ACHIEVING BETTER EFFICIENCY IN THE TRANSPORT OF HOT MIX ASPHALT TO SITE FROM A FIXED PLANT IN GAUTENG

By

Rupert Pöhl

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Study Leader: Mr. J.G. de Beer

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To God for giving me the ability to learn and work.

ABSTRACT

Title of Treatise:	Achieving Better Efficiency in the Transportation of Hot mixed Asphalt to Site from a Fixed Plant in Gauteng
Name of Author:	Rupert Pöhl
Name of Study Leader:	Mr. J. G. de Beer
Institution:	Department of Quantity Surveying and Construction Management Faculty of Engineering and the Built Environment University of Pretoria
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The primary goal of this research is aimed at investigating the current situation relating to transportation of asphalt and the inter-action between the paving crew and the asphalt producing plant, with the purpose of deducting practical steps that will improve the delivery and production process as a whole.

A study is undertaken in the analysis of the delivery and round-trip cycle times of the cartage contractors transporting the asphalt from the fixed plant to the Old Barn Project. A daily summary is compiled for every day that asphalt is delivered to the project, and this data is sorted and analyzed to deduct trends and typical patterns for a specific type of work.

The factors by which the performance is judged will be a relation between the type of work carried out as well as the production figure achieved for the specific day. Furthermore a basic model is composed that could be used as a vehicle and round trip calculator to guide the supplier as to the resources that are required on future projects. A list of practical steps is also drawn up, in the form of recommendations to conclude some of the findings of the project.

The starting point of this research is to gain insight into the processes involved and to make recommendations on a very practical level. The role of good communication between the asphalt plant and the paving crew was also found to be of critical importance, as well as the establishment of an open honest relationship between the key role players.

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CHAPTER 1

THE PROBLEM AND ITS SETTING

1.1 The Milieu of the Problem

South Africa has seen a wave of changes coming over the country during the last decade. The political changes have had a far-reaching affect on the South African population in all walks of life.

The opening of South Africa to world markets in the post 1994-elections has also meant that the mindset of managers had to shift to compete in the global market place. Unfamiliar new territory in terms of new business frontiers, currency volatility and dramatic political uncertainty in Southern Africa suddenly came the reality that the South African economy was faced with.

It would be reasonable to say, that it was becoming more and more difficult to maintain and manage any business on a profitable basis.
Suddenly, the world was the market and South African business had to adopt or fade away into remembrance. The old and the trusted way of doing things, would not necessarily guarantee survival, and change was imminent everywhere. The competitors were no more limited to South African players only, but the global marketplace.

Unfortunately, not all aspects of the New South Africa have gone without a glitch, and there are still many dissatisfied people in South Africa. Unemployment is still a major problem in South Africa, and the deterioration of the South African currency during the last few years is truly alarming. Housing, education, as well as basic health care are amongst the top priorities that have to be attended to by the local government. The endemic spread of HIV/Aids is also posing a major social as well as economical burden on the South African economy.

The results of all of this are that all businesses had to change their mindset and improve their output, producing more for less. This is not only on a physical production level, but also regarding the service given to clients. More attention has to be focused on the management of the human assets in the level of service delivered by various businesses – something that has been hugely neglected in the previous years.

There is no more isolation in the market as was previously the case in the years of sanctions and embargoes, and the competitors are not only local any more. The results with which businesses have coped with these challenges varies, and only time will tell the long term results and the position that South Africa will take in the world economy.

It is certain that a major effort will have to be made to improve the level of service given to customers if the South African economy wants to survive in the global market place.

1.2 <u>The Importance of the Study</u>

This study investigates the factors that influence the efficient delivery of asphalt from a fixed plant, and thus the level of service given to clients.

In the asphalt industry, the level of service given to the client is largely dependant on the timely delivery of the product to site. In this instance the direct client is the asphalt paving team who is supplied of asphalt by a fixed plant. Even the most efficient and technologically advanced plant, is of no use if the delivery of the asphalt is erratic. If the asphalt is delivered to the site too early or too late, there will be costly delays on both the side of the contractor as well as the supplier.

There is currently a perception amongst some client is the Gauteng area, that the asphalt suppliers do not have a lot of consideration for the work being carried out by paving contractors, and that they are unmoved by the needs of their clients regarding the delivery of the asphalt. This is a very serious problem that has to be attended to and can be very detrimental to the industry as a whole.

It is then in the light of this, that this work is undertaken, with the sole aim of being more efficient and giving the best possible service. This study will focus on the aspects relating to the use of haulers in transporting of premix to a specific project. Through studying the processes and analyzing the trends, the aim is to achieve a better understanding of the carting process.

An analysis is carried out to determine what steps can be taken to improve the efficiency of the vehicles being send to site, as well as the correct amount of vehicles needed to fulfill a day's production requirements. This will give an indication of the steps to be taken to improve the service given to clients in future.

1.3 The main problem statement

The main problem is to ascertain what can be done to improve the level of service given to paving team in the delivery of asphalt from a fixed site.

1.4 The sub problems

In order to achieve the desired results it is necessary to divide the main problem into further sub problems:

1.4.1 The first sub problem

The first sub problems will be to establish what the factors are that influence the timely delivery of asphalt to site and how much standing time on site is there on average per vehicle waiting to discharge on site at the paver.

1.4.2 The second sub problem

A standard summary sheet will have to be created which represents the daily results in terms of the delivery times in a summary, as to be able to compare with other days and evaluate any trends.

1.4.3 The third sub problem

The daily results will be analyzed and from this a model will also be created to act as a guide on how to calculate the number of vehicles needed to perform a specific day's production

After the analysis of these problems a summary will be compiled of what the important factors are to consider when aiming achieving the best efficiency in asphalt paving operations, in relationship to the delivery of the asphalt.

1.5 The hypotheses

1.5.1 The Hypothesis for the first sub problem is as follows:

The factors that influence the timely delivery of asphalt to site is the following:

a. The distance traveled to site
b. The number of vehicles assigned to the project
c. The amount of standing time on site

The amount of standing time spend on site will be determined by the timely arrival of the vehicles on site, as well as the rate at which paving takes place. If the work is slow, the vehicles will spend a longer time on site.

The amount of vehicles will also determine the standing time, if there is too many vehicles assigned to a specific type of work, a queue will form and the vehicles will be standing waiting on site.

1.5.2 The hypothesis for the second sub problem is as follows:

A Standard sheet will have to show a summary of the relevant times on site and off site for vehicles, as well as the actual production for the day. When comparison is done between the days there will be specific trends relating to the type of work being carried out.

There will be a trend relating to the standing time on a daily basis, showing a decline as the day progresses and the process speed up.

1.5.3 The hypothesis for the third sub problem is as follows:

The model used to calculate the amount of vehicles required would act as a guide of what is required for a specific set of conditions. This will need to consider the distance or time traveled to site, the typical production rate for this specific type of work, as well as the size of the vehicles transporting the asphalt to site. The typical production rates for certain types of work would be deducted from the analysis of the data to determine what is typical for a specific type of work.

1.6 The delimitations

This research will be conducted in the Gauteng province in South Africa, from the Benoni plant of MUCH Asphalt Pty (Ltd.). The Old Barn contract for Prorand Roads will be used as a model for the study.

The results of this specific project would be applied in practice to projects of similar nature or size, as well as smaller projects – seeing that the principles learned would be applicable to the industry as a whole.

The effect of multiple projects running simultaneously and the demand that places on the asphalt plant will not be investigated.

This model will not involve the development of sophisticated computer software or programs for specific application in this nature, but will use programs that are in use day-to-day and available to all members of the industry. The reasoning behind this is to avoid making this application too complicated and that almost all members of industry can use or modify these simple programs to their advantage.

1.7 The definition of terms

1.7.1 Asphalt

Asphalt is a graded mixture of crushed stone and gravel combined with hot bitumen in a specific ratio, in a mechanized and automated mixing plant, to create a stable mixture that is used for road surfacing and applied when it is still hot.

1.7.2 Bitumen

Bitumen is a black, sticky, petroleum derived material used for bonding a graded mixture of crushed stone and gravel in a specific ration to form asphalt. Bitumen is a semi-solid material at room temperature and softens as it is heated.

1.8 The assumptions

1.8.1 The first assumption

The results achieved and observations achieved on this project will be generally applicable on contracts with a similar nature as well as smaller or larger contracts seeing that the principles would span the entire industry.

1.8.2 The second assumption

The data as written down on the daily log sheets are correct and reflect the correct time that vehicles arrive and depart on site. This information will give a true reflection of the time the vehicles took to arrive on site, time spent at the paver, and the time traveled back to the plant.

1.8.3 The third assumption

There will be assumed that these results should represent the norm of factors that would normally influence the efficiency of hauling materials on similar projects involving the transportation of asphalt.

Monitoring these factors and applying these principles learned would achieve better productivity and efficiency. The assumptions are that all these factors could be controlled or manipulated by applying the principles of effective management.

1.9 The importance of the study

This study investigates the factors that influence the efficient delivery of asphalt from a fixed plant, and thus the level of service given to clients.

In the asphalt industry, the level of service given to the client is largely dependant on the timely delivery of the product to site. In this instance the direct client will be the asphalt paving team who is supplied of asphalt by a fixed plant. Even the most efficient and technologically advanced plant, is of no use if the delivery of the asphalt is substandard. If material is delivered to site too early or too late, there will be costly delays on both the side of the contractor as well as the supplier.

We furthermore tend to invest a lot of time and capital on some parts of the process like the asphalt plant and paving equipment, but unfortunately the supply chain is only as good as the weakest link – in this instance the delivery of the asphalt to site by the use of vehicles.

There is currently a perception amongst some client is the Gauteng area, that the asphalt suppliers do not have a lot of consideration for the work being carried out by paving contractors, and that they are unmoved by the needs of their clients regarding the delivery of the asphalt. This is a very serious problem that has to be attended to and can be very detrimental to the industry as a whole. It has gone so far that some parties suggest that there is no effort undertaken by asphalt suppliers to arrange the transportation of their material and that it occurs as a haphazardly activity.

It is then in the light of this, that this work is undertaken, with the sole aim of being more efficient and giving the best possible service. This study will focus on the aspects relating to the use of haulers in transporting of premix to a specific project. Through studying the processes and analyzing the trends, the aim is to achieve a better understanding of the carting process.

An analysis will be done to determine what steps can be taken to improve the efficiency of the vehicles being send to site, as well as the correct amount of vehicles needed to fulfill a day's production requirements. This will give an indication of the steps to be taken to improve the service given to clients and improve the whole supply chain.

CHAPTER 2

THE REVIEW OF RELATED LITERATURE

2.1 Relationship to theory

There is limited written theory available regarding this specific subject in the South Africa context, and therefore there will be reverted to standard production management principles, and some literature relating to the situation abroad. The intuition is that there will be a positive relationship between the applying of the theory and the research.

2.2 Literature study

As mentioned previously, there is no specific literature available on the subject of transporting asphalt in Southern Africa. Although there is some similarities in for instance transportation problems of say for instance building materials being delivered to a specific site, it is not the same situation.

The main difference lies in the fact that the asphalt should be seen as the crucial element in a production series, due to the "perishable" nature of hot mixed asphalt. The asphalt should arrive on site at the correct workable temperature and at the correct rate of delivery to suit a specific project. This contrasts sharply with for instance building sand. Furthermore, there might be some time limits imposed on the validity of a specific mix as in a bitumen-rubber blend within which it must be used.

Most other building materials will arrive on site and be stored and be used in a process within the next working day or two, with the exception of ready-mixed concrete.

Asphalt has to be on site on a "just-in-time" basis. If the asphalt arrives too early, it will lead to ineffective utilization of the fleet, and the asphalt being below temperature when the paving process is due to start.

If the asphalt arrives at the site too late, or too slow a ratio, there will also be an ineffective utilization of the fleet.

Not only is the time that the asphalt arrives on site critical, but also the rate that the rest of the vehicles arrive on site. If there is an inconsistent flow of material, there will be more stop-start cycles for the paver, resulting in more joints and a paver surface with more undulations.

A further problem is that the production rate will differ from team to team, and between the different types of work being carried out.
These are the major differentiating factors that make the consideration of this subject regarding other literature on the delivery of materials unique.

Most of the literature available abroad is compiled by the manufacturers of asphalt plants, who sell a complete system and write the related articles on the functioning of the system. The majority of the articles and literature available relate to efficiency- and cycle analysis of complete systems. These mathematical models are referred to "queuing theory" and "transportation model". The queuing theory does not necessarily refer to processes involving trucks or deliveries, but are applied to various types of problems and are relevant to the transportation of asphalt.
Transportation models are also known as shortest route examples and are used to mathematically find the shortest way to complete a specific activity.

Firstly we will look at the trucking cycle analysis as portrayed by the Astec Industries technical paper by J.D.BROCK (1995). Astec Industries are manufacturers of asphalt plants, control systems and a whole spectrum of asphalt industry related products. This documents was written in American metric units and have thus been adopted to suit South African metric measurement units, as well as typical South African conditions.
Analyzing the truck cycle, the actions that a typical premix hauler would perform during a production day, would be as follows:

Table 1.1 - Truck Cycle Time

a. Startup in morning and get in queue to be loaded.	
b. Wait before being loaded.	15 min.
c. Loading of premix onto truck.	5 min.
d. Receiving ticket and log sheet.	5 min.
e. Trip to job (Time depending on distance and traffic).	25 min.
f. Delay when arriving at paver, wait to off load	15 min.
g. Dumping mix into paver	5 min.
h. Return trip to plant	25 min.
Typical truck cycle time:	95 min.
Or	1 hour 35 min.

The typical scenario is that the plant will be producing asphalt in a 10 hours day and have 2 hours of unproductive plant time due to delays or changing between different mixtures.

The trucks are normally on site at 6h30, and will return to the plant at 18h00. This gives us an available truck production time of 11 hours 35 min. If the truck cycle is 95 minutes as in the example above, the rest follows:

Number of trips per day per truck:

= 11.5 hours x 60 min. / hour ÷ 95 min. truck cycle

= 7.26 trips per truck

≈ Some trucks will do 7 trips while others will do 8 trips.

Furthermore, if it is assumed that the typical plant produces 850t of premix on a good production day, the number of trucks required is calculated as follows: (Assume we are using only trucks with 14t load capacity)

= 850 t ÷ 14t

= 60,71 trips required

≈ 61 trips will be needed to complete all the deliveries

To now calculate the number of trucks required would be as follows:

= 61 trips per day ÷ 7.26 trips per truck

= 8,40 trucks required

≈ 9 trucks needed (Can't use only half a vehicle)

To calculate the transport cost per ton of premix produced would be as follows: (Assume the truck rate of R171, 00 per hour incl. VAT)

= (9 trucks per day for 11.5 hour day) ÷ daily production

= (9 x 11.5 h x R171, 00) ÷ daily production

= R17 698, 00 ÷ 850 t

= R20, 82 per ton of asphalt produced.

The above is a simplified method used to indicate the cost involved in trucking materials to a site, but gives a fair indication of the magnitude of the cost of trucking. This is also for a specific distance that the truck must travel to a certain project.
It must furthermore be remembered that this amount will increase if there is any delays at the plant or at the paving team on site. The reality is that sub-contractors are used to carrying out most of the transporting of the premix, and they will forward their standing- or unproductive time spent on site as a claim to the asphalt producer. This will increase the cost of transport per ton, due to the fact that this is a direct additional cost.

If it is considered that a ton of asphalt is priced at around R 316.25 per ton including VAT, (July 2002, Gauteng for Medium mix with 5.5% binder content) then the material transport cost equates to about 6,6% of the total delivered material price. This is of course given the above example where there is no standing or unproductive time spent at the site. It must also be noted that in practice, material delivered prices will vary greatly with the distance that is traveled between the plant and the site where the road is being paved. The cost of the premix delivered to site as per the details set out above is:

The average price for Medium 5.5 %:	R 316.25 per ton ex Plant
Add for transport (up to 10 km)	R 23.17
(ASTEC formula)	R 339.42 per ton delivered

By comparison, the current pricing practice depends on the following factors:

- The type of mix being used
- The total quantity of the mixture required
- The delivery distance from plant to the site
- The quantity mixed per batch required and the wastage at the plant

Some mixes are more expensive to produce than others, if the project requires a very large order, there will be discounts and the further the plant is from the project, the more expensive the transporting costs will be. It might also be a fairly large order over a long period; with small take-off every day and that will result in more wastage and a more expensive mixture.

Another factor to consider is the pricing structure for the transport, as shown in the graph below:

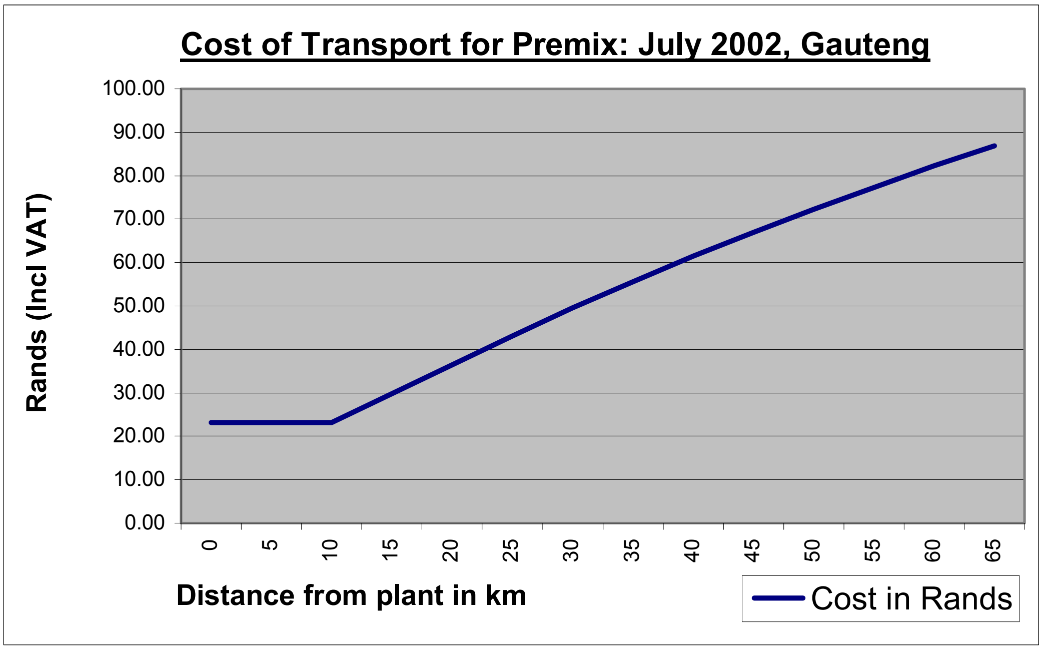


Fig.2 - Cost of transporting premix per ton per km

As can be seen, for the first 10km radius in transport distance from the plant, the cost is constant at R 23.17 per ton including VAT. This rate was negotiated with the transport contractors, and is what they consider a minimum cost to start up their vehicles. From 10km onwards, the cost increase is in a linear ratio to the distance traveled.

