## **2.5 Resource Leveling**

Resource leveling is a way to fix resource over allocation. Generally, resources are leveled in two ways:

- By delaying a task until the assigned resource has time to work on it.
- By splitting a task so that part of a task is done when planned and the rest of it is done later when the assigned resource has time.

According to wikipedia project planning resource leveling is the process of resolving resource conflicts. It can also be used to balance the workload of primary resources over the course of the project, usually at the expense of one of the traditional triple constraints (time, cost, scope).

## **2.6 Conclusion**

Chapter 2 was focused on concluding phase 2 of this project by doing a literature study on the following concepts:

- Supply chain management
- Supply chain visibility
- Inventory management
- Materials requirements planning
- Critical path method
- Resource leveling

The goal of this literature study was to identify concepts and determine how it can be used to optimize the THT for Boschmans Colliery.

Various concepts like supply chain visibility, materials requirements planning, critical path method and other project management and inventory tools were investigated. It is important to note that chapter 2 aimed to identify a variety of methods that can be used to support planning activities and the THT process, but that not all of these concepts will be investigated in more detail or implemented for the purposes of this project.

In the following phase of this project, a complete environmental analysis of the THT process will be done. Best practice methodologies will be identified, with the aim to establish the main reasons for THT durations not being on target.

## Chapter 3

### Environmental Analysis

#### 3.1 Stakeholders

To ensure a representative reflection of the process, the following stakeholders were consulted:

**Table 1: Stakeholder List**

<b>Name</b>	<b>Designation</b>	<b>Relationship</b>
Thato Gama	Boschmans Plant Manager	Manage plant
Charlie Wesselman	Witcons Plant Supervisor	Manage plant
Bruce Ince	Waterpan Plant Supervisor	Manage plant
Jackie	Witcons Foreman	Manage loading & trains
Frik van Niekerk	Sheltam - Supervisor	Supervise loco drivers
Willie	Locomotive Driver	Collect train and ensure/confirm that it is loaded
Nico	Locomotive Driver	Collect train and ensure that it is loaded
Hannes	Locomotive Driver	Collect train and ensure that it is loaded
Spoornet Representative	Spoornet - Ermelo	Distribution station
Spoornet Representative	Spoornet - Empangeni	Station near Richardsbaai
Spoornet Representative	Spoornet - Ogies	Last stop before mine
Spoornet Representative	Spoornet - Minnaar	Station at Boschmans and Waterpan
Spoornet Representative	Spoornet - Saaiwater	Station at Witcons
Xstrata Representative	Supervisor – FEL	Supervise loading process
Xstrata Representative	Front End Loader Driver	Load the train

### **3.2 THT – Process**

The THT process is graphically explained in figure 1 and summarised below:

- The Spoornet train (100 railway trucks) enters Minnaar siding.
- The Sheltam locomotives (XCSA) engage the 100 trucks (two big locomotives at the back, and one small locomotive in front)
- The trucks are transported past the crossing between Boschmans and Waterpan, where direction is changed (shunting takes place) to go to Boschmans Coal Processing Plant, with the big locomotives now in front.
- The train loading starts when the railway trucks are in position at Boschmans Coal Processing Plant.
- After the first batch (32-38 trucks) is fully loaded, the water content of the product is checked and it is washed, if required.
- This batch is engaged by one of the locomotives, taken to Hibbert siding and on to Minnaar station.
- Once authorization to enter Minnaar station is obtained, the train enters the station and the first batch of loaded trucks is delivered.
- The locomotive returns to collect the second batch and subsequent batches following the same procedure. The THT stops when the last batch is delivered at Minnaar station.