If we would apply the costing principles as currently used in the Gauteng region, we would find the following:

The average price for Medium 5.5 %:	R 316.25 per ton ex Plant
Add for transport (up to 10 km)	R 23.17
	R 339.42 per ton delivered

This price is somewhat different from the rate that was calculated in the *Astec formula* as shown above. This is due to the difference in the transport costs not being based on equal distances. The rate will now be adjusted:

In the Astec example above, it was stated that the travel time to site for the vehicle was 25 minutes, if it is assumed that the average speed of the trucks are in the region of 50 km/h when traveling within the city limits, it will follow that the typical distance to the project is:

V = S / T
S = V x T
S = 60 km/h x (25/60h)
S = 60 km/h x 0.417
S = 20,83km
S ≈ 21,0 km

The rate should now be adjusted:

The average price for Medium 5.5 %:	R 316.25 per ton ex Plant
Add for transport (up to 21,0 km)	R 36.04
(Revised actual)	R 352.29 per ton delivered

There is still a difference between the *revised actual* rate and the rate as calculated per the *Astec formula.* This can be explained due to the fact that there is a safety factor built into the transport part of the rate to compensate the truck drivers for unproductive time standing at the plant and waiting to be dispatched. We will calculate this percentage of allowance on the transport charges as follows:

Transport component of *revised actual formula:*	R 36.04
Transport component for *Astec formula:*	R 23.17
Difference in rate:	R 12.87

This can be expressed as a percentage as follows:

$$= \frac{(R\ 36.04 - R\ 23.17)}{(R36.04)} \times 100$$

= 35,7 %

≈ 36,0 % allowance for unproductive time

This is a very high percentage, but as can be seen in the truck cycle time layout shown in Table 3.1: Truck Cycle Time, there is a large portion of the truck's time that is totally unproductive whilst waiting in the queue, waiting to be loaded and waiting to be dispatched.

There is a huge potential for the cutting of costs if this time spent at the plant can be minimized.

2.3 Findings: Relationship to literature

The literature shows the importance, and high cost involved in the transport element of producing asphalt paving.

Another important fact not to lose sight of is that the process of manufacturing and delivering asphalt functions as a whole. The manufacturing and transporting cannot be viewed in isolation. This is an interdependent process and without proper functioning in either of the segments the desired results would not be achieved in terms of production quantities as well as service levels.

Furthermore most of the analysis and formulas done is purely theoretical, and this is where this research project is different. There will first be looked at the current situation in terms of trends and daily delivery times and occurrences. When there has been a thorough understanding of what the delivery process entails, then will there be looked at what can be done to improve the situation as well as what the correct guiding formulas would be to calculate number of vehicles needed for a specific project and differing daily requirements.

Although the literature relates to a situation in the United States and other European countries, it should be remembered that no two markets or operating circumstances are the same. It would thus be incorrect to apply this model directly to the South African context. What is of importance is that the basic principles should be identified and used and applied in a slightly modified version to suit the South African conditions. The following important lessons can be learnt from the literature study:

1. The cost of transporting asphalt is a high portion of the total material cost.
2. The delivery process is dependant on the plant as well as the paving team performing at their peak

3. This is a simplified evaluation of a truck cycle and does not consider the different working conditions encountered on a project.
4. There is opportunity for huge saving if the transporting process could be streamlined and the correct number of vehicles is used.

The point of the departure of this project will be to apply these principles and evaluate this to a local project and thereby come to a better understanding of the factors that influence the transporting of asphalt, and what can be done to improve the situation.

CHAPTER 3

THE DATA

3.1 Introduction

This chapter describes the way in which the data will be handled and the way the data collection will be done. The source of the data, as well as the manipulation will be described.

3.2 The data

The data is separated in two main types: primary data and secondary data. The nature of this data will be discussed below:

3.2.1 The primary data

The primary data will be gathered from the Benoni plant of MUCH Asphalt Pty (Ltd.). This will be in the form of the weighbridge tickets and log sheets for trucks. This information will be collected and sorted on a daily basis when there was production. This is the raw data that will be collected and manipulated.

3.2.2 The secondary data

The secondary data will be gathered from the plant relating to the daily production figures for the production of asphalt for the specific contract.

3.3 The data analysis strategies

The data will be fed into the Microsoft ® Excel system on a daily basis in a specific form. This data will be sorted in sequence of time, as to analyze the chronological occurrence of events. Graphs will also be used to illustrate the variance of traveling time and standing time on site as well as to show daily trends. Both the primary and secondary data will be represented on this sheet. Calculations will also be done to show the average daily production rate as well as the average standing time and traveling time to site for a one-way trip.

3.4 Presentation of the results

The results will be in a printed document, in a narrative report. All the data will be represented as an addendum in the document showing the processed data sheets for the daily results. This will describe the various aspects as well as the representation of the data and the findings.

3.5 Methods of achieving trustworthiness

The data gathered will be crosschecked. The information represented on the log sheet as well as the weighbridge tickets should be the same seeing that they represent the same information. Seeing that the arrival times of the vehicles are sorted chronologically any discrepancies relating to a specific weighbridge ticket will be shown immediately.

3.6 Summary

The data is quite readily available from the printed weighbridge tickets which is a standard forms, as well as the daily log sheets that are complied for each vehicle. This data forms the core of this analysis and is essential to the outcome of this project. This data is unique and specific to this project and would it would not be possible to duplicate or create this data through use of a computer simulation. The summary sheets are a method to manipulate and summarize the data into workable packages.

CHAPTER 4

THE SCOPE OF THE WORKS

4.1 <u>The Project:</u>

<u>N3 Old Barn: Re-habilitation of sections on National Route 3</u>
<u>Between Vosloosrus and Heidelberg</u>

This project entails the milling of existing deteriorated wearing course asphalt on marked out sections of the N3 national route. The work was done on both the north- as well as the southbound lanes.
The majority of the work being carried out is in the left lane, where the heavy vehicles drive in the slower lane, and where the biggest deterioration has occurred.

The work for each day would start off with each section being cordoned of for the diversion of traffic. A typical day on site starts out at 7h30, and the construction team must be off the road by 16h00 in the afternoon, otherwise lane-closure penalties apply.

No work was allowed to be carried out on public holidays or school holidays as well as the days preceding the holidays, due to the increased amount of traffic on this route that have to be accommodated.

The work was planned in such a way that the intersections and work on the bridge decks were completed last in the sequence of events.

A typical working day would start with the closure of a selected section of the road, and then the areas to be milled out is marked on the road surface by the resident engineer to indicate which sections will be milled and replaced.

Only a single lane of the dual carriage way was closed at a time to still allow the flow of traffic.

After a section was marked out properly, the milling process would start.

The milling was done in depths of 30mm or 60mm, depending on the severity of the deterioration. If there were severe cracking from the sub-base level, then a reinforced sheet of bidum cloth would be inserted on tack-coat before the premix is paved.

The milled material was placed on the sides of the road to give additional protection on the edges of the shoulder of the road. This material would be trimmed and lightly compacted.

When the milling was completed, a mechanized broom would be used to sweep all loose pieces of aggregate of the road. A joint would also be cut at the end of the milling run to ensure a straight and neat edge where a specific section finished. These edges were formed using a compressor with a jackhammer and saw-cut machine to give off a neat finish did this.

After a section was thoroughly cleaned, a spray tanker would be used to spray the tack-coat on the milled surface, to ensure a good adhesion between the existing material and the new layer of asphalt to be placed.

When all of this preparatory work has been completed, the asphalt-paving process would start, and follow on the whole sequence of preceding steps. The material is paved, and the rolled to achieve compaction with both a steel drum rolled and a rubber wheeled roller.

After completion of a whole section, the area where work was carried out would be cleaned, and the machines would be moved to the following day's section. A quick inspection would be done, and the engineer will allow the contractor to open the road for traffic again. The following day the whole process would be repeated.

It is clear to see from the above that this is a sequential process, where the one activity can only follow after the successful completion of the preceding activity – the critical path items – and that a delay in any activity, will influence the following activity and the day's production. It is therefore important to ensure the correct flow of work and materials on all the different aspects of this process, to achieve efficiency.

This is the driving force behind this research project. The investigation into the delivery of the asphalt to this project was undertaken with the sole purpose of streamlining the process of delivering of asphalt and giving better service to our customers.

4.2 The Project source data:

4.2.1 The weighbridge tickets and vehicle log sheets

The weighbridge ticket is the primary source of data regarding the material delivered to site, as well as the time it was done. This is backed up by the vehicle log sheet, that is an individual record for each truck for each day, giving a detailed breakdown of the trips completed to different locations on a specific day. The log sheets are used to calculate the payment of the haulers on a monthly basis. These two documents will now be discussed in more detail:

4.2.2 The weighbridge ticket and loading of the material

The PM96 Control module of the Astec continuous process asphalt mixing plant creates the weighbridge ticket. This is the computer system that controls all the variables on the plant as well as the weighing and loading of the premix onto the trucks. This system originates from the United States of America, and is used in various plants around the globe.
Before going into more detail on the actual document, the process of loading and ordering the material should be discussed.

4.3 The loading and ordering of the material

To plan the project, a weekly program for the required daily quantities are forwarded to the offices of Much Asphalt per fax by no later than 16h00 on a Thursday afternoon for the following week. All these quantities are to be confirmed on the evening before the next day's work starts.
The reality is that this procedure wasn't followed to the letter, the problem being that it was difficult to estimate ahead accurately predict what the production would be. This was mainly due to the fact that the specific amount of work to be milled out would only be known on the morning that the work would be carried

out, after the road was closed and the resident engineer marked out the work on the road.

The weekly program was forwarded as required, but wasn't really accurate. What normally happened is that the call would come on the afternoon to place the next day's order, asking for approximately 400t, to be confirmed in the morning. The plant was thus actually taking the risk to decide how much it should mix, due to the fact that the mixing should start at 6h00 in the morning to ensure that it is available on site at 7h30.

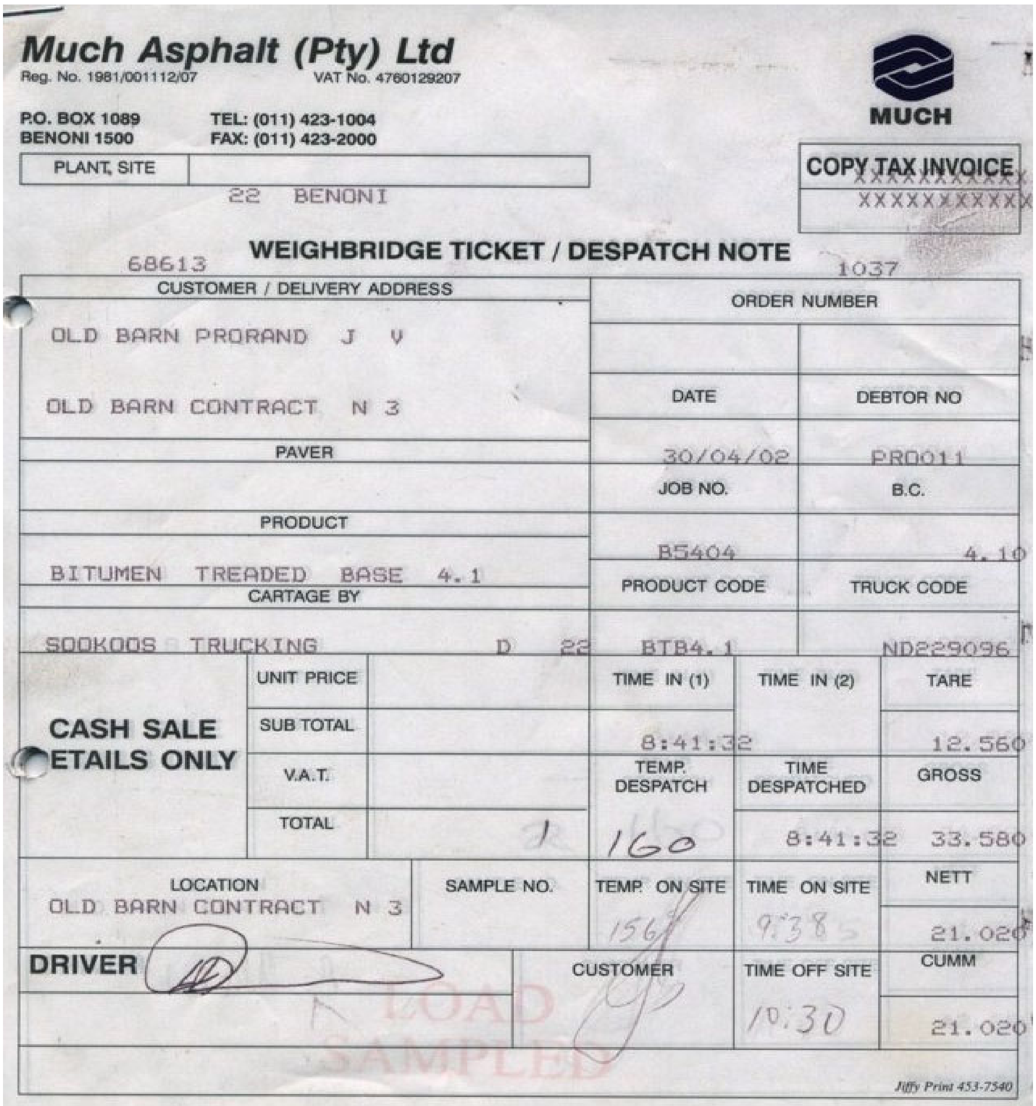
The confirmation was normally received at 7h00, asking to send the first 150t and to wait before sending the rest. Luckily, these mixes could also be used on other projects, so it didn't present an unsurpassable obstacle. It would however be advisable to try and devise a system whereby the quantity of work to be preformed on the next day would be more accurately determinable. This would help the premix plant to schedule its production and deliver better service to the client and eliminate unnecessary wastage and claims. The plant would encounter losses in terms of wasted material as well as extra costs to start up the plant to mix an additional quantity would the required amount not be met, or there be a small additional order to complete a section that was milled out.

4.4 The weighbridge ticket

The weighbridge ticket is printed on a pro-forma ticket, and is the document that is sent to site to be signed by the customer to acknowledge the receipt of the material. This is the single most important document in the delivery process of the asphalt to site. It can be seen as a modified delivery note giving additional information and proof of acceptance of material delivered.

Some of the information as printed at the plant, while the on site the site clerk writes in the balance of the information per hand on site.

The details on the ticket will now be discussed with relation to the example that follows below:


Much Asphalt (Pty) Ltd
Reg. No. 1981/001112/07 VAT No. 4760129207
P.O. BOX 1089 BENONI 1500
TEL: (011) 423-1004 FAX: (011) 423-2000
MUCH
COPY TAX INVOICE
PLANT, SITE: 22 BENONI
WEIGHBRIDGE TICKET / DESPATCH NOTE
68613 1037

CUSTOMER / DELIVERY ADDRESS	ORDER NUMBER	
OLD BARN PRORAND J V		
OLD BARN CONTRACT N 3	DATE: 30/04/02	DEBTOR NO: PRO011
PAVER	JOB NO.: B5404	B.C.: 4.10
PRODUCT: BITUMEN TREADED BASE 4.1	PRODUCT CODE: BTB4.1	TRUCK CODE: ND229096
CARTAGE BY: SOOKOOS TRUCKING D 22		

CASH SALE DETAILS ONLY		TIME IN (1)	TIME IN (2)	TARE
UNIT PRICE		8:41:32		12.560
SUB TOTAL		TEMP. DESPATCH	TIME DESPATCHED	GROSS
V.A.T.		160	8:41:32	33.580
TOTAL		TEMP. ON SITE	TIME ON SITE	NETT
LOCATION: OLD BARN CONTRACT N 3	SAMPLE NO.	156	9:38	21.020
DRIVER		CUSTOMER	TIME OFF SITE	CUMM
			10:30	21.020

LOAD SAMPLED
Jiffy Print 453-7540

Fig. 3 - Example of a weighbridge ticket for 30 April 2002

Field	Written down	Remark
Plant, Site:	*22 Benoni*	This is the plant from where the mix was sent
	1037	The printed weighbridge ticket number
Customer:	*Old Barn Prorand JV Old Barn N3*	The name of the customer and project
Product:	*Bitumen Treated Base 4.1*	The type of mix delivered and binder content 4.1 percent
Cartage by:	*Sookoos Trucking*	The contractor who transports the mix
Debtor No.:	*PRO 011*	The account number for this whole contract, Prorand JV's debtor number

Field	Written down	Remark
Job No.:	*B5404*	Benoni plant's job number 5404
Product: Code:	*BTB 4.1*	Bitumen Treated base with 4.1% binder
B.C:	*4.10*	4.10 % bitumen content
Truck Code:	*ND229096*	The registration number of the truck
Temp. Dispatch:	*160*	The temperature was 160°C when loaded
Temp on Site:	*156*	The temperature was 156°C on site
Time in:	*8:41:32*	The time the truck reported for duty
Time Dispatched:	*8:41:32*	The time the truck was send out after being loaded
Time on Site:	*9:38*	The time the truck arrived on site
Time off Site:	*10:30*	The time the truck left site
Total	*1*	The number of the load – first load
Tare:	*12.560*	The empty weight of the truck
Gross:	*33.580*	The total weight when loaded
Nett:	*21.020*	The weight of the premix on the truck
Cumm:	*21.020*	The cumulative total delivered
Driver:	*sign*	The signature of the driver delivering the material to the site
Customer:	*sign*	The signature of the clerk or foreman receiving the material on site.