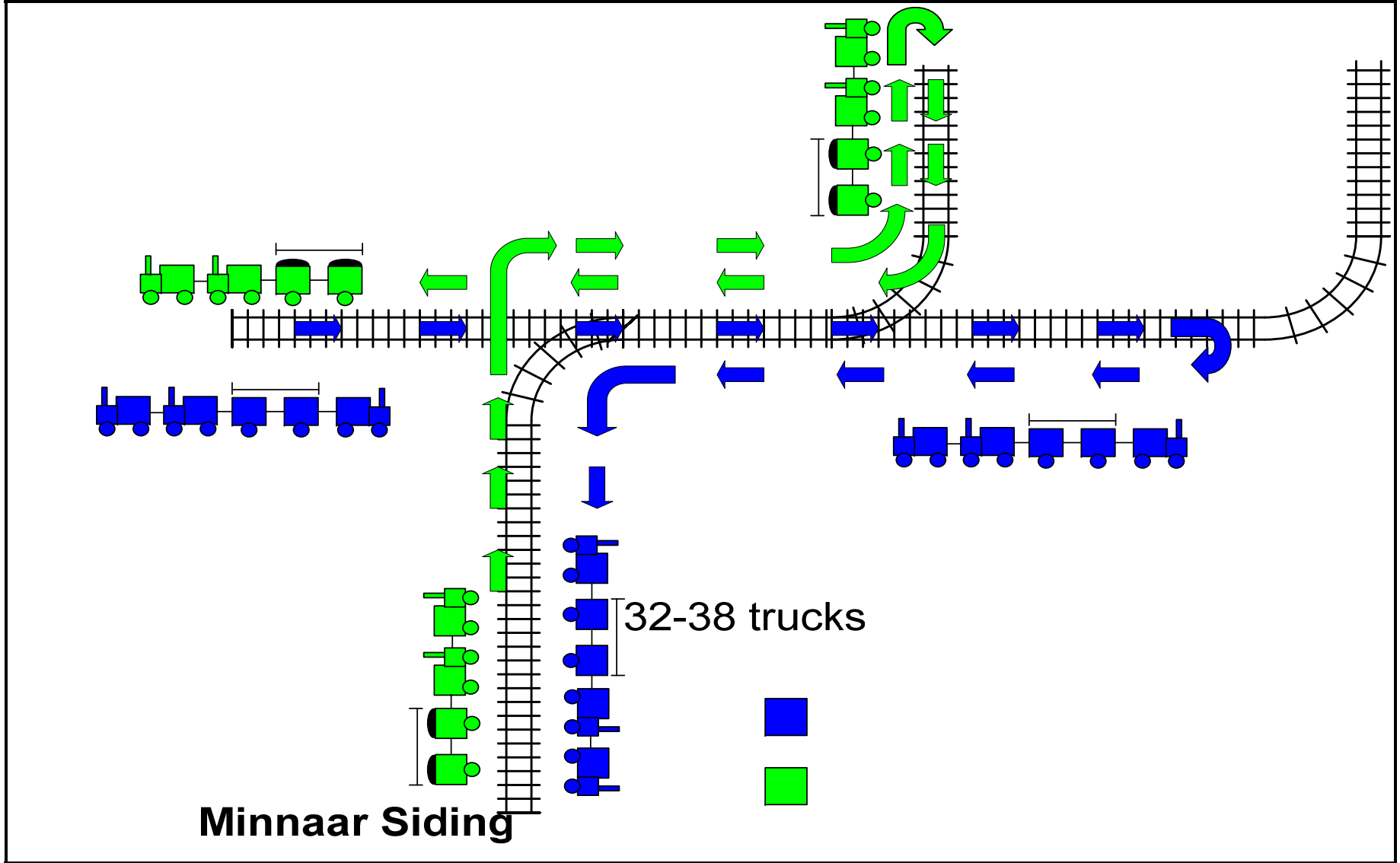


Figure 1: THT Process

100 trucks

### 3.3 Roles and Responsibilities

There are various role players in the train handling process with each contributing to the loading effort and subsequent time spent. The roles and responsibilities of the various stakeholders are summarised in table 2.

**Table 2: Responsibility Matrix**

	FEL Drivers	Plant Foreman	Locomotive Driver	Sheltam	Out loading Supervisor	Shunters	Minnaar station/Spoornet
<b>Activities:</b>							
Trigger Ermelo		S	C		C		P
Trigger Ogies		S	C		C		P
Train at Minnaar station		C	C	C	C		P
Sheltam collect trucks			P	S		C	
Travelling + Shunting			P			S	
Loading	C	S			P		
Shift changes	S		S	P		S	
Access procedure at Minnaar			C			C	P
Delivery at Minnaar			P	C		S	C

**Key:**

Primary Responsibility	P
Secondary Responsibility	S
Communication	C

### 3.4 Results and Interpretation

A time study was done on train BM177. The train arrived at 16h20 and the last batch of loaded trucks was delivered to Minnaar at 03h30. The duration was 11 hours and 10 minutes, which was within the target of 12 hours. The activities and durations are displayed in more detail in Appendices C and E.

### 3.5 Gantt chart for Boschmans Train Activities:

The following summarised Gantt chart indicates the critical path for the measured activities. For a more detailed gantt chart, which includes all activities, see appendix E.

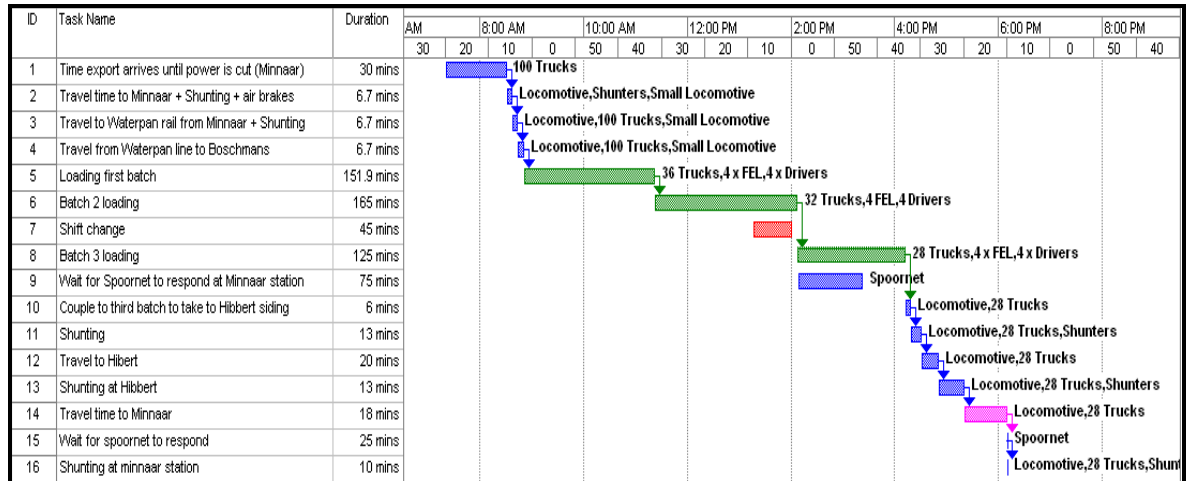


Figure 2: Gantt chart for the critical path

### 3.6 Distribution of THT

Figure 3 represents a distribution chart of the THT activities on the critical path. From the chart, it is clear that loading time contributes to more than half of the total THT duration. For a loading distribution with parallel activities included, see appendix B.

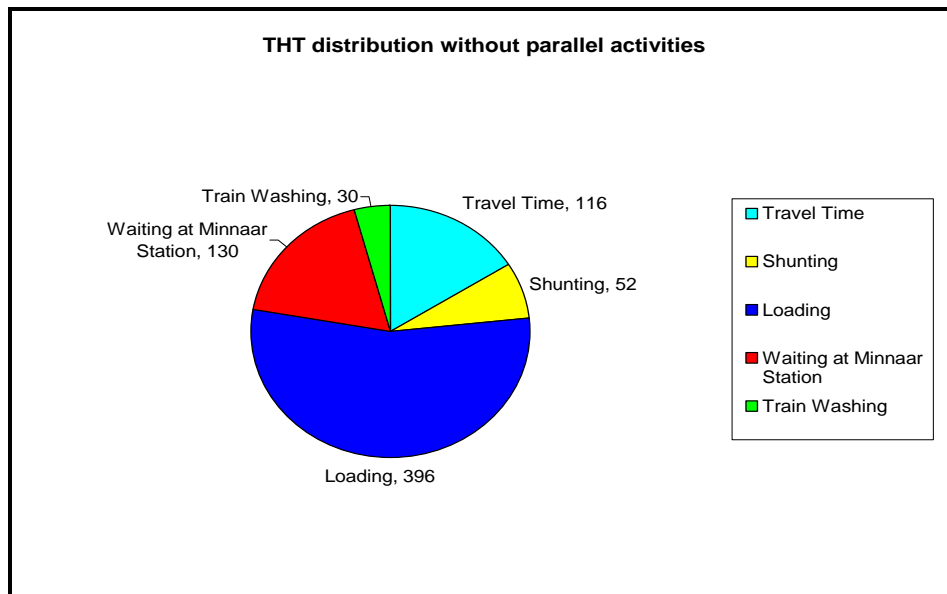


Figure 3: THT distribution without parallel activities

### 3.7 Causes for long THT's

The information gathered, indicates that a number of factors contribute to the poor THT performance of Boschmans. These factors are presented in the following diagram and discussed in more detail below.

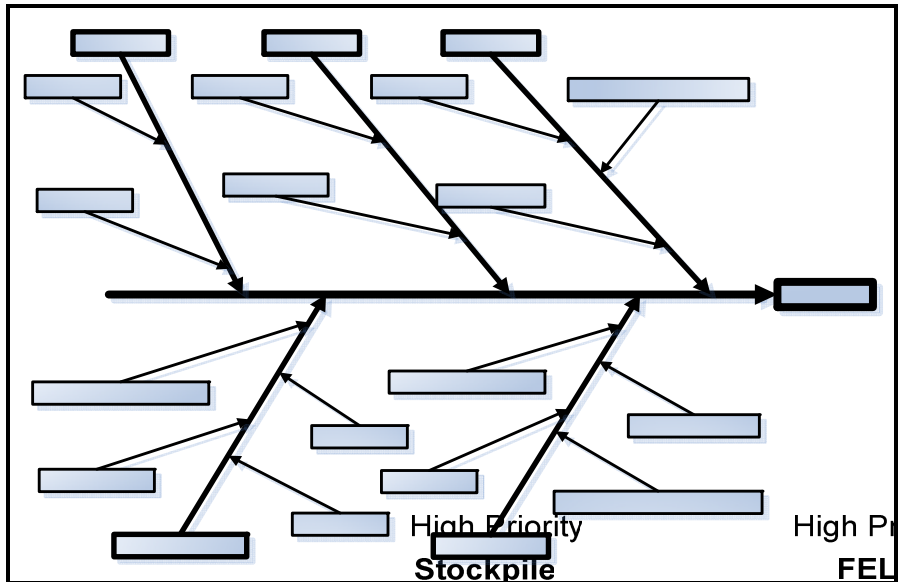


Figure 4: Fishbone diagram indicating key reasons for THT delays

#### 3.7.1. Stockpile Management

Coal product is delivered from the plant by trucks to the stockpile area, which is located alongside the rail tracks at Boschmans Coal Processing Plant. The stockpile area's primary function is to act as temporary buffer for the loading activity.

A secondary function of the stockpile is to act as a longer term storage buffer for product to:

- ensure a stable supply, and
- to reduce risk for unplanned production losses.

The distance between the rail and stockpile has a direct impact on the time required to load trucks with a FEL. The optimum distance was identified as 15m (based on discussions with the out loading supervisor), but is often exceeded. The maximum distance observed was approximately 50m. The following table indicates a comparison of distances (with different numbers of FEL) from the stockpile and the resultant loading times:

Distance	Availability	Licenses
Buffer	Diesel fill up	Performance
Minipar authorization	Shunting	Spoornet Schedule
Shift changes	Reporting	Watering

**Table 3: Impact of distance and FEL's on the time required to load an export train (100 trucks)**

No. of FEL	Distance					
	15 m	20 m	25 m	30 m	40 m	50 m
1	12.28 hr	14.08 hr	15.89 hr	18.06 hr	23.47 hr	28.89 hr
2	6.14 hr	7.04 hr	7.94 hr	9.03 hr	11.74 hr	14.44 hr
3	4.09 hr	4.69 hr	5.30 hr	6.02 hr	7.82 hr	9.63 hr
4	3.07 hr	3.52 hr	3.97 hr	4.51 hr	5.87 hr	7.22 hr
5	2.46 hr	2.82 hr	3.18 hr	3.61 hr	4.69 hr	5.78 hr

The optimum distance of 15m corresponds to a FEL loading cycle of 35 seconds. If the distance increases to 50m, the loading cycle increases to 81 seconds, more than double the duration.

### **3.7.2. Front End Loaders (FEL's)**

Various problems with the FEL's have an effect on the THT and include:

- Unavailability due to maintenance and breakdowns
- Time spent during diesel fill ups

Diesel fill ups affect FEL availability. It was observed that drivers are in no hurry to fill them up and return. There is also a diesel pump attendant involved during the fill up process, which causes further delays, since he is not always readily available.

### **3.7.3. Drivers**

FEL's availability is a critical function in the train loading process. Some drivers are only licensed to operate a 500 FEL and not a 600 FEL, which causes problems when the "600" driver is not available. The 600 FEL has a capacity to load double the amount of a 500 FEL. If a driver is not available, there is also no standby option that can be used.