As can be seen it is quite a large amount of information, with some repetition of facts or information. The only information that is completed on site or written in by hand is the signature of the driver and foreman, as well as the time on site and the time off site, as well as the temperature of the mix when received on site. The most important information for the purpose of this analysis is the different times given on this ticket: *time dispatched*, *time on site* and *time off site*. This information is used to calculate the one way trip time to site as well as the time spend on site, from arrival till the material is off loaded and the truck starts with the return trip.

There was some inaccuracy in the times written down when the vehicles arrive on site, normally the tally clerk on site would not be keen to write the arrival times on the slips when the trucks are waiting on site, or there is a delay on the paving side. The reason for this is that according to the supply agreement standing time would be paid if the trucks spend more than one hour on site, since their time of arrival, as would occur when there is paver breakdown. This was realized when there were some discrepancies discovered between the times written in on the log sheets and the values on the weighbridge tickets. After some discussion with our client, the problem was solved and the weighbridge tickets were completed more accurately.

The weighbridge ticket is printed in triplicate, with one copy being kept at the plant as a record of material send out, and the other two send to site. The signed copy of the tickets send to site is then returned to the plant for processing. The tickets are used to calculate the amount of material send out to a specific project as well as the standing time charges for a specific contract.

4.5 The procedure for ordering asphalt

On a weekly basis the client would forward a programme of the following weeks production required. This would give the amount of premix required per day in ton, as well as the time it was required on site. This would be supplemented by the placing of an order on the afternoon before the next days work would occur. The foreman on site phoning the plant manager would do this telephonically.

The problem with this process is that unfortunately the amount of work carried out would never be certain. This was due to the fact that the resident engineer on site would do the road inspection on the same day as when the work would be occurring, in the morning before the mix is ordered.

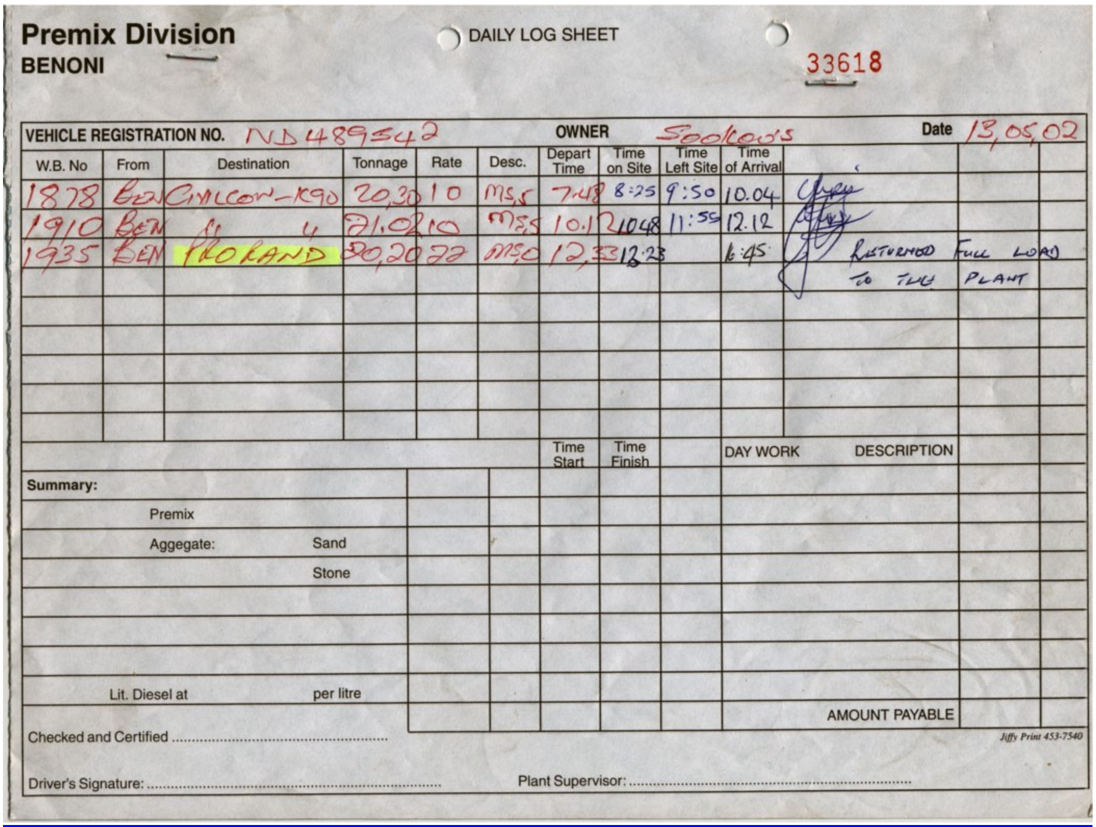
The reality is that the weekly order programme that was sent to the plant per fax was barely ever very accurate. The next factor that added to uncertainty in planning is that the confirmation of the order in the morning would normally be not definite as well. Atypical situation is that the weekly programme would show ±400 ton for every day. The call would then be received from site on the preceding afternoon, indicating that they would require ±390 ton as an example. In the morning at around 7h15, the foreman would ask for the first 150 ton to be send, and “that the plant should standby for the rest” – meaning that the rest of the production would be called for as required.

This might not seem like an unreasonable request, but the plant sits with a difficult predicament. The mixing capacity of the plant is in the region of 140 ton per hour. Furthermore, the plant has silo storage capacity of about 320 ton. Firstly, the plant can't store the full day's production requirements in the silos, and furthermore, there are also other mixes made with different specifications, for other customers. Thus, you have a situation where there is a storing capacity for about 160 ton available for this specific project. If the client asked for the first 150 ton, without being sure if the rest of the mix would be required, it means that there would be at least a two hour delay from using the last of the production, till when the plant have mixed enough mix to supply the project and have it delivered to site, if he then required it. It is fortunate though, that the mix type required for this project was medium with a 5.0% binder content, and this was also the sundry mix used by all other customers requiring a medium graded mixture. The reality is that the plant carries the risk for producing a large enough amount of mixture to supply all the customers, and in the case of it not being used, a breakdown, delay or work stoppage due to rain occurring.

For a more efficient operation of the plant, it would be required that more accurate quantities be given through to the plant on a timely basis.

The other practice that is distressing is the fact that some of the paving foremen would be bluffing, by over stating their quantity of mix required for the day, in the belief that this would ensure them of an efficient stream of production to their project, with ample supply that can be terminated as soon as the have completed their production for the day. This is a practice that leads to inefficient operation, and is to the disadvantage of the plant, as well as the other customer it is providing a service to. No effective planning can be done when working on this basis. To rectify this situation there should be a mutual trust relationship existing between the contractor and the plant, as well as effective honest communication.

4.6 The daily log sheet



Premix Division
BENONI

DAILY LOG SHEET

33618

VEHICLE REGISTRATION NO. ND 489542 OWNER Sookool's Date 13,05,02

W.B. No	From	Destination	Tonnage	Rate	Desc.	Depart Time	Time on Site	Time Left Site	Time of Arrival			
1878	Ben	Gimcon-K90	20,30	10	MSS	7.48	8:25	9:50	10.04			
1910	Ben	" "	21,02	10	MSS	10.12	10.48	11:55	12.12			
1935	Ben	Proland	20,20	22	MSO	12,33	12.23		6:45	Returned to the	Full load plant	

Time Start | Time Finish | DAY WORK | DESCRIPTION

Summary:
Premix
Aggegate: Sand
Stone

Lit. Diesel at per litre

AMOUNT PAYABLE

Checked and Certified ....

Jiffy Print 453-7540

Driver's Signature: .... Plant Supervisor: ....

Fig. 4 - Example of the daily log sheet 13 May 2002

The log sheet is a daily record for a specific vehicle, which indicates all the trips that were undertaken and the materials that were delivered. The purpose is to be able to add up the cost for a specific vehicle for a specific month and to have a record of the traveling charges.

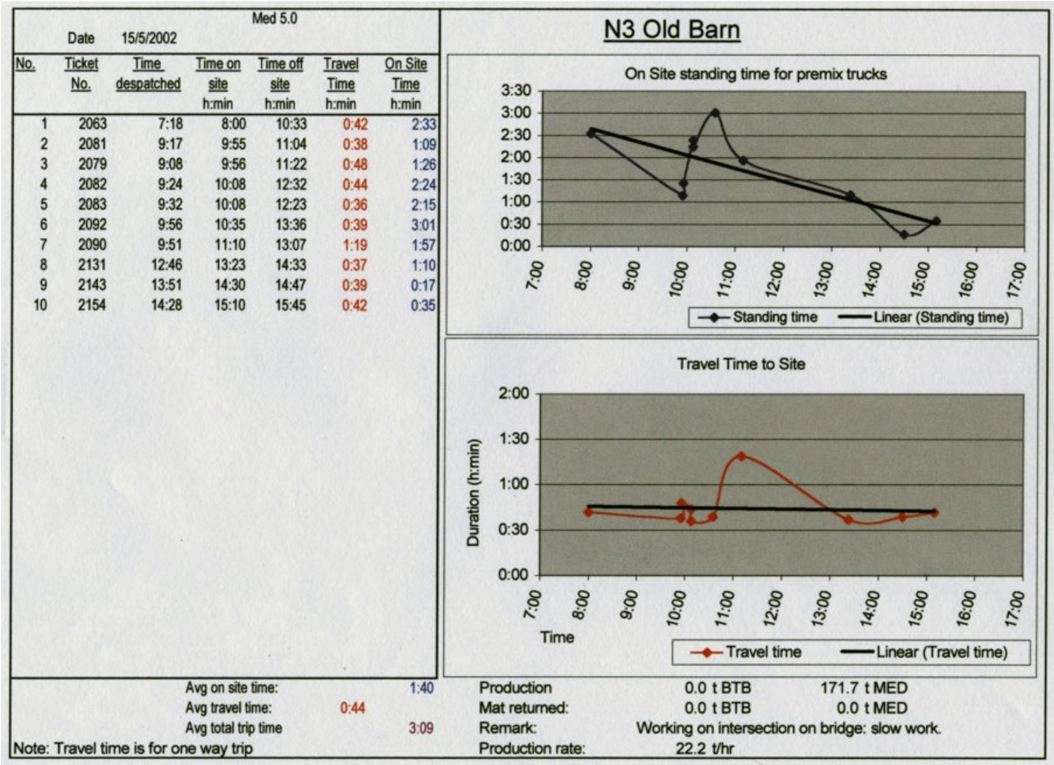
The log sheet will have the registration number of the truck , the owner and the date written as a heading and the following columns:

Field	Written down	Remark
W.B No:	*1878*	The corresponding weighbridge ticket number
From:	*Ben*	The vehicle traveled from Benoni plant

Field	Written down	Remark
Destination:	*Civilcon K90*	The site where the truck is going - Civilcon
Tonnage:	*20,30*	The truck transported 20.30t material
Rate:	*10.00*	The rate/ ton for transport to a specific project
Desc. :	*M5.5*	The truck was transporting Medium 5.5 asphalt
Depart Time:	*7:48*	The time the truck left from Benoni plant
Time on Site:	*8:25*	The time the truck arrived at the Civilcon site
Time left Site:	*9:50*	The time the truck left after off-loading at the site
Time of Arrival:	*10:04*	The time the vehicle reported back at the Benoni plant

As can be seen, there is a lot of duplication between the log sheet and the weighbridge ticket. This is used as a verification system, if there are any doubts about the correctness of values written in on either form. As simple as both these forms may seem, they are very important documents used in the efficient running of the plant and delivering of the materials. In off peak situation, these vehicles are also used to collect aggregates to build up the stock being used by the plant, and the same log sheet is used to record this.

4.7 The daily data sheet



Med 5.0

Date 15/5/2002

No.	Ticket No.	Time despatched	Time on site h:min	Time off site h:min	Travel Time h:min	On Site Time h:min
1	2063	7:18	8:00	10:33	0:42	2:33
2	2081	9:17	9:55	11:04	0:38	1:09
3	2079	9:08	9:56	11:22	0:48	1:26
4	2082	9:24	10:08	12:32	0:44	2:24
5	2083	9:32	10:08	12:23	0:36	2:15
6	2092	9:56	10:35	13:36	0:39	3:01
7	2090	9:51	11:10	13:07	1:19	1:57
8	2131	12:46	13:23	14:33	0:37	1:10
9	2143	13:51	14:30	14:47	0:39	0:17
10	2154	14:28	15:10	15:45	0:42	0:35

Avg on site time:		1:40
Avg travel time:	0:44	
Avg total trip time		3:09

Note: Travel time is for one way trip

Production	0.0 t BTB	171.7 t MED
Mat returned:	0.0 t BTB	0.0 t MED
Remark:	Working on intersection on bridge: slow work.	
Production rate:	22.2 t/hr	

Fig. 5 - A Typical daily summary sheet

The daily data sheet is a visual representation of the data that is gathered from the log sheet and weighbridge tickets on a daily basis. This document summarizes the deliveries to site in relation to the time traveled to site and the time spent on site. The two graphs on this sheet, graphically depicts this, with a black line representing the trend for the standing time on site, as well as the one-way travel time to site. The results were plotted on these graphs in the order that the trucks arrived on site, as deducted from the weighbridge tickets and the log sheets. The value on the X-axis represents the time of day that the specific load arrived on site. The value on the Y-axis for both graphs represent the duration, or time spent performing either the driving to site, or waiting on site to off-load the premix, depending on the graph.

The data is sorted in ascending order by the time the vehicles arrived on site, so the order does not necessarily represent the sequence that the vehicles left from the plant. At the bottom of the columns the averages for the day are also given. Below the graphs the quantities for the daily production actually delivered to site as well if there was any material returned. Any specific remarks relating to events that might have occurred during that specific day are also noted. The average total trip time is calculated by doubling the average travel time and adding the average time spent on site. This is an indication of what a typical cycle time should be for one truck delivering mix to site and returning.

The production rate is the rate achieved by dividing the total quantity of mix delivered to site by the time difference from the first truck on site, till the last truck departed.

CHAPTER 5

ANALYSIS OF TYPICAL DAILY TRENDS

5.1 Introduction

The daily delivery of premix was summarized in the previous sections. We will now examine the results as summarized on the sheet for a few days, giving examples of typical occurrences that may present themselves during the progress of the project.

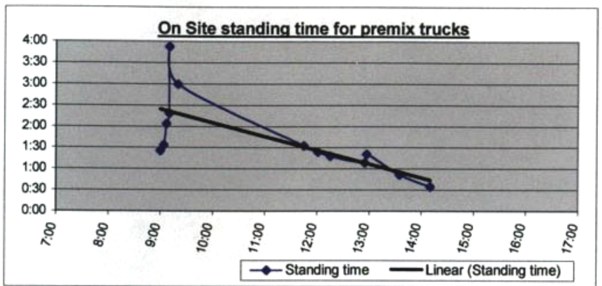
5.2 Examination of the daily data sheet: 4 May 2002

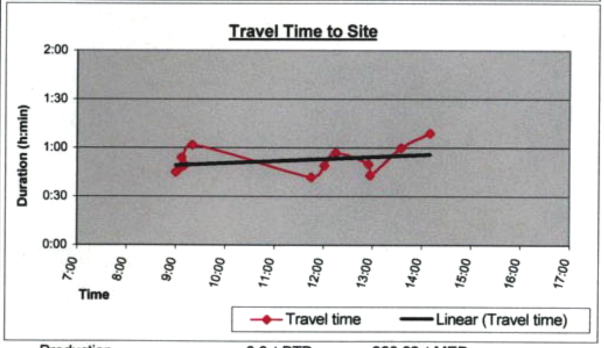
Med 5.0

Date 4/5/2002

No.	Ticket No.	Time despatched	Time on site h:min	Time off site h:min	Travel Time h:min	On Site Time h:min
1	1362	8:15	9:00	10:26	0:45	1:26
2	1363	8:17	9:04	10:38	0:47	1:34
3	1361	8:13	9:07	11:11	0:54	2:04
4	1365	8:20	9:10	11:29	0:50	2:19
5	1366	8:21	9:10	13:03	0:49	3:53
6	1364	8:18	9:20	12:20	1:02	3:00
7	1397	11:03	11:45	13:18	0:42	1:33
8	1399	11:12	12:01	13:25	0:49	1:24
9	1401	11:18	12:15	13:33	0:57	1:18
10	1409	12:05	12:55	14:04	0:50	1:09
11	1411	12:14	12:57	14:18	0:43	1:21
12	1417	12:35	13:35	14:27	1:00	0:52
13	1419	13:01	14:10	14:45	1:09	0:35

N3 Old Barn





Avg on site time: 1:43
Avg travel time: 0:52
Avg total trip time 3:27
Note: Travel time is for one way trip

Production 0.0 t BTB 260.62 t MED
Mat returned: 0.0 t BTB 0.0 t MED
Remark: Working on intersections: Slow work.
Production rate: 45.3 t/hr

Fig. 6- Summary sheet for 4 May 2002

On this day, there was only one type of mix delivered to the project, namely Medium. The first truck arrived on site at 9:00, after traveling for 45 minutes. We note that there is a slight increase in the travel time to site as the day progresses. If the standing time on site is considered, it can be seen that there was an increase in the standing time for the vehicles, from the first load till the sixth load. Once again, this is a communication problem between the plant and the paving site. If it were known that the work was being carried out on an intersection, the vehicles would be dispatched at a slower rate. The first six trucks all left site in a matter of 8 minutes, and arrived on site within a twenty-minute period. There is no way that the paving team can handle this rate of receiving material when doing slow work, such as paving an intersection. It can be seen that from load number seven onwards, the situation was much better. The vehicles arrived on site at intervals of about fifteen minutes, and this resulted in less unproductive or standing time being spent on site. There were actually six trucks assigned to this contract and the seventh load was actually the vehicle that delivered load number one returning to the site for a second delivery.

There is a large gap in the arrivals of the vehicles on site between load number six and load number seven, from 9:20 to 11:45.

This can be explained as follows:

The first truck to be able to leave site was load number one, leaving site at 10:26. Due to this, it is only possible to be back at site at least after 1½ hour, due to the fact that the time to travel back to site will be slightly less than the 45 minutes (say 40 minutes) it took when the truck was loaded. The vehicle must then get loaded, and return to site again, taking on average 50 minutes to be loaded and drive back to site.

The roundtrip time for one vehicle returning from the site would thus be:

Time traveling back from site to plant:	0:40
Time to load and dispatch mix:	0:05
Time to travel back to site:	0:45
Cycle time	1:30

The earliest time that the vehicle could be back on site would thus be:

Time left site:	10:26
Add Cycle time as above:	1:30
Time on site for second delivery:	11:56

As per delivery schedule, we can see that load number 7 was on site at 11:45, which is very good. This means that the vehicle saved some time by driving faster and cutting the time back to the yard and that there was no delay in loading the mixture at the plant.

This analysis highlights the problems encountered when the transporters send to site are delayed and don't return quickly. It is a problem that compounds itself when there is one delay, especially if the project is not very close to the plant. This is because by the time it is realized that the vehicles are spending extra time on site and not returning, there might already have been three to four other vehicles that have already been dispatched. These vehicles will then also arrive on site "early" due to the previous delay and the sequence is broken. It is also a very contentious issue to charge standing time to the clients and what the correct figures are, so it is best to try and avoid a situation like this, and when it does arrive, early and accurate communication is essential to prevent further wastage of time and money.

5.3 Analysis of a day with a high production rate: 2 May 2002

As discussed earlier, the production rate is determined by looking at the amount of premix delivered to site, divided by the length of the production day – from the time the first vehicle arrived on site, till the last vehicle departed. The production rate for this day was the highest of any day during the project at 86,4t/hr.

The first thing to be noted is that the work didn't start very early or continued till after 15h00 in the afternoon, so this was really a great achievement and not just a long day. There was 500,9t BTB (Bitumen Treated Base) delivered to the site in total. When BTB is paved, it is normally as a supporting layer to be done before the final layer is being placed. It is correct to say that it is easier to perform this type of paving than doing the final wearing course, and also that the BTB layer is normally a lot thicker than the wearing course. This all played a positive roll in achieving this high production rate.

It is also noteworthy to see that there was no mixture returned on this day, and thus no problems with the quality of material delivered to the project.

When analyzing the travel time to site, it can also be seen that it was very much an average time, so it can't be said that the high production rate is due to the part of the work being closer to the plant, there were many other sections that were a lot closer to the plant. This good average travel time is achieved in spite of load no. 11 taking 1:29 to reach the site, due to a flat tire that had to be replaced.

The really noteworthy aspect is that the time on site was on average of the lowest achieved throughout the run of the project. Out of the 24 vehicles that delivered to the project, there were 7 vehicles from delivery no. 4 till no. 11 that spend more than the allowed 1-hour time on site. This was due to the fact that the lane was changed where the paving occurred, due to a small section of work that was not part of the straight run to be done. From load no. 12 onwards, it can be seen that all the time spent on time values are very low.

In conclusion it can be said that there is a great relationship between the steady flow and return of the vehicles to and from the site, and high paving production rates being achieved.

BTB 4.1

Date 2/5/2002

No.	Ticket No.	Time despatched	Time on site h:min	Time off site h:min	Travel Time h:min	On Site Time h:min
1	1186	8:35	9:15	10:09	0:40	0:54
2	1187	8:36	9:17	10:15	0:41	0:58
3	1189	8:38	9:21	10:23	0:43	1:02
4	1190	8:40	9:22	11:57	0:42	2:35
5	1188	8:37	9:35	11:49	0:58	2:14
6	1191	8:41	9:40	12:03	0:59	2:23
7	1196	9:17	10:10	12:12	0:53	2:02
8	1195	9:15	10:15	12:18	1:00	2:03
9	1217	10:44	11:28	12:35	0:44	1:07
10	1218	10:46	11:30	12:43	0:44	1:13
11	1206	10:02	11:31	12:29	1:29	0:58
12	1225	11:31	12:17	12:50	0:46	0:33
13	1224	11:28	12:30	13:12	1:02	0:42
14	1228	11:40	12:35	13:21	0:55	0:46
15	1236	12:29	13:15	13:35	0:46	0:20
16	1233	12:21	13:18	13:27	0:57	0:09
17	1247	12:57	13:36	14:13	0:39	0:37
18	1239	12:37	13:38	13:41	1:01	0:03
19	1245	12:50	13:40	13:51	0:50	0:11
20	1246	12:52	13:57	14:07	1:05	0:10
21	1251	13:23	14:10	14:29	0:47	0:19
22	1253	13:33	14:20	14:38	0:47	0:18
23	1257	13:51	14:49	15:03	0:58	0:14
24	1258	14:00	14:50	14:51	0:50	0:01

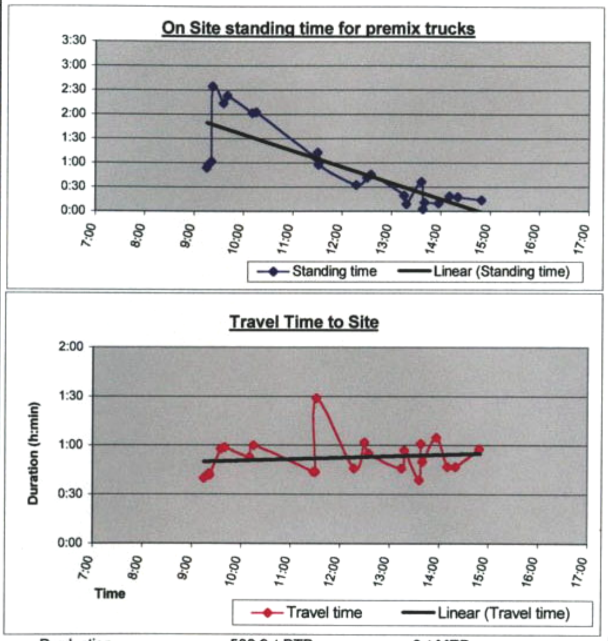
Avg on site time: 0:54

Avg travel time: 0:52

Avg total trip time 2:39

Note: Travel time is for one way trip

N3 Old Barn



Production	500.9 t BTB	0 t MED
Mat returned:	0.0 t BTB	0.0 t MED
Remark:		
Production rate:	86.4 t/hr	

Fig. 7- Summary sheet for 2 May 2002

5.4 Analysis when there is a paver breakdown

Med 5.0

Date 15/4/2002

No.	Ticket No.	Time despatched	Time on site h:min	Time off site h:min	Travel Time h:min	On Site Time h:min
1	455	7:51	8:32	10:57	0:41	2:25
2	454	7:49	8:37	11:14	0:48	2:37
3	456	7:53	8:45	11:33	0:52	2:48
4	457	7:55	8:51	11:43	0:56	2:52
5	458	8:13	9:05	11:56	0:52	2:51
6	460	8:19	9:15	12:12	0:56	2:57
7	462	8:31	9:32	13:25	1:01	3:53
8	459	8:15	9:45	13:25	1:30	3:40
9	469	10:01	10:57	13:30	0:56	2:33
10						
11						
12						
13						
14						
15						
16						
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20						
21						
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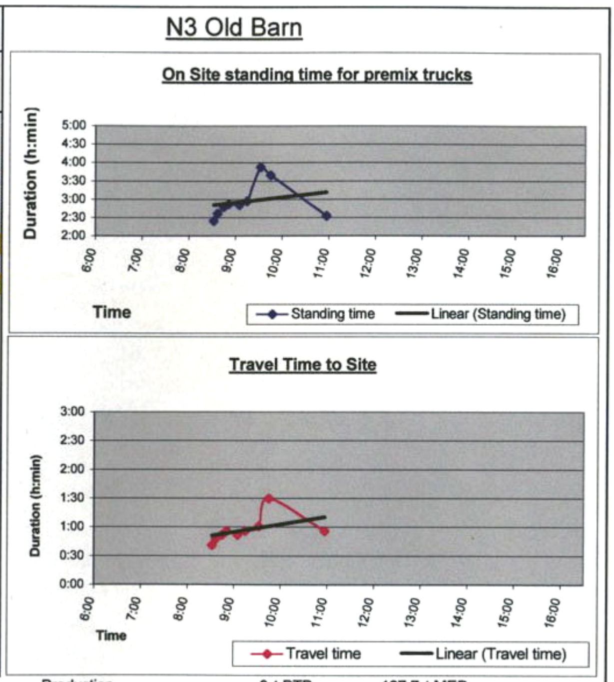
23						



Avg on site time: 2:57
Avg travel time: 0:56
Avg total trip time 4:51
Note: Travel time is for one way trip

Production 0 t BTB 167.7 t MED
Mat returned: 39.6 t BTB 0.0 t MED
Remark: Breakdown on site: milling machine. Trucks waiting on site.
Production rate: 41.7 t/hr

Fig. 8- Summary sheet for 15 April 2002

As with any process, what are the consequences when things go wrong?

Here we are seeing what happened when there was a breakdown experienced by the paving team on site. Unfortunately when the paver breaks, no further paving will occur, unless it is only a minor problem that can be repaired in a few minutes. Furthermore it is essential that the site notify the plant as soon as possible about the problem, and that no more mix should be dispatched to site.

The next step is to send back the vehicles that are on site, and see if it is possible to divert the material to another project, if the mix hasn't been on the truck too long and possibly cooled down. Mostly if the mix is returned early in the day (before 12h00) it will be possible to find alternative delivery points – that is if it is not a specialist mix with a modified binder. In this instance, there were two vehicles with mix returned, namely no. 7 and no. 9. Fortunately the mixture was Medium graded with 5.0% binder content, which is used on a lot of other projects. The downside is that the mixture was below temperature and had to be dumped. The respective time on site for these vehicles were 3:53 and 2:33. If the average traveling time to site of 1 hour there and back is added to both of these, you would have mixture that is between 5 and 6 hours old when it is back at the plant. This mixture was thus dumped and scrapped when returned to the plant.

When looking at the other averages it can be seen that in both graphs the trends are significantly upward for both the time on site, as well as the on site standing time. The fact that there is an increase in the standing time on site can be explained due to the fact that there were problems experienced with the paver before it broke down and that explains the slower production rate.

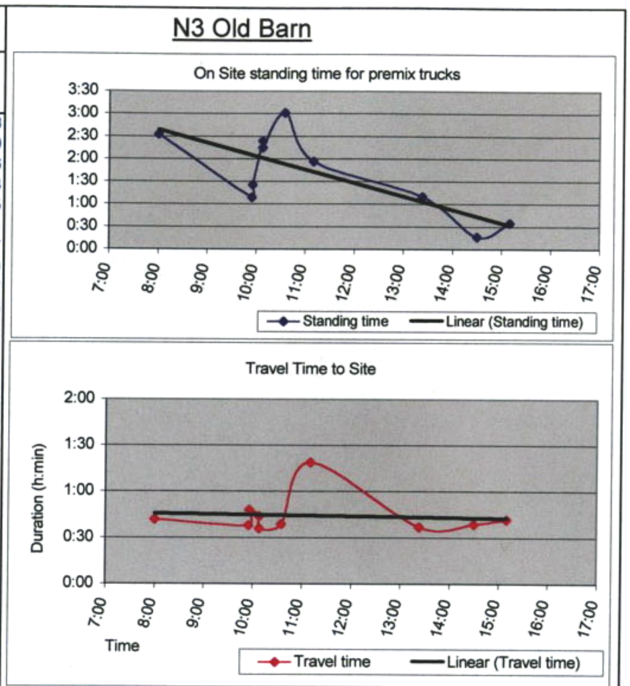
The only explanation for the longer travel times to site is the fact that the foreman on site recorded the times incorrectly. This may be pure co-incidence, but is has been found before that the foreman on site deliberately records later time on site, as to give him a longer window to off-load the material before standing time is recorded. It may also be said that the team might have been so busy with trying to sort out the problem with the paver on site that not a lot of attention was given to the vehicles arriving on site, and that could explain the incorrect values of the on site time values.

5.5 Analysis when working on an intersection

Med 5.0

Date 15/5/2002

No.	Ticket No.	Time despatched	Time on site h:min	Time off site h:min	Travel Time h:min	On Site Time h:min
1	2063	7:18	8:00	10:33	0:42	2:33
2	2081	9:17	9:55	11:04	0:38	1:09
3	2079	9:08	9:56	11:22	0:48	1:26
4	2082	9:24	10:08	12:32	0:44	2:24
5	2083	9:32	10:08	12:23	0:36	2:15
6	2092	9:56	10:35	13:36	0:39	3:01
7	2090	9:51	11:10	13:07	1:19	1:57
8	2131	12:46	13:23	14:33	0:37	1:10
9	2143	13:51	14:30	14:47	0:39	0:17
10	2154	14:28	15:10	15:45	0:42	0:35



Avg on site time:	1:40
Avg travel time:	0:44
Avg total trip time	3:09

Note: Travel time is for one way trip

Production	0.0 t BTB	171.7 t MED
Mat returned:	0.0 t BTB	0.0 t MED
Remark:	Working on intersection on bridge: slow work.	
Production rate:	22.2 t/hr	

Fig. 9 - Summary sheet for 15 May 2002

As the project continued, all the work on the bridges and the intersections joining on to the highway also had to be done. This type of work is quite different from the typical work being preformed on a straight section of the highway. The first obvious aspect is that the work will be a lot slower than when doing the straight sections. If we consider the production rate, we can see that the rate is very low at 22,2 t/hr for this section of work. This is about a third of what the production rate would be on a typical average production rate on a straight section. Depending on where the intersection is situated, there might also be a time constraint on when the work can start due to the fact that the flow of traffic onto and from the highway may not be hampered. This section of work had the limitation that the work may not start before 7h30 and that the team should have cleared and completed the work before 16h00.

The premix was ordered for 8h00 on site. This shows that no thorough consideration was given to the fact that even if the work started at 7h30, it would take at least 15 minutes to cordon off a section of the road. Furthermore, all the work on this project is mill and replace, so even if it only took 15 minutes to cordon off an area to work in, there would at least be another 30 minutes that would have gone by to mill and clean a section. It is therefore clear that the delivery of the asphalt should have been ordered later. It can be clearly seen from the on site time for the first vehicle that there was a lot of time wasted for the first vehicle to be off loaded and paved. The fact that the vehicle would also spend a lot more time on site to off load the mixture while the paver is being maneuvered to work in the narrow and curved section should also not be forgotten. The typical cycle time for this operation is therefore also a lot longer.

It is interesting to note that the trend in the on site time is also to reduce as the day progresses. This mainly to the fact that it is always slower to set up the paver machine to work correctly with the type of work being preformed, and as the day progresses, the people are getting more accustomed with the work as well as the setup of the paving machine.

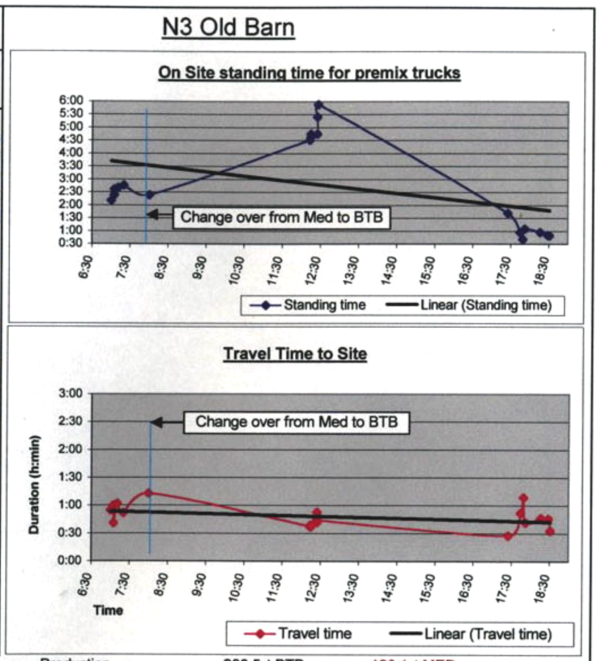
The one-way travel time for this section was also quite good, and this work was done relatively closer to the plant than the other intersections on this project. The one value of 1h19 for load no. 7 is unexplained.

The conclusion is that it is definitely wise to allow for the slower pace of production when programming work that is considered to be of a slower production rate, but it should also be remembered that the vehicles will automatically spend a longer amount of time on site, so the interval at which the vehicles are send to site should be slower.

5.6 Analysis when there a trial section is done

Date 16/4/2002 Med 5.0 / BTB

	Ticket No.	Time despatched	Time on site h:min	Time off site h:min	Travel Time h:min	On Site Time h:min
1	483	6:05	7:00	9:11	0:55	2:11
2	484	6:05	7:05	9:29	1:00	2:24
3	486	6:24	7:05	9:42	0:41	2:37
4	485	6:09	7:11	9:52	1:02	2:41
5	487	6:28	7:20	10:07	0:52	2:47
6	490	6:47	8:00	10:24	1:13	2:24
7	505	11:35	12:13	16:45	0:38	4:32
8	506	11:36	12:15	16:54	0:39	4:39
9	507	11:38	12:15	17:01	0:37	4:46
10	504	11:32	12:25	17:11	0:53	4:46
11	510	11:43	12:25	17:50	0:42	5:25
12	509	11:42	12:26	18:20	0:44	5:54
13	526	16:57	17:25	19:07	0:28	1:42
14	525	16:52	17:44	18:42	0:52	0:58
15	524	16:40	17:49	18:30	1:09	0:41
16	527	17:10	17:52	18:58	0:42	1:06
17	529	17:29	18:16	19:14	0:47	0:58
18	530	17:42	18:28	19:19	0:46	0:51
19	531	17:58	18:31	19:21	0:33	0:50
20						
21						
22						
23						



Avg on site time:		2:44
Avg travel time:	0:48	
Avg total trip time		4:20

Note: Travel time is for one way trip

Production	280.5 t BTB	120.1 t MED
Mat returned:	12.2 t BTB	7.9 t MED
Remark:	Trial section with cement as stabalizer done	
Production rate:	34.1 t/hr	

Fig. 10 - Summary sheet for 16 April 2002

The work that had to be preformed on this day, called for two different portions of work that had to be done in succession, using two different types of asphalt.

The difficulty in this is that there has to be very good co-ordination between the plant and the site to orchestrate the change over of the asphalt composition. The quantity of medium asphalt, that was required first would be mixed at the plant early in the morning and stored in the hot storage silo. This would then be dispatched as required for the first section of the work. In the mean time, the other customers would also be using the medium asphalt mixture, because it is the most common used. The plant should thus estimate exactly how much they should mix and store to anticipate the day's requirements for medium asphalt, but still allow for the period when the bitumen treated base is required. Luckily this specific plant has four hot storage bins, and can mix at quite a high rate, thus giving the plant the flexibility.