### **3.7.4. Train Handling**

The locomotive operation, as well as the logistics around the movement of the trucks, forms an important part of the resultant THT. During the beginning and end of the train handling process, all the locomotive activities are on the critical path. Once loading has started, the locomotive related activities are less critical, although it is still close to a second critical path.

#### **3.7.4.1 Shift Changes**

It was observed that during shift changes the locomotive has to return to Boschmans to do the shift change, so that the next shift (drivers and shunters) can take over from the previous shift. The result is an increase in the THT.

#### **3.7.4.2 Minnaar authorization**

Sheltam's locomotives have to wait at Minnaar station for Spoornet to leave the yard before the overhead power can be switched off. Only then can they enter to engage the trucks. This procedure was introduced as a safety measure a few years ago, due to a fatal accident (person standing on top of truck was electrocuted) that took place at the time. Xstrata has since introduced additional safety measures that will prevent the occurrence of similar incidents.

Sheltam often has to wait during the night for Minnaar station to respond. Spoornet officials are slow to respond at night times or they don't respond at all. On train BM177 Sheltam waited more than an hour and a half for Minnaar station to respond before they could enter.

#### **3.7.4.3 Watering**

Xstrata gets penalized when they deliver "dusty" (dry) coal to Richards Bay. To rectify the problem coal is being "watered" at the plant (only if the moisture content is low) once it is loaded on the trucks and before departure to Minnaar Station. This process takes up to 90 minutes to complete, which increases the total duration of the THT. It contributes directly to the critical path.

#### **3.7.4.4 Shunting**

It was observed that Sheltam shunters at Boschmans work slower, compared to the Xstrata shunters at Witcons.

#### **3.7.5. Co-ordination**

The co-ordination between Xstrata and Spoornet during scheduling and planning activities can improve. It is very difficult to establish exactly when a train will arrive at Minnaar station, which makes planning and scheduling of resources at Xstrata very difficult.

### **3.7.5.1 Spoornet schedules**

During the three time studies that were done, it was found that Spoornet's schedules were not accurate. Spoornet schedules are normally out by 12 hours.

### **3.7.5.2 Communication**

THT recording and reports are done by Spoornet after which it is communicated to Xstrata.

### **3.7.5.3 Reporting**

- Sheltam  
Sheltam's locomotive driver's fills out a report stating when each batch has been fetched, coupled and delivered. It also records the THT with the various delays (including Spoornet delays). This data is currently compiled and filed with Sheltam, but not processed further.
- Spoornet  
THT recording and reports are done by Spoornet after which it is communicated to Xstrata.

## Chapter 4

### Recommendations

#### 5.1. Stockpile Management

From the study it seems as if the optimal loading performance is achieved when the distance between the stockpile and rail is maintained between 15 and 20 meters. This is especially important for the first loading batch of 35 trucks.

Rehandling or extra handling of product has a direct cost and time impact on the operations and therefore need to be eliminated wherever possible. Ideally product delivered from the plant should be stockpiled within a range of 15 to 20 meters from the rail to ensure optimum loading conditions. In other words, every load delivered from the plant that is dumped further than 20 to 25 meters from the rail, will result in extra handling or re-handling. There are however constraints that impact on this ideal situation:

- Total stockpile area (m<sup>2</sup>) versus the stockpile area that will be available if the distance is maintained at 15 to 30 meters from the rail. (rail distance x 2)
- Number of different products (Raw Duff, Large Nuts, Small Nuts, Brick Duff and Peas)
- Age of coal (a good principle normally is to follow a first in first out rule, but this might not be cost effective in this case from a logistic perspective). It is recommended to always fill up the loading stockpile first, after which the buffer stockpile receive the remaining coal.
- Stockpile height is restricted to 3m due to safety factor for underground workings.

The recommendation is to split the stockpile area into a "Loading" stockpile and a "Buffer" stockpile and demarcate the loading stockpile at an optimal distance of 15m from the rail. The "buffer" stockpile can be demarcated at the back from where it can feed the loading stockpile if and when required. An example of a demarcated stockpile is represented in the figure below:



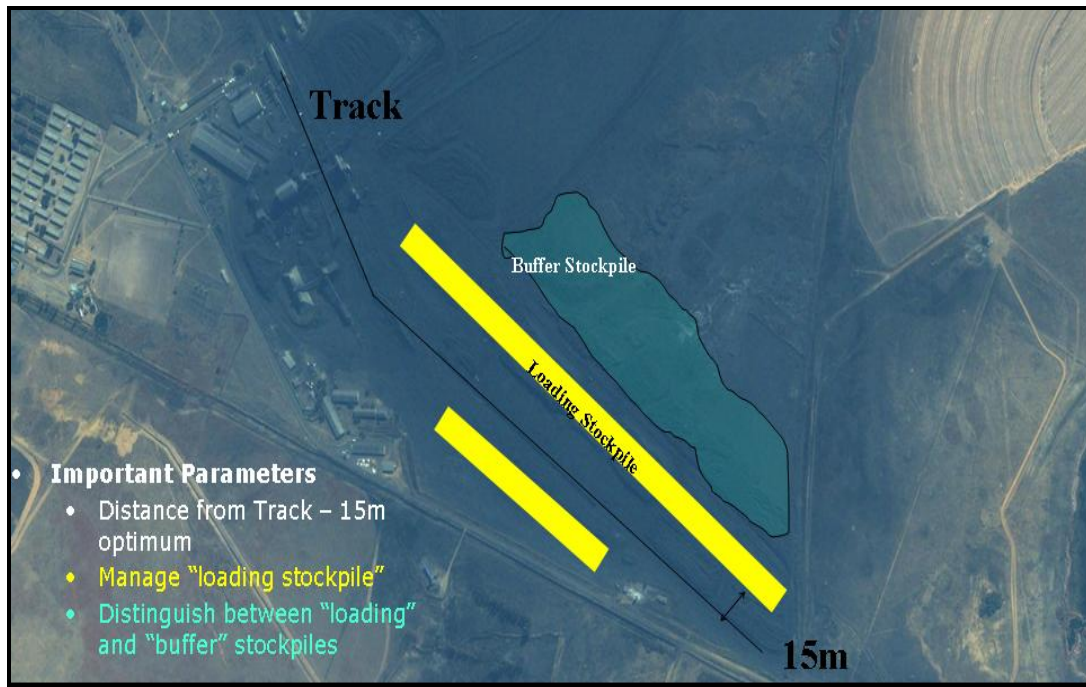


Figure 5: Concept view of the proposed "Loading" and "Buffer" stockpile arrangement.