The modus operandi was to start early in the morning and mix medium asphalt and store it in three of the four hot storage silos, giving the plant a capacity of 240 t asphalt to dispatch. Subsequently there was a production run of bitumen treated base mixed and stored in silo number four, having a capacity of 80 t.

When the medium asphalt was used and some of the other hot storage silos became available, the remainder of the bitumen treated base would be produced and stored in the silo that became available.

To even make matters more complicated, the specific portion of work was part of a trial section that was done, where cement was used as stabilizer in the bitumen treated base mixture, and bidum cloth was used as a crack prevention membrane that was placed below the asphalt base layer.

As can be seen, loads number one to six, proceeded moderately, the 120,1 t Medium asphalt being delivered to the project in a time span of about three hours. This was a small section of overlay that had to be preformed after milling. There was quite a large delay for the vehicles waiting on site to pave after the milling was completed. All of the first six vehicles spend more than two hours on site. In the defense of the paving team, it can be said that the age old problem of the dispatching plant showed it's ugly face again, and that is that the trucks are just send to site as soon as possible, with no interval between them to allow for off loading of the material and maneuvering the vehicle into position. The first five trucks all arrived on site within twenty minutes. This is actually creating "false" standing time on site, the vehicles should be send with about a fifteen to twenty minutes interval between them to allow for a proper flow of production and no unnecessary standing time on site. The interval between the vehicles would vary with the type of work being preformed, and the accessibility of the position being worked in.

If we go back to the second portion of the work, this is where we see some drastic unproductive time being spent on site. Firstly, there is a gap of about an hour between the times the last vehicle delivering the medium asphalt left site, and the first vehicle delivering the bitumen treated base (BTB) to site. This is a very good performance. Seeing that the average travel time to site was in the region of 48 minutes, it would be logical to say that the other 12 minutes was being spent at the plant to load and dispatch the vehicle. All things considered, very good to have the vehicle on site within an hour, seeing that the site would have only called for the next mixture when the medium asphalt was almost completed.

From this point onwards, things changed for the worse. Yet again, the plant sends the next batch of vehicles with almost no gap between them. From vehicle number seven to twelve, there was barely a gap of thirteen minutes.

Even though the batch of vehicles was send in very close sequence, there was a huge delay before this second batch of material was used. This was due to the bidum cloth that had to be placed before the bitumen treated base material could be paved. This can be explained due to the fact that this was a new type of action, and the inexperience of the team trying to learn this new method. There was also a period of waiting for the tack-coat to “break” before the cloth could be laid, as per the instructions of the resident engineer.

This explains the standing time of about four hours for the next six vehicles on site on average. At this stage, the team was already facing penalties in terms of the road not being opened for traffic at 16h30 – the so called “lane closure penalty”. The rest of the asphalt was delivered to site and the work was only completed at 19h21,which was by far the worst performance of the whole contract in transgressing the opening of the road.

In conclusion, the average values tell the story best. The travel time to site was quite respectable and well within the norm. It is when we look at the average time on site that we can see where the problems occurred. The recommendation should be to try and do a smaller section of work when a trial section is done, and that the plant should try and send the vehicles to site with a reasonable interval between the vehicles.

CHAPTER 6

TIME STUDY

6.1 Introduction

In order to verify the data that was recorded on the log sheets and the weighbridge tickets, it was decided that an independent study should be undertaken as a sample for comparison. This would show how accurate the results are that are recorded by the various parties on site.

6.2 Time Study done on the 30 April 2002

This was a typical day of work being carried out relating to milling out of the existing surface as marked by the consultants and then repaving the section with hot mixed asphalt.

The initial order for the day was placed at ± 400 T Medium premix asphalt, and the required time on site set at 10h00. The work was being carried out on the northbound lane and access was gained from Barry Marais road. The distance from the plant to the section where the work was being preformed is approximately 45 km.

All the results were written down and compiled into a table as shown below:

Time Study				Old Barn N3		30-Apr-02			
Del No	Truck On Site Time	T	Off-Loading Start	Off-Loading Finish	Truck Standing Time	Off - Loading Cycle	Paver Standing Time	No. Of Trucks On Site	Remarks
1038	9:35	21.2	10:15	10:26	0:40	0:11	0:00	1	On site too early, mix only ordered for 10h00
1037	9:38	21.0	10:28	10:32	0:50	0:04	0:02	2	On site too early, mix only ordered for 10h00
1040	9:51	20.1	10:35	10:39	0:44	0:04	0:03	3	On site too early, mix only ordered for 10h00
1041	9:57	22.2	10:48	10:54	0:51	0:06	**0:09**	4	On site too early, mix only ordered for 10h00
1042	10:07	22.1	10:57	11:02	0:50	0:05	0:03	5	First 5 trucks finishes - good flow of production
1039	11:02	22.1	11:05	11:12	0:03	0:07	0:03	6	Truck had breakdown, out of sequence
1055	11:57	20.1	11:59	12:06	0:02	0:07	**0:47**	1	Waiting for mix, trucks reduced to 5
1060	12:15	20.2	12:19	12:26	0:04	0:07	**0:13**	2	Waiting for mix
1061	12:20	20.2	12:29	12:36	0:09	0:07	0:03	3	On time
1062	12:21	20.4	12:38	13:16	0:17	0:38	0:02	4	Long standing time, forming joint
1080	13:21	20.2	13:38	13:44	0:17	0:06	**0:22**	1	Long standing time, forming joint
1083	13:48	20.4	13:52	13:58	0:04	0:06	**0:08**	2	Waiting for mix
1084	14:03	20.4	14:05	14:18	0:02	0:13	**0:07**	3	Waiting for mix
1092	14:41	22.1	14:45	14:50	0:04	0:05	**0:27**	4	Waiting for mix
1094	15:04	20.9	15:06	15:13	0:02	0:07	**0:16**	1	Waiting for mix
1098	15:12	15.2	15:14	15:20	0:02	0:06	0:01	2	On time
1097	15:19	23.0	15:21	15:31	0:02	0:10	0:01	3	On time
1105	15:51	15.1	15:52	16:04	0:01	0:12	**0:21**	4	Waiting for last load
Total:	(t)	367.0							
Average: (hr: min)						0:08	0:10		

Paving Start time	10:15	Avg truck load	20.39T	Paver Production	
Paving Completed	16:04			-Actual	63.09T / hr
Production day (hr: min)	5:49				

Note: Paver considered to be standing if more than 3 minutes passed before next load.

Table 2.1 - Analysis of time study for 30 April 2002

6.3 Findings from time study

The first interesting aspect to note is that the trucks did not arrive on site in the same sequence as they were dispatched from the plant. The second truck arrived at the project first. When enquiring about this it was found that the different drivers had different routes that they preferred. This did not mean that the distance they traveled differed significantly, but that a short detour here or there might influence the timing that they arrived at a robot. If they stopped less, it made their travel time less due to the fact that the heavily laden trucks accelerate very slowly.

Furthermore, the truck delivering weighbridge ticket no. 1039 had a mechanical breakdown next to the road. This vehicle was dispatched at 8:47, but only arrived on site at 11:07. This relates to a traveling time of over two hours, which is very drastic and this explains the peak as shown on the travel time to site graph for the specific day.

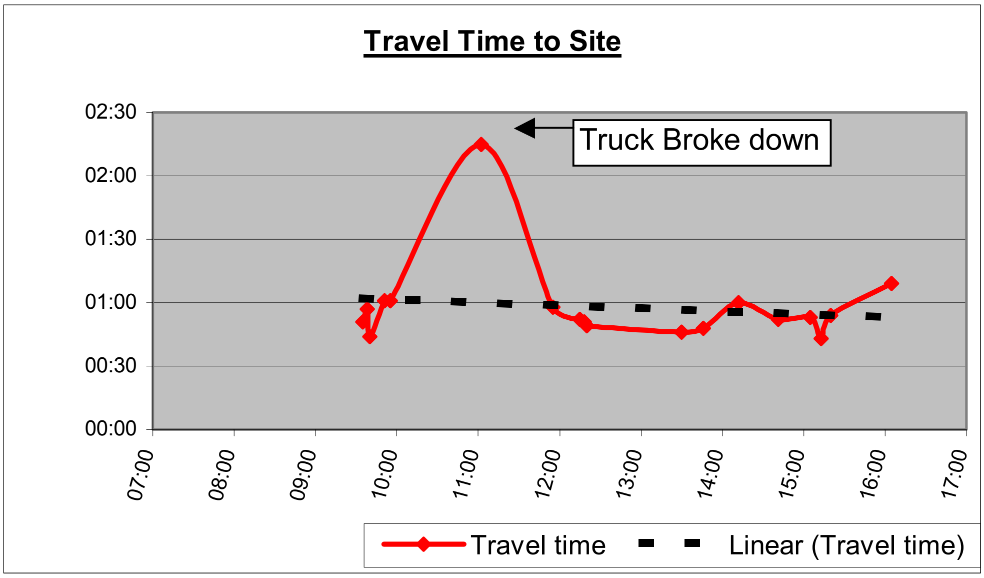


Fig. 12 - Travel time to site graph for 30 April 2002. (Travel time is one way.)

It was found that the first area where improvement could be made relates to actually ensuring that the first trucks are on site on the correct time requested. The first vehicle arrived on site at 9:35, which was 25 minutes too early. The reality is that of the first five trucks send to site, three of them were more than ten minutes early. A better solution would be to be about 5 minute early for the first truck, and that the rest of the trucks should then follow at an interval, dependant on the rate of production.

The next problem is that the trucks get dispatched in batches of five at a time, and they are send as soon as they are loaded at the plant, resulting in the trucks arriving in intervals of approximately 5 to 7 minutes gap between them.

The correct time for the next truck to arrive at site would be just a few minutes early before the paver runs out of mix. The first two or three trucks will normally be on site for a shorter while, due to the fact that the paver is empty and that they can dispatch into the feeder bin of the paver as soon as the preceding truck has left. From the time study done, it can be seen that it take on average 8 minutes to complete the whole process of off loading the premixed asphalt. This does not mean that the paver will stand if it does not receive a truck every eight minutes, there is also a time lapse of about 4 minutes from the finish of the one truck being off loaded till the process is started again. This results that if there is continuous production with no stoppages there should be a new truck arriving or be available to deliver the premix approximately every 12 minutes.

This is based on the assumption that the average truck load is 20 t, which entails that there would be some semi-articulated as well as fixed chassis tippers making up the delivery fleet. The space available to maneuver the vehicle will increase this average arrival rate on site, if there is less room available to maneuver the larger vehicle, but bear in mind that the quantity that is delivered per trip is more for the articulated tipper truck than the fixed chassis double rear axle tipper.

When a further analysis is done, there can be seen that the number of trucks were reduced from six to five at around 12h00, due to a shortage of vehicles to supply on another job. Fortunately for the hot mix asphalt supplier, the paving team also experienced a problem at about 12h30, due to the fact that they were waiting for a joint to be formed where the milling sequence had finished. This gave the supply chain a chance to catch up with the fewer trucks they had available. The only significant delay was experienced at around 14:18, when there was a waiting period of 27 minutes by the paving team, and the effect of the reduced number of trucks became evident. Had there not been a delay in the paving team's work earlier, this would have been worse.

CHAPTER 7

FORMULA FOR VEHICLES CALCULATION

7.1 Formula for amount of vehicles required

When calculating the number of vehicles to transport the required quantity of asphalt to a specific project, there are a number of factors to consider.
The first aspect to consider is the distance from the plant where the asphalt is manufactured. The further the plant is, the more vehicles will be needed to fulfill the production cycle. The next aspect to consider is the type of work that is being carried out. Work being done in straight sections is generally preformed faster than work being carried out on inter-sections and curved sections.
The next aspect regarding the type of work relates to the thickness of the material being placed, as well as the fact whether it is a final wearing course being very thinly and accurately applied or a thicker base course. Normally a base course would consume more material and the rate in ton per hour being paved, would be a lot faster than a final layer. Obviously the experience of the paving team with a specific product and their knowledge of its properties would also influence the work. Were people are uncertain and busy learning a process will be slower. This definitely applies when trial sections or trial mixes are being paved.
A general tendency is also for the production rate to accelerate as the day progresses and the team is becoming more efficient in what they are doing.

When looking at a typical production day it should also be remembered that there might be limitations on the time that the work may begin and when the work must be completed.

The table below shows the major figure that was used as input values in trying to determine the number of vehicles for a specific set of circumstances. The values are all inserted into a spreadsheet from where a few guiding calculations are made, and then shown in table form to explain the projected occurrence of events.

Input Values	**(Values to be inserted are in bold)**				
Production Qty Required	**250**	T	Off loading cycle at paver	**0:14**	H: min
			Loading time at plant	**0:08**	H: min
Time on site	**9:00**		Time to travel to site	0:34	H: min
Time to be finished	**16:00**		Time to travel back to site	0:34	H: min
Max. Paver production rate	**80.0**	T / hr	Total roundtrip cycle time	1:30	H: min
Production day	7:00	Hours	(Plant - Site - Plant - Site)		
Production per hour	35.71	T per hour			
			Total roundtrip cycle time when there additional delay of:		
			+Standing time	16 Min	1:46
Distance to site:	**34**	Km	+Standing time	08 Min	1:38
Average traveling speed	**60**	Km / h			
Typical truck capacity	**17.5**	T			

Table 3.1 - Input Values for vehicle calculator

This table shows the information as entered into the spreadsheet. All the values in red are variable, and will differ from one project to another, as well as from one plant to another, and will be accurately determined with experience.

The results calculated are shown in the following table, as set out below and will briefly be explained:

	Results Calculated:	Number of Trucks: Value rounded up To next integer	Production Rate T/hr	Is the rate sufficient?
A1	Minimum number of trips required	15.0		
B1	No. Of trucks for roundtrip time (1 truck every 14.0 Min on site)	7.0	71.43	Yes
C1	No. Of trucks to finish in allowable time (rate of 35.71 T / hr)	4.0	35.71	Equal
D1	No Of trucks when 16 Min. additional standing time	4.0	33.33	No
E1	No Of trucks when 8 Min. addition standing time	5.0	45.45	Yes

Table 3.2 - Results for vehicle calculator

A1. The minimum number of trips required to the site is calculated as follows:

= Quantity of premix to deliver / Average size of transport vehicle

= 250 T / 17.5 T

= 14.2 trips

≈ 15.0 trips, you can't send a fraction of a vehicle, the last vehicle won't be loaded fully.

B1. The number of vehicles required for roundtrip time:

This assumes that there is no delay at the paver and as soon as that the vehicle is off-loaded it can leave the site, except for the minimum time it takes to maneuver the vehicle into position in front of the paver and to tip.

= Total roundtrip cycle time / Off-loading cycle at paver

= 1:20 / 0:14

= 90 Min. / 14 Min.

= 6.42 vehicles

≈ 7.0 vehicles, there will be some inefficient time, but you can't send half a vehicle.

C1. Calculation to finish in allowable time

Below follows an explanation of the method used to calculate the number of vehicles needed with the set of input values as given:

CALCULATION FOR NUMBER OF VEHICLES REQUIRED:			
Start time on site	9:00	Total roundtrip cycle	
Time to be finished	16:00	Time:	1:30 (h:min)
Production day	7:00 Hours	Typical Truck size	17.50 T
		Delivery rate of	17.50 T every 1:30
Asphalt to be delivered	250 T	Average per hour:	11.67 T / hr
Quantity to be delivered per hour	35.71 T / hr	As per Qty required =	35.71 11.67 = 3.06 = 4.00 Trucks
You will need four trucks to meet the required delivery rate with no delays.			

Table 3.3 - Vehicle calculator check

Shown below in **Example 1** is a table of the sequence of events to indicate the number of vehicles needed to full fill the required rate of production:

Example1

	Time Left Plant	Time On Site		Time Off Loaded	Time Back At Plant	Time Finished Loading at Plant		Time back At paver	Wait To Off - load	Cumulative Quantity Delivered
1	8:26	9:00		9:14	9:48	9:56	A	10:30	0:00	17.5
2	8:40	9:14		9:28	10:02	10:10	B	10:44	0:00	35.0
3	8:54	9:28		9:42	10:16	10:24	C	10:58	0:00	52.5
4	9:08	9:42		9:56	10:30	10:38	D	11:12	0:00	70.0
5	9:22	9:56		10:10	10:44	10:52	E	11:26	0:00	87.5
6	9:36	10:10		10:24	10:58	11:06	F	11:40	0:00	105.0
7	9:50	10:24		10:38	11:12	11:20	G	11:54	0:00	122.5
8	10:04	10:38	A	10:52	11:26	11:34	H	12:08	0:08	140.0
9	10:18	10:52	B	11:06	11:40	11:48		12:22	0:08	157.5
10	10:32	11:06	C	11:20	11:54	12:02		12:36	0:08	175.0
11	10:46	11:20	D	11:34	12:08	12:16		12:50	0:08	192.5
12	11:00	11:34	E	11:48	12:22	12:30		13:04	0:08	210.0
13	11:14	11:48	F	12:02	12:36	12:44		13:18	0:08	227.5
14	11:28	12:02	G	12:16	12:50	12:58		13:32	0:08	245.0
15	11:42	12:16	H	12:30	13:04	13:12		13:46	0:08	262.5

Table 3.4 - Program schedule for seven vehicles

As can be seen above, vehicle number one will be available on site after delivering it's first load again at **10:30**. If the rest of the vehicles are scheduled to arrive in 14-minute intervals on site, seven vehicles will be needed to prevent the paver standing idle. Vehicle no.1 will be available 8 minutes earlier than the time it is required on site, but it will be better than having an eight vehicle. As can be seen there will be **15** trips required to complete the work. As can be seen the final load will go past the 250 T required for the day, and will thus only be a partial load. This work will finish well in advance of the required off site time of 16h00. The production rate is 52,45 T / hr that exceeds the required minimum.

There will now be looked at the tabled results of what the sequence on site would be of there is 16 minutes additional standing or waiting time on site before a vehicle can leave the paver and return to the plant, as shown in **Example 2**.