## 5.2. Front End Loaders

- Downtimes, breakdowns and unavailability's must be a recorded and measured to ensure that the process can be managed optimally.
- Consider sharing and exchanging FEL's between the various mines. For example, when Boschmans have an export train to load, Waterpan's FEL can come to Boschmans to assist with the loading process. A further recommendation is to have fixed diesel fill up times to ensure that the process can be co-ordinated efficiently.
- It is critical that FEL should not refill during the first batch loading cycle

## 5.3. Drivers

- Driver availability must be a recorded and measured to ensure that the process can be managed optimally.
- All drivers should be trained to operate both types of FEL's.
- Other plant personal could be trained to perform this "stand in" function.
- FEL driver performance should be measured by the number of trucks done per hour/time unit. The number of loads can be recorded by using a simple counter (manual or electronic, ideally with the date and time). The best performing driver should be operating the 600. Training and monitoring of the drivers on the critical

parameters i.e. distance of stockpile, loading cycles, importance of loading the first batch, etc. is also recommended.

- Install load cell on FEL's to measure the tons of coal moved per driver (driver performance)
- Ideally, there should be more drivers than FEL's to compensate for when drivers are off sick, or on leave, etc

#### **5.4. Shift Changes**

- A personnel vehicle should be made available to Sheltam, to transport the people for the next shift to where the train is, instead of having the train go to them. It is also recommended that workers from the previous shift gets 30 minutes overtime (to allow for transport and safety meeting of the new shift) so that the shift change can be done without any time loss. A measure, such as adding a "duration" column in the existing train driver log, must be implemented to see how long shift changes takes (only when they are busy with an export train), so that it can be managed.

#### **5.5. Minnaar authorization**

- The requirement to switch off the power before Minnaar authorisation should be reviewed and revised if possible. The requirement of "cutting the power" is inconsistent with other stations with similar operations.
- The handover to Spoornet should be simplified and improved while their effectiveness should also be documented in the train driver log. All Spoornet related delays should also be recorded and reported on.

Currently batches of +/-35 loaded trucks are transported back to Minnaar. There might be an opportunity to increase the number to 50 trucks, which will reduce the amount of traveling required between Boschmans and Minnaar station from three trips to two trips. This will give Sheltam more time and flexibility.

#### **5.6. Watering**

- Some of the loaded trucks should be watered while the FEL's are busy loading (if the locomotive is available and not at Hibbert siding or Minnaar siding with another batch). This will require the FEL to start loading as close as possible to the locomotive and then to work away from the locomotive.

## **5.7. Spoornet schedules**

- A system between Spoornet and Xstrata to accurately manage train schedules will definitely add value to the process. Then all the stakeholders can plan for the arrival of the train.
- Install tracking devices on the Spoornet locomotives to track the trains from Richardsbay to Minnaar siding
- It is also important that the locomotive is already waiting at Minnaar station when the export train arrives, to ensure that time is not wasted unnecessarily

## **5.8. Communication**

- The communication between Xstrata and Spoornet should be revised and improved at Minnaar station to ensure quicker response times during the authorization procedure. Xstrata should supply Spoornet with a customer satisfaction report at the end of each month stating the quality of Spoornet's service.

## **5.9. Reporting**

The opportunity exists to process the data into graphs to measure performance and to report on it on a weekly basis.

The following reports are suggested:

- FEL performance measure per driver
- FEL availability
- Driver availability
- Stockpile distance measure

## **Chapter 5**

### **Conclusion**

The train handling and loading activities at Boschmans require a number of different resources and stakeholders to work together effectively. Coordination, measurement and reporting are critical management tools that should be used to effectively manage the process. The root cause of the problem is multi dimensional, which also explains the variance of the THT measures over the last six months. This study therefore recommends the implementation of key measures to manage the important parameters as identified earlier in this report.

From all the recommendations the stockpile distance will have the biggest impact on the THT and would most likely be the easiest to manage and implement. The shift changes, FEL availabilities and Minnaar authorisation recommendations will also have a big impact and are also easy to implement.

For the short term the Minnaar authorisation, shift changes, driver and FEL availabilities would be the easiest to implement and will decrease the THT. For the long term, the stockpile distance will have the biggest effect but will take some time to implement.

The current target of 12 hours is achievable with the current available resources, if managed effectively.

## Chapter 6

### References

Foster, D.L (2004), *Supplier selection and management report*, issue 04-11, published by the Institute of Management & Administration, Inc.

Foster, D.L (2005) Improving Logistics and Supply chain management, *Inventory Management Report*, issue 05-01, published by the Institute of Management & Administration, Inc.

Segerstedt, A (2006), Master Production Scheduling and a comparison of Material Requirements Planning and cover-time planning, *International Journal of Production Research*, Vol. 44, Nos. 18–19.