Example 2

	Time Left Plant	Time On Site		Time Off Loaded (+16 min standing)	Time Back at Plant	Time Finished Loading at Plant		Time Back at paver	Wait to Off - load	Cumulative Quantity Delivered
1	8:26	9:00		9:30	10:04	10:12	A	10:46	0:00	17.5
2	8:56	9:30		10:00	10:34	10:42	B	11:16	0:00	35.0
3	9:26	10:00		10:30	11:04	11:12	C	11:46	0:00	52.5
4	9:56	10:30		11:00	11:34	11:42	D	12:16	0:00	70.0
5	10:26	11:00	A	11:30	12:04	12:12	E	12:46	0:14	87.5
6	10:56	11:30	B	12:00	12:34	12:42	F	13:16	0:14	105.0
7	11:26	12:00	C	12:30	13:04	13:12	G	13:46	0:14	122.5
8	11:56	12:30	D	13:00	13:34	13:42	H	14:16	0:14	140.0
9	12:26	13:00	E	13:30	14:04	14:12	I	14:46	0:14	157.5
10	12:56	13:30	F	14:00	14:34	14:42	J	15:16	0:14	175.0
11	13:26	14:00	G	14:30	15:04	15:12	K	15:46	0:14	192.5
12	13:56	14:30	H	15:00	15:34	15:42	L	16:16	0:14	210.0
13	14:26	15:00	I	15:30	16:04	16:12		16:46	0:14	227.5
14	14:56	15:30	J	16:00	16:34	16:42		17:16	0:14	245.0
15	15:26	16:00	K	16:30	17:04	17:12		17:46	0:14	262.5

Table 3.4 - Program schedule with standing time

As can be seen above, vehicle number one will be available on site after delivering the first load again at **10:46**. If the rest of the vehicles are scheduled to arrive in 30-minute intervals on site, four vehicles will be needed to prevent the paver standing idle. Vehicle no.1 will be available 14 minutes earlier than the time it is required on site, but it will be better than having seven vehicles. As can be seen there will be **15** trips required to complete the work. As can be seen the final load will go past the 250 T required for the day, and will thus only be a partial load of 5 ton. Even though thee last load is a partial load, this work will not finish before the on site time limit of 16h00.

The last vehicle will only arrive on site at 16h00 and will then not even have started off-loading, and won't finish before 16h30 if there are no other delays experienced. The production rate is 35,71 T / hr that is lowered than the required 35,71 T / hr and that is why the time limit will be exceeded.

It can be seen from this that the minimum duration that is spend on site has a huge influence on the number of vehicles needed. Not only should there be looked at the standing time on site, but also how that influences the length of the production day. Seven vehicles will be enough (Example 1) if there is now additional standing time, and the work will be finished before 16h00 with the least amount of standing time.

When there is a total of 30 minutes standing time on site, four vehicles will be enough to have the minimum amount of standing time, but not achieve efficient production to finish before 16h00. Even if there were more vehicles, the 30 minutes cycle time at the paver is too long to accommodate the production that is needed in the allowable time. The time on site should be less to accommodate this production cycle.

To illustrate this, there will be looked at the sequence of events if the paver cycle time is 22 minutes in total, made up of 14 minutes to off-load and 8 minutes standing time on site. The sequences of events are shown below in **Example 3**.

Example 3

	Time Left Plant	Time On Site	Time Off Loaded (+8 min standing)	Time Back At Plant	Time Finished Loading at Plant		Time Back At paver	Wait to Off - load	Cumulative Quantity Delivered
1	8:26	9:00	9:22	9:56	10:04	A	10:38	0:00	17.5
2	8:48	9:22	9:44	10:18	10:26	B	11:00	0:00	35.0
3	9:10	9:44	10:06	10:40	10:48	C	11:22	0:00	52.5
4	9:32	10:06	10:28	11:02	11:10	D	11:44	0:00	70.0
5	9:54	10:28	10:50	11:24	11:32	E	12:06	0:00	87.5
6	10:16	10:50	11:12	11:46	11:54		12:28	0:12	105.0
The actual projected production would be as follows:									
1	8:26	9:00	9:22	9:56	10:04	A	10:38	0:00	17.5
2	8:48	9:22	9:44	10:18	10:26	B	11:00	0:00	35.0
3	9:10	9:44	10:06	10:40	10:48	C	11:22	0:00	52.5
4	9:32	10:06	10:28	11:02	11:10	D	11:44	0:00	70.0
5	9:54	10:28	10:50	11:24	11:32	E	12:06	0:00	87.5
6	10:16	10:50 A	11:12	11:46	11:54	F	12:28	0:12	105.0
7	10:38	11:12 B	11:34	12:08	12:16	G	12:50	0:12	122.5
8	11:00	11:34 C	11:56	12:30	12:38	H	13:12	0:12	140.0
9	11:22	11:56 D	12:18	12:52	13:00	I	13:34	0:12	157.5
10	11:44	12:18 E	12:40	13:14	13:22	J	13:56	0:12	175.0
11	12:06	12:40 F	13:02	13:36	13:44		14:18	0:12	192.5
12	12:28	13:02 G	13:24	13:58	14:06		14:40	0:12	210.0
13	12:50	13:24 H	13:46	14:20	14:28		15:02	0:12	227.5
14	13:12	13:46 I	14:08	14:42	14:50		15:24	0:12	245.0
15	13:34	14:08 J	14:30	15:04	15:12		15:46	0:12	262.5

Table 3.5 - Program schedule with reduced standing time

From this example can be observed that five vehicles will be adequate to serve the paver with the minimum amount of standing time. There will be **twelve minutes** time spend waiting from load number 6, due to the vehicles arriving back at the paver before the previous load has been completed off-loading.

The load will finish before the 16h00 time restriction to be off site, and the last vehicle will leave the site at 14h30, which is well in time, giving the paving team some time to finish off and remove the road-closures.

In this production process, a reduction of 8 minutes in the paver cycle time from 30 minutes (**Example 2**) to 22 minutes (**Example 3**) have resulted that the time that the work would have been finished reduced from 16h30 to14h30.

It can therefore be appreciated that if every vehicle spends five minutes less on site, the amount of vehicles needed will be even less, and this rate at which the vehicles arrive and off-load on site is the single most important factor when aiming at achieving higher production rates.

The correct number of vehicles will be determined by the rate that the material is off-loaded on site and returned to the plant. For this set of values five vehicles will be the optimum as shown above.

CHAPTER 8

CONCLUSION AND FINDINGS

8.1 Introduction

This project started out with the aim to investigate methods of achieving better efficiency in the transporting of asphalt, and analyzing what the current situation is. This was done to the backdrop of the dramatic political changes taking place in Southern-Africa during the past decade, with the major impact being for all businesses that the competition isn't only restricted to local competitors, but the global market as well. The importance of giving a world-class product and service became essential to all members of industry.

The importance of this study evolves around the fact that not only is the asphalt industry affected by all these changes, but there is a negative and unfavorable situation where there seems to be an unhappiness about the level of service given to customers relating to the paving of roads.

After these facts were considered and the results analyzed there are a huge amount of insight that was gained relating to the subject. The following is the conclusions and recommendations drawn from this:

8.2 The results in relationship to the Hypotheses

8.2.1 The Findings for the First Sub Problem are as follows:

The factors that influence the timely delivery of asphalt to site were the following according to the first Hypotheses:

a. The distance traveled to site
b. The number of vehicles assigned to the project
c. The amount of standing time on site

These factors were all correct and the following could be added to the list that was discovered through the project:

d. The timely placing of orders
e. Informing the plant if there are any delays or if the work will be starting late
f. Any break-down of the plant, paving or transporting equipment

8.2.2 <u>The Hypothesis for the Second Sub Problem were as follows:</u>

A Standard sheet is used to indicate a summary of the relevant times on site and off site for vehicles, as well as the actual production for the day. When comparison is done between the days there will be specific trends relating to the type of work being carried out.
There will be a trend relating to the standing time on a daily basis, showing a decline as the day progresses and the process speed up.

These statements were all confirmed from the results attained throughout the project. The following could be added to the list that was discovered through the project:

- The trend for the traveling time the vehicles spend to arrive at site was fairly constant. The upward and downward trends could be explained due to the fact that as the work was progressing, the distance having to be traveled reduced as the area where work occurred moved closer to a specific on-ramp or off-ramp on the highway. The total variance was not much if the breakdown of vehicles is excluded.

Furthermore, the factors that influence the amount of standing time on site were the following according to the second Hypotheses:

- The amount of standing time spend on site will be determined by the timely arrival of the vehicles on site, as well as the rate at which paving takes place. If the work is slow, the vehicles will spend a longer time on site. The amount of vehicles will also determine the standing time, if there is too many vehicles assigned to a specific type of work, a queue will form and the vehicles will be standing waiting on site.

These hypotheses were all correct and the following could be added to the list that was discovered through the project:

- The tendency was for the standing time to reduce on average on a daily basis as the work progressed and the rate at which the asphalt was used increased. This is due to the fact that the paver has to be set up when the daily production starts, and as the day progresses the paving team becomes more familiar with the process and thus the production speeds up.

- If there was a change over from one section of work and the paver was moved to another section, there would be additional delays – like a second start-up and setting up process. This resulted in additional standing time for the vehicles on site. This was due to the fact that the vehicle would be arriving at more or less the same rate on site, but the production rat eon the paving side would have a temporary low, before picking up speed again.

8.2.3 <u>The hypothesis for the third sub problem are as follows:</u>

The model used to calculate the amount of vehicles required would act as a guide of what is required for a specific set of conditions. This will need to consider the distance or time traveled to site, the typical production rate for this specific type of work, as well as the size of the vehicles transporting the asphalt to site. The typical production rates for certain types of work would be deducted from the analysis of the data to determine what is typical for a specific type of work.

These statements were all confirmed in the formulation of the amount of vehicles needed. It must be added that this method can only be used as a guide and that there is also a fair amount of experience needed as well as proper communication between the plant and the site to ensure that the correct variables are used to calculate the amount of vehicles needed for a specific day's production.

8.3 Summary and closing comments

From the study it was found that there needs to be a better understanding on the manufacturing plant's side, as well as the paving team, as to the impact of what they are doing, and trying to understand the other teams perspective and needs. Proper information regarding the time that material is needed on site being provided in good time, as well as being accurately will make the planning and production from the plant a whole lot easier. If the plant knew more accurately the production demands for the next day, it would be in a better position to arrange the different projects as well additional transport if so required. This would entail the hiring of tipper vehicles for a few days at hourly rates to accommodate the surge in demand, or transferring the vehicles from the other plants in the region that are not so busy. If it only comes to light on the morning before a larger amount than normal is needed, there won't be sufficient time to make proper arrangements to have the vehicles in time.

Furthermore if the process of "sandbagging" or inflating orders to ensure that the paver gets sufficient mix is eliminated, it will also lead to a better service being rendered from the plant. If the plant isn't sure if the 150 T ordered is the real quantity, or inflated to ensure that the paver does get the required 120 T, they wont be able to plan properly on the allocation of the vehicles to a specific project. The more uncertainty there is, the less certain decisions and results will be, and the worse the service to the client.

Good practice would be to send a weekly program that is fairly accurate representation of the following weeks work, but to also confirm the afternoon before the asphalt is required on site what the order quantity is for the next day.

When it comes to breakdowns or plant stoppages, it is crucial that both parties communicate their problems to each other. This will ensure that there is no unnecessary wastage and that a good relationship is build between the parties.

On the subject of communication, it is also necessary that the site inform the plant of the type of work that they will be carrying out. As mentioned before, trial sections are slower than work on an ordinary day, and curved sections or work on intersections and bridges take a longer time to complete. If there is a delay or problem with access on the road, the plant should also be notified so that they know that they can send the other vehicles to site a bit later.

If we are looking at the actual dispatching from the vehicles at the plant, it is crucial to note that the plant should not try and send the first batch of vehicles at once. The common perception from various plant operators is that when it is out of my yard, it is not my problem. The fact is that there will be inefficient time spend on site as the other vehicles wait on site, and doing this extends the truck cycle.
Furthermore, if there is a problem at the paver and all the vehicles have left the yard, there will be more vehicles affected. The practice to load the mix out of the silo and dispatch all the trucks at once also results in colder mix being delivered to site, due to the fact that each truck waits longer on site since the time when the hot asphalt has been loaded out of the silo.

To summarize, the following are some practical points to implement to achieve better production when delivering asphalt from a fixed plant to a specific project:

- Plan ahead: get accurate information of the program and the delivery times and quantities.
- Communication: Appoint relevant parties on both sides who will be responsible for placing orders as well as receiving orders. Be honest and don't give false information regarding breakdowns or what quantities are required. Inform the paver when an order cannot be met due to other commitments, or problems at the plant.
- Keep it up to date: Agree on a daily basis what quantity was used on the previous day as well as the confirmation of the next day's order.
- Train the drivers: Ensure that they know exactly where they are to deliver on a specific day, if possible give them a map as well as a contact number for the foreman on site. They must understand that the faster they return to site the more beneficial to the plant as well as the customer.
- Maintenance: Keep the plant, the trucks and the paver as well as any auxiliary equipment in a good running order. There will be less conflict and more production when there are no stoppages of work due to breakdowns.

- Give accurate orders: An order should state the quantity, the specific address, the type of work being preformed, the required time on site, as well as the rate of delivery required and any other limitations or information on access to the site.
- Calculate the actual amount of vehicles needed to supply the client. Don't send the vehicles just because they are available – they could be used more effectively somewhere else.

If there is a good relationship that is being built on honesty and correct facts between the paving team as well as the plant that is supplying the premix, then great gains will be made in the process of paving asphalt roads.

There needs to be a better understanding on both parties side as to the difficulties and daily problems experienced on either side. The process should be seen as a system with a mutual goal, and not as two parties acting independently and only looking after their own interest.

Proper education and training on managing of this system, as well as a process of building relationships and forming trust can only achieve this.

There also needs to be a change of mindset regarding the control and use of vehicles, which is more scientific and calculated than the previous set ways used by managers. The importance of the quality of the people behind the process should never be forgotten. Communication and relationship between the role-players is what it comes down to.

CHAPTER 9

POSSIBILITIES FOR FUTURE RESEARCH

9.1 Future research

The opportunities for future research in this field are ample. There could be looked at the situation relating to customer service and delivery of asphalt in other regions of Southern-Africa.
Further more, the calculating and allocation of standing time rate for hauler sub-contractors is also a very time consuming process and an investigation can be done to establish ways of achieving a flat-rate standing time per project. This would entail a lot of negotiation with all role-players.

Alternative to this, there might be looked at a computerized data capture system, where each vehicle has an unique bar code that give the details of the vehicle, and each time a site is reached this is just scanned with a reader and all the relevant information would be captured. At the end of the week all of this could be logged onto a system that would automatically calculate the totals for each individual project.

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ADDENDUMS

Addendums1 a – z
Addendums1 aa – hh

Addendums2 a - b

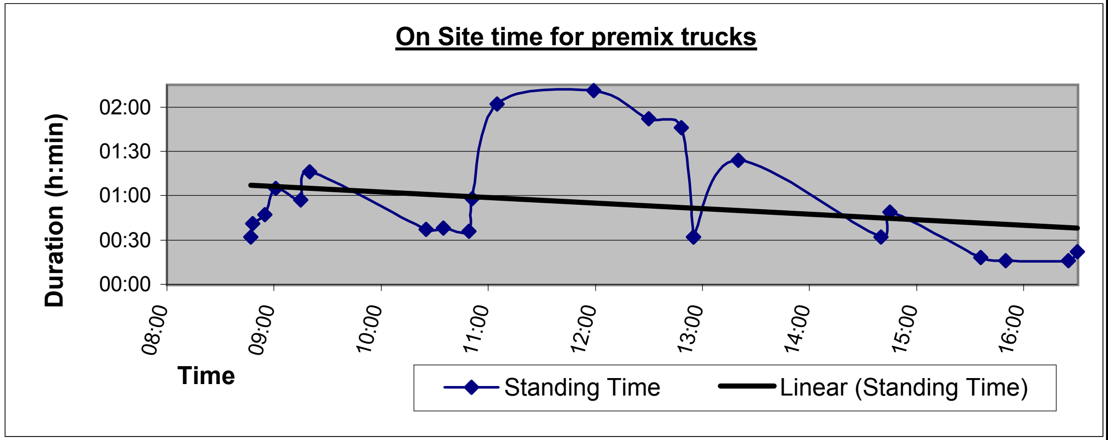
Date 21/03/2002 MED 5.0

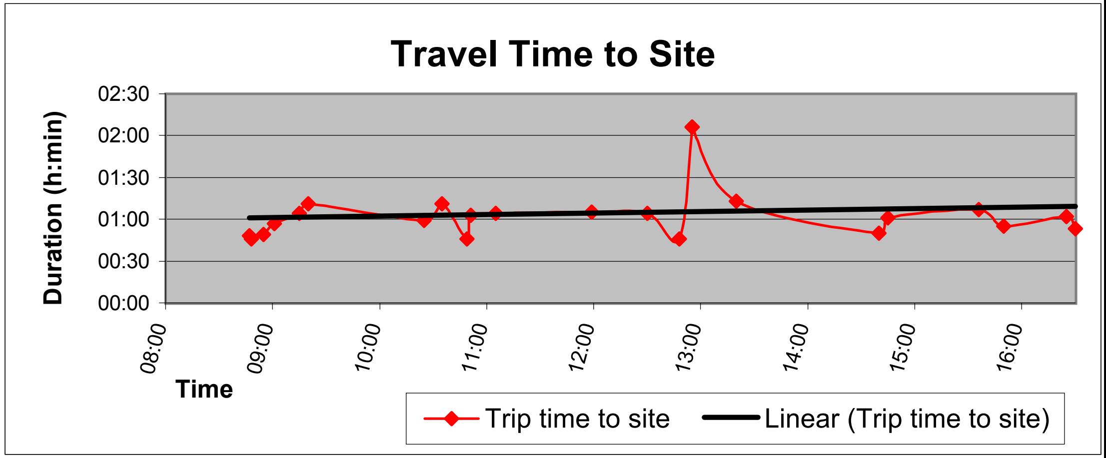
No.	Ticket No.	Time despatched	Time on site h:min	Time off site h:min	Travel Time h:min	On Site Time h:min
1	64175	07:59	08:47	09:19	00:48	00:32
2	64176	08:02	08:48	09:29	00:46	00:41
3	64178	08:06	08:55	09:42	00:49	00:47
4	64177	08:04	09:01	10:06	00:57	01:05
5	64180	08:11	09:15	10:12	01:04	00:57
6	64179	08:09	09:20	10:36	01:11	01:16
7	64186	09:26	10:25	11:02	00:59	00:37
8	64185	09:24	10:35	11:13	01:11	00:38
9	64190	10:03	10:49	11:25	00:46	00:36
10	64188	09:48	10:51	11:49	01:03	00:58
11	64189	10:01	11:05	13:07	01:04	02:02
12	64195	10:54	11:59	14:10	01:05	02:11
13	64200	11:26	12:30	14:22	01:04	01:52
14	64206	12:02	12:48	14:34	00:46	01:46
15	64191	10:49	12:55	13:27	02:06	00:32
16	64194	10:49	12:55	13:27	02:06	00:32
17	64208	12:07	13:20	14:44	01:13	01:24
18	64221	13:50	14:40	15:12	00:50	00:32
19	64220	13:44	14:45	15:34	01:01	00:49
20	64222	14:29	15:36	15:54	01:07	00:18
21	64226	14:55	15:50	16:06	00:55	00:16
22	64228	15:23	16:25	16:41	01:02	00:16
23	64229	15:37	16:30	16:52	00:53	00:22