## Appendix A

### Loading Cycle for various distances

**Table 4: Loading Cycle**

**Data for travel times – (Distance to Stockpile)**

**On 20 meters**

**On 30 meters**

Number	Load	Unload	Tot cycle
1	20	20	40
2	20	24	44
3	24	17	41
4	19	17	36
5	20	17	37
6	21	17	38
7	21	18	39
8	22	19	41
9	18	17	35
10	19	19	38
11	20	18	38
Average	20.4	18.5	38.8
Minimum	18.0	17.0	35.0
Maximum	24.0	24.0	44.0

Number	Load	Unload	Tot cycle
1	23	24	47
2	20	25	45
3	22	24	46
4	25	25	50
5	26	24	50
6	26	21	47
7	29	24	53
8	25	26	51
9	27	24	51
10	25	28	53
11	27	25	52
Average	25	25	50
Minimum	20	21	45
Maximum	29	28	53

## Appendix B

### THT distribution with parallel activities

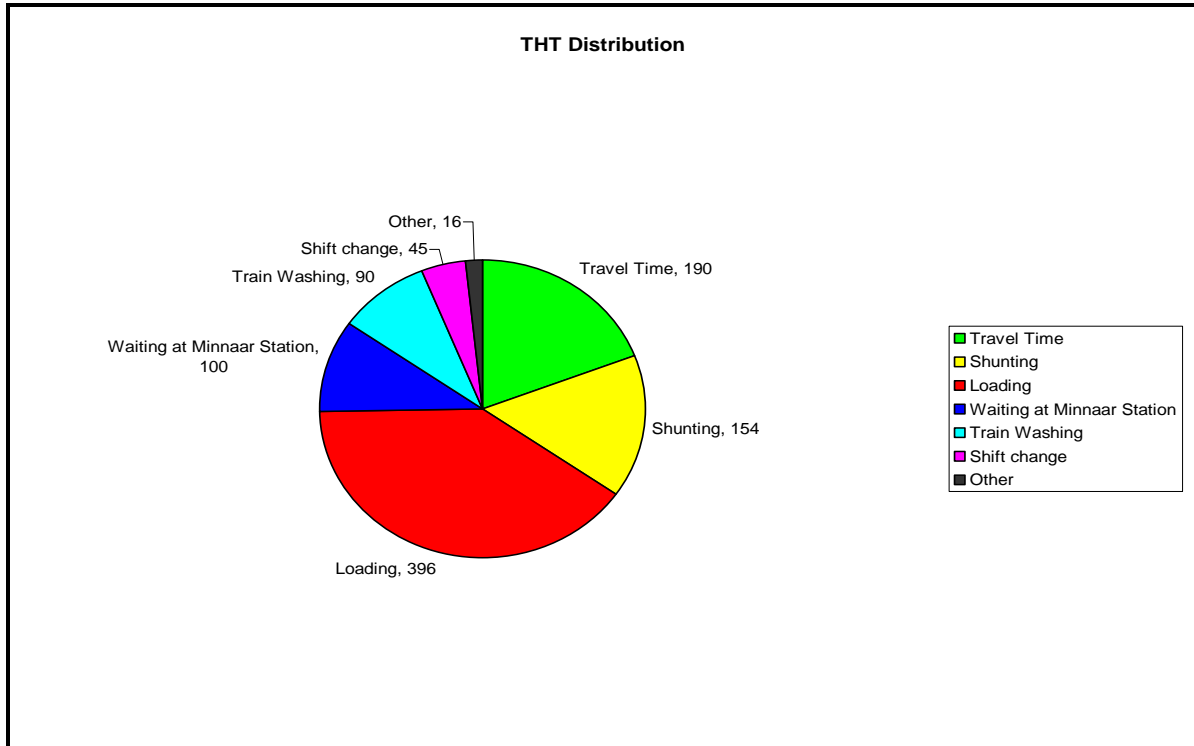


Figure 6: THT distribution with parallel activities

## Appendix C

### Process Diagram

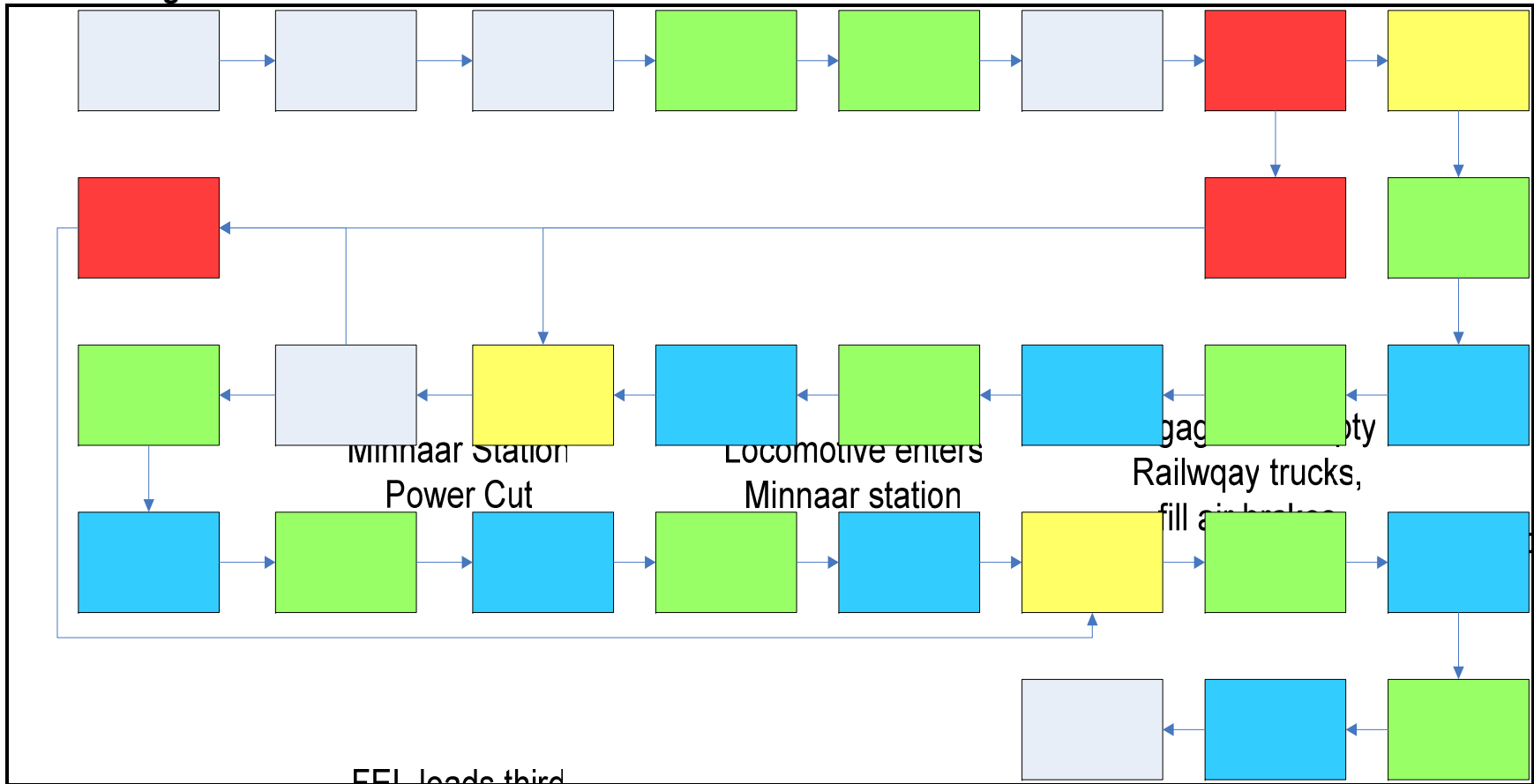


Figure 7: Mapped Train loading activity process diagram  
 FFI loads third batch



## Appendix D

### Time study Results

**Table 5: Time study**

		Measured duration of activities (minutes)	Proposed Target:	Comments
<b>Train BM177</b>				
<b>Activities:</b>				
Time export arrives until power is cut (Minnaar)			30	Should be deducted from THT, responsibility should be on Spoornet's side
Minnaar station Power Cut	16h20			
Wait for rocks to be removed from rail		16	0	Not part of the normal operation.
Travel time to Minnaar + Shunting + air brakes		20	20	
Travel to Waterpan rail from Minnaar + Shunting		20	20	
Travel from Waterpan line to Boschmans		20	15	Shunters should work faster
Loading begins (4 FEL was working - 3x 500's and 1 x 600)	17h49			
Couple in front to pull forward	18h11	22	22	Not critical path activity (Parallel with loading)
Shunting + opening rail crossings				
First 36 trucks fully loaded	20h15	146		
Couple to first 36 to take to Hibbert siding	20h17	2	5	
Shunting + waiting for shunter	20h30	13	10	Boschmans shunters could work faster (compared to Witcons)
Wash first batch (36 trucks)		N/A		The coal had a high enough moisture content. Washing was not required.
Arrive at Hibbert siding	20h43	13	13	
Shunting at Hibbert		13	13	
Travel from Hibbert to Minnaar		18	18	Opportunity exist to increase the batch size from +/-35 to 50 trucks.
Arrive at Minnaar station with first batch	21h14			

Shunting at Minnaar Station		11	11	
Travel to Boschmans from Minnaar		20	20	
Arrive at Boschmans	21h45			
Shift change		45	0	Shift changes have a significant impact on the THT. More can be done to minimize the impact. Recommend overtime - 30min for 10 people + suitable transport.
Second batch completed (32 trucks)	23h00	165		
Couple to second batch to take to Hibbert	23h05	5	5	
Shunting	23h18	13	10	
Wash second batch (32 trucks)		N/A	90	The coal had a high enough moisture content. Washing was not required.
Arrive at Hibbert siding	23h30	12	13	
Shunting at Hibbert		13	13	
Travel from Hibbert to Minnaar		18	18	
Wait for Spoornet to respond at Minnaar station		75	15	Improve handover – coordination with Spoornet, no response from Minnaar station caused delays.
Third batch (32 trucks) completed	01h05	125		
Arrive at Minnaar station with second batch	01h16			
Shunting at Minnaar Station		10	10	
Travel to Boschmans from Minnaar		20	20	
Arrive at Boschmans	01h46			
Couple to third batch to take to Hibbert siding	01h52	6	5	
Shunting		13	13	
Arrive at Hibbert siding	02h20	11	13	
Shunting at Hibbert		13	13	
Travel from Hibbert to Minnaar		18	18	
Wait for Spoornet to respond at Minnaar station		25	15	
Arrive at Minnaar station with third batch	03h16			
Shunting at Minnaar Station		10	10	
THT stops (Export train completed)	03h30			

<b>Total Time:</b>	11h 10min			
Spoornet activities	1h 40min			
Sheltam shift change	0h 45min			
<b>THT without Spoornet activities and Sheltam shift change</b>	8h 45min			
<b>Loading time:</b>				
First batch (36 trucks)	2h 31min			
Second batch (32 trucks) (45 min shift change)	2h 45min			
Third batch (32 trucks)	2h 5min			
<b>Total loading time excluding delays:</b>	<b>6h 36min</b>			

## Appendix E

### Complete Gantt Chart

The Gantt chart shows that locomotive operations in the beginning as well as the end of the process are on the critical path. The loading time of the first batch of +/- 36 trucks is also on the critical path. Thereafter both the locomotive and loaders can potentially be on the critical path, since both paths durations are close to each other. Front end loaders, shift changes and response at Minnaar station have a direct impact on the “locomotive “path and can therefore also be seen as a potential critical path.