Avg on site time:		00:54
Avg travel time:	01:04	
Avg total trip time		03:03

Note: Travel time is for one way trip

N3 Old Barn





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Production rate: 50.8 t/hr

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	1440	
	485	min
Production per hour	50.8	t / hr
Avg truck size	17	t
No trucks / hr	2.9886	
Say (Rounded)	3.000	no / hr
Total no of truck trips	23	no
Total time	08:05	h : min
1 truck evey	21.1	min

01:30	0.0625000
15:00	0.6250000
01:00	0.0416667
02:15	0.0937500
00:30	0.0208333

N3 Old Barn

Date 22/03/2002 MED 5.0

No.	Ticket No.	Time despatched	Time on site h:min	Time off site h:min	Travel Time h:min	On Site Time h:min
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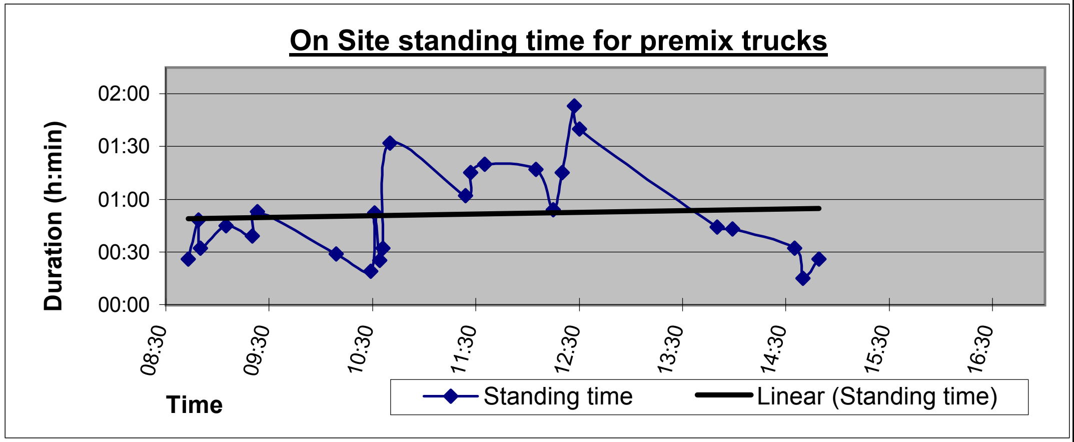
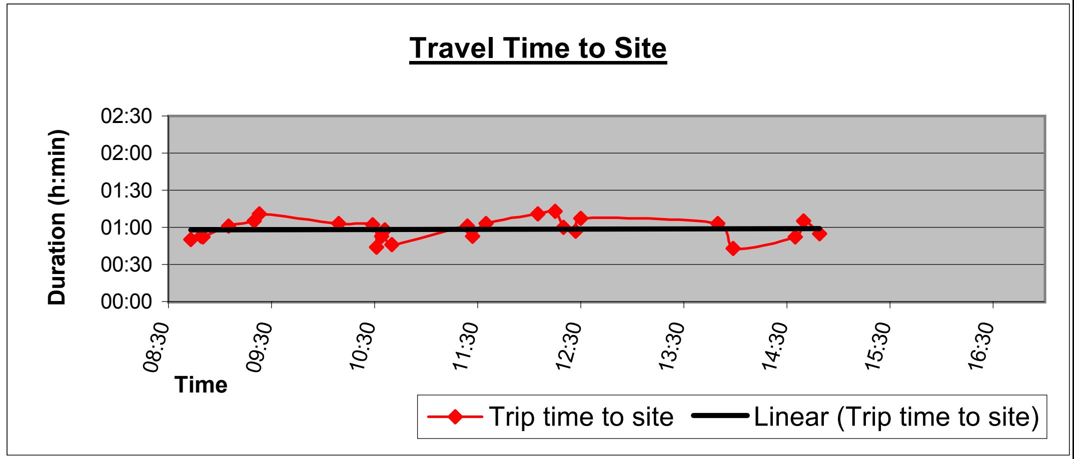
2	64235	07:56	08:49	09:37	00:53	00:48
3	64236	07:58	08:50	09:22	00:52	00:32
4	64237	08:04	09:05	09:50	01:01	00:45
5	64239	08:15	09:20	09:59	01:05	00:39
6	64238	08:12	09:23	10:16	01:11	00:53
7	64243	09:06	10:09	10:38	01:03	00:29
8	64246	09:27	10:29	10:48	01:02	00:19
9	64251	09:47	10:31	11:23	00:44	00:52
10	64249	09:41	10:34	10:59	00:53	00:25
11	64248	09:38	10:36	11:08	00:58	00:32
12	64254	09:54	10:40	12:12	00:46	01:32
13	64256	10:23	11:24	12:26	01:01	01:02
14	64261	10:34	11:27	12:42	00:53	01:15
15	64260	10:32	11:35	12:55	01:03	01:20
16	64263	10:54	12:05	13:22	01:11	01:17
17	64264	11:02	12:15	13:09	01:13	00:54
18	64265	11:20	12:20	13:35	01:00	01:15
19	64267	11:30	12:27	14:20	00:57	01:53
20	64266	11:23	12:30	14:10	01:07	01:40
21	64276	12:47	13:50	14:34	01:03	00:44
22	64278	13:16	13:59	14:42	00:43	00:43
23	64288	13:43	14:35	15:07	00:52	00:32
24	64282	13:35	14:40	14:55	01:05	00:15
25	64285	13:54	14:49	15:15	00:55	00:26

Avg on site time: 00:52
Avg travel time: 00:59
Avg total trip time 02:50

Note: Travel time is for one way trip





Production 428.82 t

Production rate: 65.6 t/hr

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Earliest	08:43		01:30	0.0625000		
			15:00	0.6250000		
Production duration :	06:32	h : min	01:00	0.0416667		
			02:15	0.0937500		
	0.27222222		00:30	0.0208333		
	1440					
	392	min				
Production per hour	65.6	t / hr				
Avg truck size	17	t				
No trucks / hr	3.8609					
Say (Rounded)	4.000	no / hr				
Total no of truck trips	25	no				
Total time	06:32	h : min				
1 truck evey	15.7	min				

N3 Old Barn

Date 23/03/2002 MED 5.0

No.	Ticket No.	Time despatched	Time on site h:min	Time off site h:min	Travel Time h:min	On Site Time h:min
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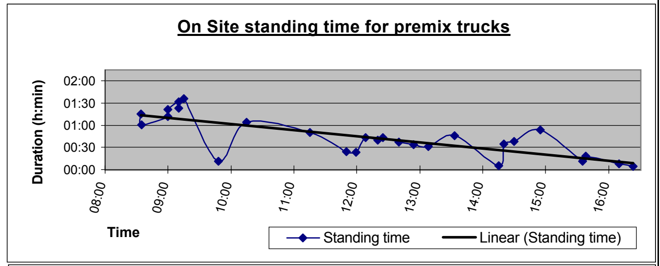
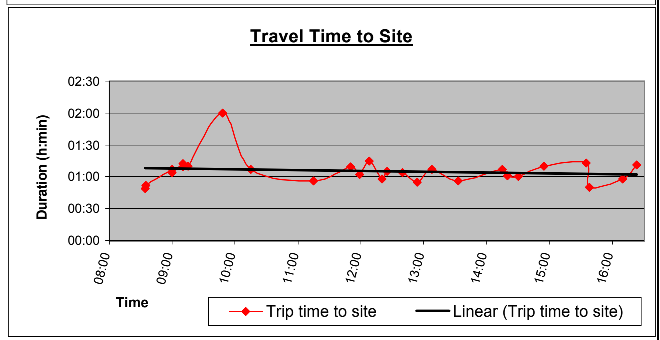
3	64296	07:53	09:00	10:12	01:07	01:12
4	64297	07:56	09:00	10:21	01:04	01:21
5	64298	07:58	09:10	10:42	01:12	01:32
6	64299	08:01	09:10	10:33	01:09	01:23
7	64300	08:05	09:15	10:51	01:10	01:36
8	64295	07:48	09:48	09:59	02:00	00:11
9	64306	09:08	10:15	11:19	01:07	01:04
10	64312	10:19	11:15	12:05	00:56	00:50
11	64313	10:41	11:50	12:14	01:09	00:24
12	64315	10:57	11:59	12:22	01:02	00:23
13	64314	10:53	12:08	12:51	01:15	00:43
14	64318	11:22	12:20	13:00	00:58	00:40
15	64317	11:20	12:25	13:08	01:05	00:43
16	64321	11:36	12:40	13:17	01:04	00:37
17	64323	11:59	12:54	13:28	00:55	00:34
18	64324	12:01	13:08	13:39	01:07	00:31
19	64326	12:37	13:33	14:19	00:56	00:46
20	64327	13:08	14:15	14:20	01:07	00:05
21	64330	13:19	14:20	14:55	01:01	00:35
22	64331	13:30	14:30	15:08	01:00	00:38
23	64333	13:45	14:55	15:49	01:10	00:54
24	64336	14:22	15:35	15:46	01:13	00:11
25	64337	14:48	15:38	15:56	00:50	00:18
26	64341	15:12	16:10	16:18	00:58	00:08
27	64332	15:12	16:23	16:27	01:11	00:04
			Avg on site time:			00:43
			Avg travel time:		01:05	
			Avg total trip time			02:54

Note: Travel time is for one way trip





Production 447.36 t

Production rate: 57.8 t/hr

Latest	16:18	
Earliest	08:34	
Production duration :	07:44	h : min
	0.32222222	
	1440	
	464	min
Production per hour	57.8	t / hr
Avg truck size	17	t
No trucks / hr	3.4028	
Say (Rounded)	3.000	no / hr
Total no of truck trips	27	no
Total time	07:44	h : min
1 truck evey	17.2	min

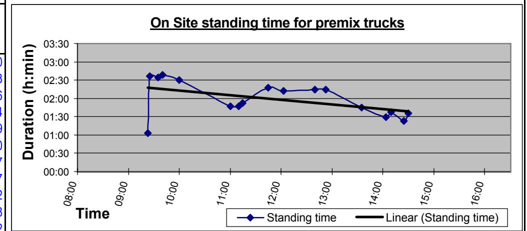
01:30	0.0625000	02:00	0.0833333
15:00	0.6250000	16:30	0.6875000
01:00	0.0416667		
02:15	0.0937500		
00:30	0.0208333		

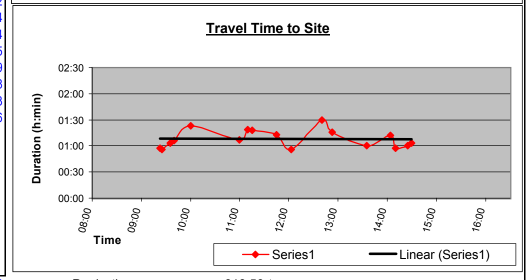
N3 Old Barn

Date 25/03/2002 MED 5.0

No.	Ticket No.	Time despatched	Time on site h:min	Time off site h:min	Travel Time h:min	On Site Time h:min
1					00:00	00:00
2	64354	08:26	09:23	10:26	00:57	01:03
3	64355	08:29	09:25	12:01	00:56	02:36
4	64356	08:32	09:35	12:09	01:03	02:34
5	64357	08:34	09:40	12:19	01:06	02:39
6	64358	08:37	10:00	12:30	01:23	02:30
7	64363	09:53	11:00	12:47	01:07	01:47
8	64362	09:51	11:10	12:57	01:19	01:47
9	64365	09:57	11:15	13:07	01:18	01:52
10	64369	10:32	11:45	14:03	01:13	02:18
11	64374	11:07	12:03	14:15	00:56	02:12
12	64375	11:10	12:40	14:54	01:30	02:14
13	64376	11:37	12:53	15:07	01:16	02:14
14	64387	12:35	13:35	15:20	01:00	01:45
15	64388	12:52	14:04	15:33	01:12	01:29
16	64390	13:13	14:10	15:48	00:57	01:38
17	64391	13:25	14:25	15:48	01:00	01:23
18	64392	13:27	14:30	16:06	01:03	01:36
19						
20						
21						
22						
23						
24						
25						
26						
27						
		Avg on site time:				01:52
		Avg travel time:			01:04	
		Avg total trip time				04:00

Note: Travel time is for one way trip





Production 318.56 t

Remark: Breakdown on site: Trucks waiting for sprayer to continue.

Production rate: 47.4 t/hr

Latest	16:06	
Earliest	09:23	
Production duration :	06:43	h : min
	0.27986111	
	1440	
	403	min
Production per hour	47.4	t / hr
Avg truck size	17	t
No trucks / hr	2.7899	
Say (Rounded)	3.000	no / hr
Total no of truck trips	27	no
Total time	06:43	h : min
1 truck evey	14.9	min

00:00	0.0000000
00:30	0.0208333
01:00	0.0416667
01:30	0.0625000
02:00	0.0833333
02:30	0.1041667
03:00	0.1250000
03:30	0.1458333
04:00	0.1666667
04:30	0.1875000
05:00	0.2083333
05:30	0.2291667
06:00	0.2500000
06:30	0.2708333
07:00	0.2916667
07:30	0.3125000
08:00	0.3333333
08:30	0.3541667
09:00	0.3750000
09:30	0.3958333
10:00	0.4166667
10:30	0.4375000
11:00	0.4583333
11:30	0.4791667
12:00	0.5000000
12:30	0.5208333
13:00	0.5416667
13:30	0.5625000
14:00	0.5833333
14:30	0.6041667
15:00	0.6250000
15:30	0.6458333
16:00	0.6666667
16:30	0.6875000
17:00	0.7083333

15:00	0.6250000
01:00	0.0416667
02:15	0.0937500
00:30	0.0208333

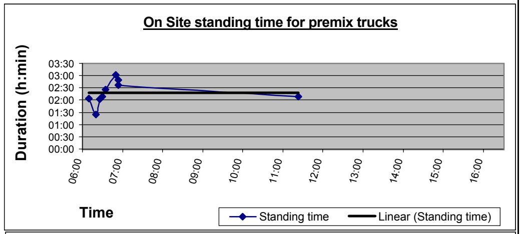
08:00	0.3333333
02:00	0.0833333
16:30	0.6875000
03:00	0.1250000
03:30	0.1458333

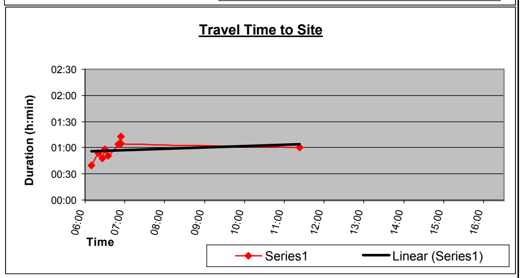
N3 Old Barn

Date 27/03/2002 MED 5.0

No.	Ticket No.	Time despatched	Time on site h:min	Time off site h:min	Travel Time h:min	On Site Time h:min
1	49	05:30	06:10	08:14	00:40	02:04
2	48	05:26	06:20	07:45	00:54	01:25
3	51	05:38	06:26	08:28	00:48	02:02
4	50	05:32	06:30	08:38	00:58	02:08
5	53	05:44	06:35	09:00	00:51	02:25
6	54	05:46	06:50	09:52	01:04	03:02
7	52	05:41	06:54	09:44	01:13	02:50
8	55	05:49	06:54	09:30	01:05	02:36
9	72	10:23	11:23	13:31	01:00	02:08
10						
11						
12						
13						
14						
15						
16						
17						
18						
19						
20						
21						
22						
23						
24						
25						
26						
27						
			Avg on site time:			02:17
			Avg travel time:		00:57	
			Avg total trip time			04:11

Note: Travel time is for one way trip





Production 148.4 t

Remark: Short day start earlier before Easter holiday.