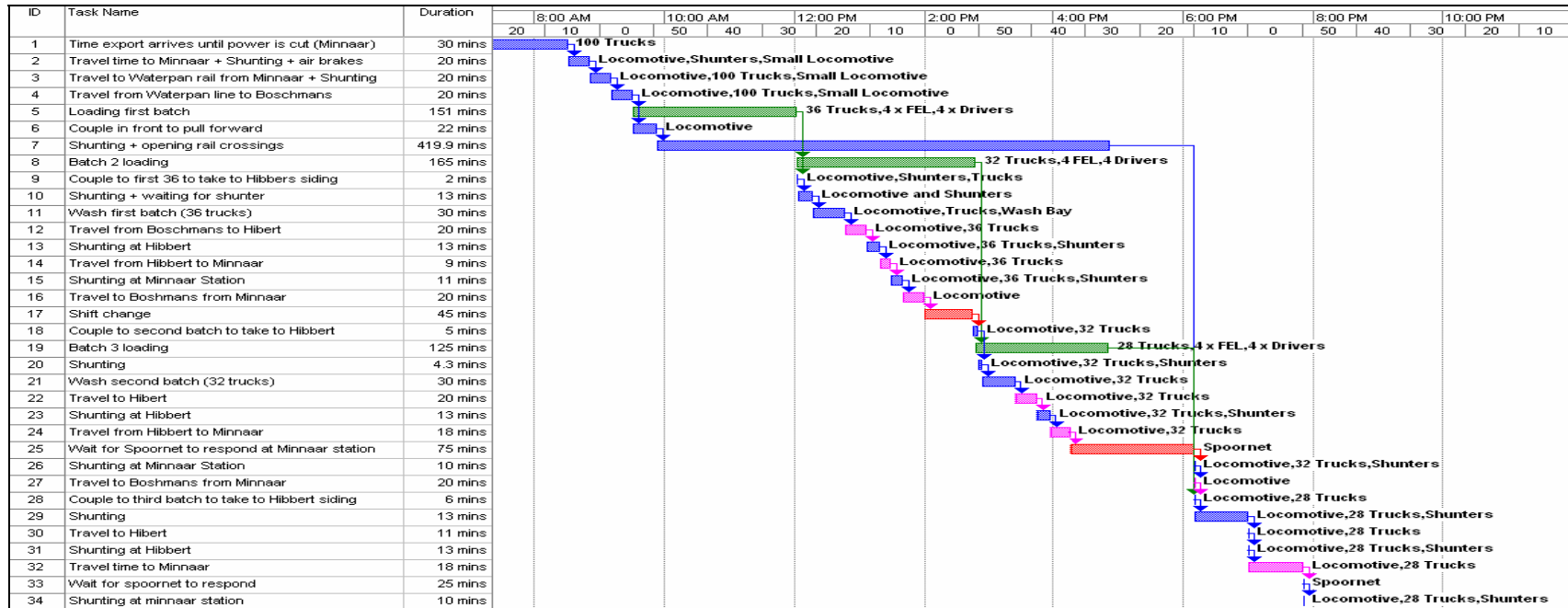


Figure 8: Detailed Gantt chart, showing all parallel activities

## Appendix F

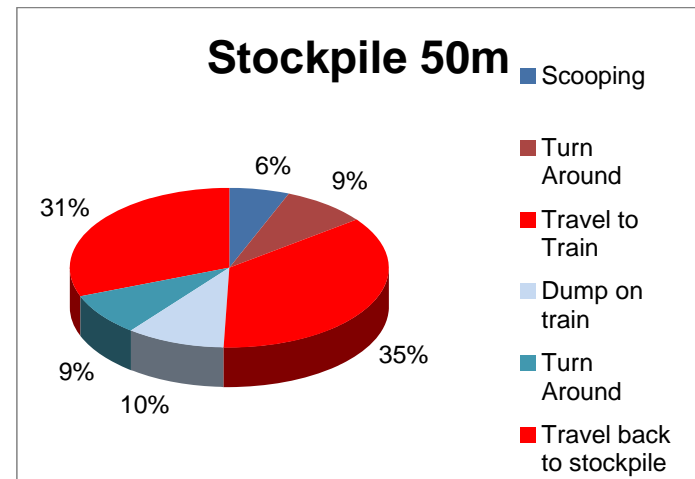
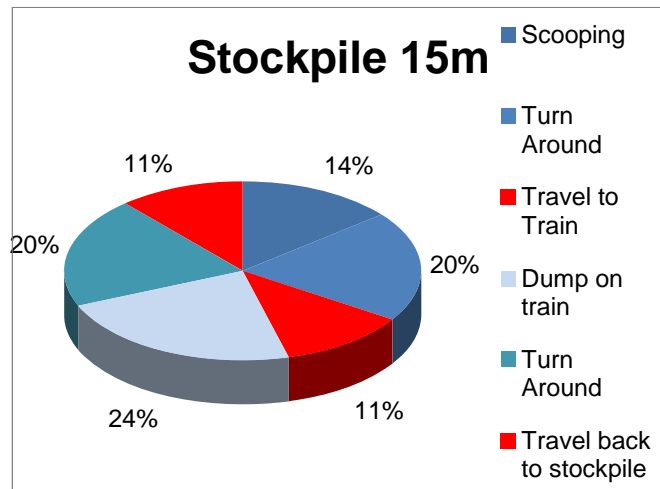
### Time study data of the loading cycle of one FEL (load to load):

**Table 6: Detailed loading cycles**

Loading Times	15m	50m
Scooping	5 sec	5 sec
Turn Around	7 sec	7 sec
Travel to Train	4 sec	29 sec
Dump on train	8 sec	8 sec
Turn Around	7 sec	7 sec
Travel back to stockpile	4 sec	25 sec
	35 sec	81 sec



**Figure 9: Stockpile Distance**



The areas marked in red indicate the traveling time of the front end loader during its loading cycle. The percentage time spend on traveling increases significantly when the distance between the track and stockpile increases.