Production rate: 20.2 t/hr

Latest	13:31	
Earliest	06:10	
Production duration :	07:21	h : min
	0.30625000	
	1440	
	441	min
Production per hour	20.2	t / hr
Avg truck size	17	t
No trucks / hr	1.1877	
Say (Rounded)	1.000	no / hr
Total no of truck trips	27	no
Total time	07:21	h : min
1 truck evey	16.3	min

00:00	0.0000000
00:30	0.0208333
01:00	0.0416667
01:30	0.0625000
02:00	0.0833333
02:30	0.1041667
03:00	0.1250000
03:30	0.1458333
04:00	0.1666667
04:30	0.1875000
05:00	0.2083333
05:30	0.2291667
06:00	0.2500000
06:30	0.2708333
07:00	0.2916667
07:30	0.3125000
08:00	0.3333333
08:30	0.3541667
09:00	0.3750000
09:30	0.3958333
10:00	0.4166667
10:30	0.4375000
11:00	0.4583333
11:30	0.4791667
12:00	0.5000000
12:30	0.5208333
13:00	0.5416667
13:30	0.5625000
14:00	0.5833333
14:30	0.6041667
15:00	0.6250000
15:30	0.6458333
16:00	0.6666667
16:30	0.6875000
17:00	0.7083333

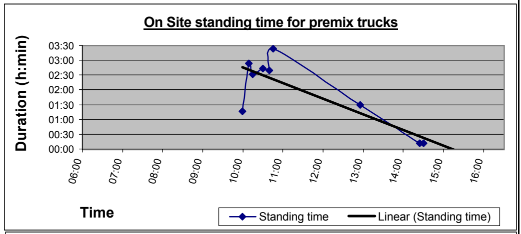
15:00	0.6250000
01:00	0.0416667
02:15	0.0937500
00:30	0.0208333

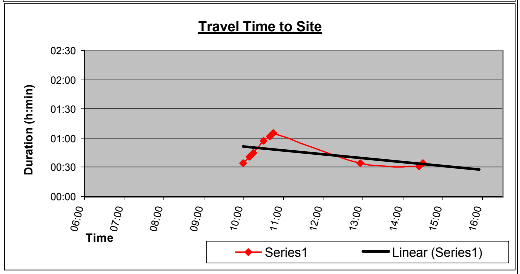
06:00	0.2500000
07:00	0.2916667
08:00	0.3333333
02:00	0.0833333
16:30	0.6875000
03:00	0.1250000
03:30	0.1458333

N3 Old Barn

Date 2/4/2002 MED 5.0

No.	Ticket No.	Time despatched	Time on site h:min	Time off site h:min	Travel Time h:min	On Site Time h:min
1	79	09:25	09:59	11:16	00:34	01:17
2	80	09:28	10:09	13:03	00:41	02:54
3	81	09:30	10:15	12:47	00:45	02:32
4	82	09:33	10:30	13:13	00:57	02:43
5	83	09:38	10:40	13:20	01:02	02:40
6	84	09:40	10:45	14:08	01:05	03:23
7	96	12:22	12:56	14:25	00:34	01:29
8	105	13:54	14:25	14:37	00:31	00:12
9	106	13:56	14:30	14:42	00:34	00:12
10	108	14:06	14:42	15:05	00:36	00:23
11	111	14:25	14:58	15:48	00:33	00:50
12	114	15:01	15:55	16:15	00:54	00:20
13						
14						
15						
16						
17						
18						
19						
20						
21						
22						
23						
24						
25						
26						
27						





Avg on site time: 01:34
Avg travel time: 00:43
Avg total trip time 03:02

Production 205.8 t

Remark: New foreman on site

Production rate: 32.8 t/hr

Note: Travel time is for one way trip

Latest	16:15	
Earliest	09:59	
Production duration :	06:16	h : min
	0.26111111	
	1440	
	376	min
Production per hour	32.8	t / hr
Avg truck size	17	t
No trucks / hr	1.9318	
Say (Rounded)	2.000	no / hr
Total no of truck trips	27	no
Total time	06:16	h : min
1 truck evey	13.9	min

00:00	0.0000000
00:30	0.0208333
01:00	0.0416667
01:30	0.0625000
02:00	0.0833333
02:30	0.1041667
03:00	0.1250000
03:30	0.1458333
04:00	0.1666667
04:30	0.1875000
05:00	0.2083333
05:30	0.2291667
06:00	0.2500000
06:30	0.2708333
07:00	0.2916667
07:30	0.3125000
08:00	0.3333333
08:30	0.3541667
09:00	0.3750000
09:30	0.3958333
10:00	0.4166667
10:30	0.4375000
11:00	0.4583333
11:30	0.4791667
12:00	0.5000000
12:30	0.5208333
13:00	0.5416667
13:30	0.5625000
14:00	0.5833333
14:30	0.6041667
15:00	0.6250000
15:30	0.6458333
16:00	0.6666667
16:30	0.6875000
17:00	0.7083333

15:00	0.6250000
01:00	0.0416667
02:15	0.0937500
00:30	0.0208333

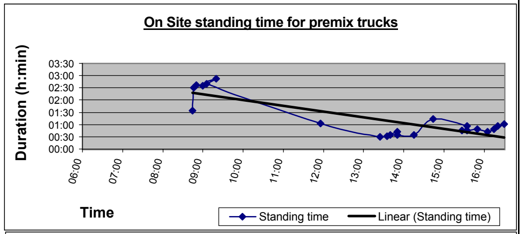
06:00	0.2500000
07:00	0.2916667
08:00	0.3333333
02:00	0.0833333
16:30	0.6875000
03:00	0.1250000
03:30	0.1458333

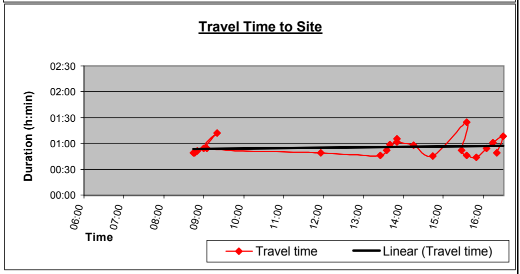
N3 Old Barn

Date 3/4/2002 MED 5.0

No.	Ticket No.	Time despatched	Time on site h:min	Time off site h:min	Travel Time h:min	On Site Time h:min
1	118	07:55	08:44	10:18	00:49	01:34
2	119	07:57	08:46	11:17	00:49	02:31
3	120	07:59	08:50	11:27	00:51	02:37
4	121	08:06	09:00	11:35	00:54	02:35
5	122	08:08	09:20	12:12	01:12	02:52
6	123	08:11	09:05	11:45	00:54	02:40
7	131	11:07	11:56	12:58	00:49	01:02
8	143	12:39	13:25	13:54	00:46	00:29
9	144	12:41	13:40	14:15	00:59	00:35
10	145	12:43	13:35	14:06	00:52	00:31
11	146	12:45	13:50	14:32	01:05	00:42
12	147	12:48	13:50	14:24	01:02	00:34
13	150	13:17	14:15	14:50	00:58	00:35
14	154	13:59	14:44	15:58	00:45	01:14
15	155	14:10	15:35	16:31	01:25	00:56
16	157	14:35	15:27	16:13	00:52	00:46
17	159	14:49	15:35	16:21	00:46	00:46
18	160	15:06	15:50	16:39	00:44	00:49
19	161	15:11	16:05	16:47	00:54	00:42
20	162	15:14	16:15	17:04	01:01	00:49
21	163	15:22	16:30	17:31	01:08	01:01
22	165	15:31	16:20	17:16	00:49	00:56
23						
24						
25						
26						
27						
		Avg on site time:				01:14
		Avg travel time:			00:55	
		Avg total trip time				03:05

Note: Travel time is for one way trip





Production 403.6 t

Remark: Mixe called in two portions, second after 13h00

Production rate: 46.0 t/hr

Latest	17:31	
Earliest	08:44	
Production duration :	08:47	h : min
	0.36597222	
	1440	
	527	min
Production per hour	46.0	t / hr
Avg truck size	17	t
No trucks / hr	2.703	
Say (Rounded)	3.000	no / hr
Total no of truck trips	27	no
Total time	08:47	h : min
1 truck evey	19.5	min

00:00	0.0000000
00:30	0.0208333
01:00	0.0416667
01:30	0.0625000
02:00	0.0833333
02:30	0.1041667
03:00	0.1250000
03:30	0.1458333
04:00	0.1666667
04:30	0.1875000
05:00	0.2083333
05:30	0.2291667
06:00	0.2500000
06:30	0.2708333
07:00	0.2916667
07:30	0.3125000
08:00	0.3333333
08:30	0.3541667
09:00	0.3750000
09:30	0.3958333
10:00	0.4166667
10:30	0.4375000
11:00	0.4583333
11:30	0.4791667
12:00	0.5000000
12:30	0.5208333
13:00	0.5416667
13:30	0.5625000
14:00	0.5833333
14:30	0.6041667
15:00	0.6250000
15:30	0.6458333
16:00	0.6666667
16:30	0.6875000
17:00	0.7083333

15:00	0.6250000
01:00	0.0416667
02:15	0.0937500
00:30	0.0208333

06:00	0.2500000
07:00	0.2916667
08:00	0.3333333
02:00	0.0833333
16:30	0.6875000
03:00	0.1250000
03:30	0.1458333

Med 5.0
Date 3/4/2002 BTB 4.1

N3 Old Barn

No.	Ticket No.	Time despatched	Time on site h:min	Time off site h:min	Travel Time h:min	On Site Time h:min
1	175	10:42	11:35	14:24	00:53	02:49
2	176	10:45	11:38	15:54	00:53	04:16
3	177	10:59	11:43	16:12	00:44	04:29
4	178	11:02	11:45	16:26	00:43	04:41
5						
6						
7						
8						
9						
10						
11						
12						
13						
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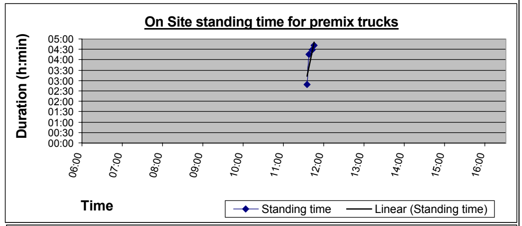
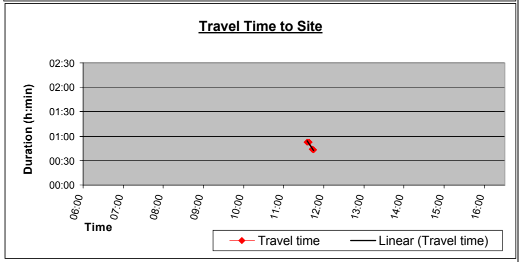
25						
26						
27						





Avg on site time: 04:03
Avg travel time: 00:48
Avg total trip time 05:40
Note: Travel time is for one way trip

Production 75.76 t BTB
30.42 t Med
Remark: Trial section for BTB 4.1 - waitng for tack to cure.
Production rate: 21.9 t/hr

Latest	16:26	
Earliest	11:35	
Production duration :	04:51	h : min
	0.20208333	
	1440	
	291	min
Production per hour	21.9	t / hr
Avg truck size	17	t
No trucks / hr	1.2878	
Say (Rounded)	1.000	no / hr
Total no of truck trips	27	no
Total time	04:51	h : min
1 truck evey	10.8	min

00:00	0.0000000
00:30	0.0208333
01:00	0.0416667
01:30	0.0625000
02:00	0.0833333
02:30	0.1041667
03:00	0.1250000
03:30	0.1458333
04:00	0.1666667
04:30	0.1875000
05:00	0.2083333
05:30	0.2291667
06:00	0.2500000
06:30	0.2708333
07:00	0.2916667
07:30	0.3125000
08:00	0.3333333
08:30	0.3541667
09:00	0.3750000
09:30	0.3958333
10:00	0.4166667
10:30	0.4375000
11:00	0.4583333
11:30	0.4791667
12:00	0.5000000
12:30	0.5208333
13:00	0.5416667
13:30	0.5625000
14:00	0.5833333
14:30	0.6041667
15:00	0.6250000
15:30	0.6458333
16:00	0.6666667
16:30	0.6875000
17:00	0.7083333

15:00	0.6250000
01:00	0.0416667
02:15	0.0937500
00:30	0.0208333

06:00	0.2500000
07:00	0.2916667
08:00	0.3333333
02:00	0.0833333
16:30	0.6875000
03:00	0.1250000
03:30	0.1458333

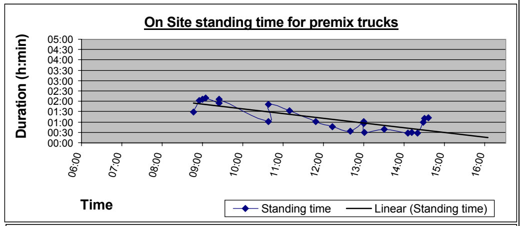
Med 5.0

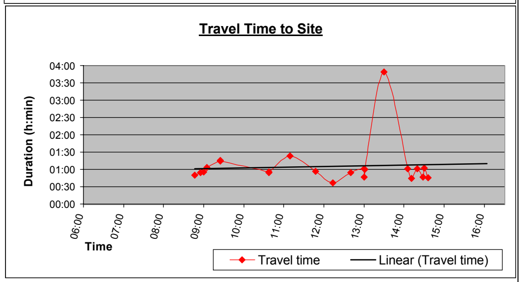
Date 5/4/2002

No.	Ticket No.	Time despatched	Time on site h:min	Time off site h:min	Travel Time h:min	On Site Time h:min
1	202	07:57	08:47	10:16	00:50	01:29
2	203	08:00	08:55	10:57	00:55	02:02
3	205	08:04	09:00	11:06	00:56	02:06
4	204	08:02	09:05	11:15	01:03	02:10
5	206	08:09	09:25	11:20	01:16	01:55
6	207	08:11	09:25	11:30	01:14	02:05
7	218	09:42	10:38	11:39	00:56	01:01
8	219	09:44	10:38	12:29	00:54	01:51
9	220	09:46	11:09	12:41	01:23	01:32
10	228	10:51	11:48	12:50	00:57	01:02
11	233	11:36	12:13	12:59	00:37	00:46
12	234	11:46	12:40	13:13	00:54	00:33
13	235	11:59	13:00	14:02	01:01	01:02
14	240	12:13	13:00	13:55	00:47	00:55
15	237	12:01	13:01	13:31	01:00	00:30
16	*217*	*09:41*	*13:30*	*14:09*	03:49	00:39
17	241	13:04	14:05	14:33	01:01	00:28
18	245	13:26	14:11	14:41	00:45	00:30
19	243	13:19	14:20	14:48	01:01	00:28
20	247	13:41	14:28	15:27	00:47	00:59
21	246	13:28	14:30	15:41	01:02	01:11
22	249	13:50	14:36	15:49	00:46	01:13
23	250	13:54	15:10	15:56	01:16	00:46
24	251	14:16	15:25	16:03	01:09	00:38
25	257	15:21	15:55	17:05	00:34	01:10
26	254	14:52	15:56	16:10	01:04	00:14
27	253	14:50	16:00	16:21	01:10	00:21
28	256	15:18	16:04	17:01	00:46	00:57
			Avg on site time:			01:05
			Avg travel time:		01:04	
			Avg total trip time			03:13

Note: Travel time is for one way trip

N3 Old Barn





Production	0 t BTB	480.38 t MED
Mat returned:	0 t BTB	0 t MED
Remark:		
Production rate:	57.9 t/hr	

Latest	17:05	
Earliest	08:47	
Production duration :	08:18	h : min
	0.34583333	
	1440	
	498	min
Production per hour	57.9	t / hr
Avg truck size	17	t
No trucks / hr	3.4045	
Say (Rounded)	3.000	no / hr
Total no of truck trips	28	no
Total time	08:18	h : min
1 truck evey	17.8	min

00:00	0.0000000
00:30	0.0208333
01:00	0.0416667
01:30	0.0625000
02:00	0.0833333
02:30	0.1041667
03:00	0.1250000
03:30	0.1458333
04:00	0.1666667
04:30	0.1875000
05:00	0.2083333
05:30	0.2291667
06:00	0.2500000
06:30	0.2708333
07:00	0.2916667
07:30	0.3125000
08:00	0.3333333
08:30	0.3541667
09:00	0.3750000
09:30	0.3958333
10:00	0.4166667
10:30	0.4375000
11:00	0.4583333
11:30	0.4791667
12:00	0.5000000
12:30	0.5208333
13:00	0.5416667
13:30	0.5625000
14:00	0.5833333
14:30	0.6041667
15:00	0.6250000
15:30	0.6458333
16:00	0.6666667
16:30	0.6875000
17:00	0.7083333

15:00	0.6250000
01:00	0.0416667
02:15	0.0937500
00:30	0.0208333

06:00	0.2500000
07:00	0.2916667
08:00	0.3333333
02:00	0.0833333
16:30	0.6875000
03:00	0.1250000
03:30	0.1458333

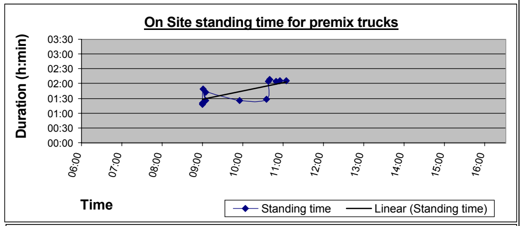
Med 5.0

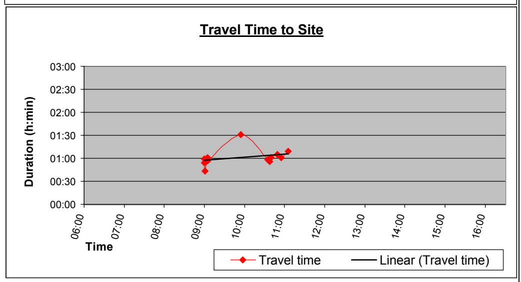
Date 8/4/2002

No.	Ticket No.	Time despatched	Time on site h:min	Time off site h:min	Travel Time h:min	On Site Time h:min
1	269	08:01	09:00	10:21	00:59	01:21
2	271	08:06	09:00	10:18	00:54	01:18
3	273	08:18	09:01	10:50	00:43	01:49
4	270	08:04	09:05	10:30	01:01	01:25
5	272	08:08	09:05	10:47	00:57	01:42
6	274	08:24	09:55	11:21	01:31	01:26
7	279	09:37	10:35	12:03	00:58	01:28
8	281	09:42	10:38	12:42	00:56	02:04
9	280	09:39	10:40	12:48	01:01	02:08
10	282	09:44	10:49	12:54	01:05	02:05
11	283	09:54	10:55	13:01	01:01	02:06
12	284	09:56	11:05	13:11	01:09	02:06
13					00:00	00:00
14					00:00	00:00
15					00:00	00:00
16					00:00	00:00
17					00:00	00:00
18					00:00	00:00
19					00:00	00:00
20					00:00	00:00
21					00:00	00:00
22					00:00	00:00
23					00:00	00:00
24					00:00	00:00
25					00:00	00:00
26					00:00	00:00
27					00:00	00:00
28					00:00	00:00
			Avg on site time:			01:44
			Avg travel time:		01:01	
			Avg total trip time			03:47

Note: Travel time is for one way trip

N3 Old Barn





Production 0 t BTB 202.02 t MED

Mat returned: t BTB 6.87 t MED

Remark: Plant breakdown, production stopped. Loading from silo's

Production rate: 49.9 t/hr

Latest	13:11	
Earliest	09:00	
Production duration :	04:11	h : min
	0.17430556	
	1440	
	251	min
Production per hour	49.9	t / hr
Avg truck size	17	t
No trucks / hr	2.9373	
Say (Rounded)	3.000	no / hr
Total no of truck trips	28	no
Total time	04:11	h : min
1 truck evey	9.0	min

00:00	0.0000000
00:30	0.0208333
01:00	0.0416667
01:30	0.0625000
02:00	0.0833333
02:30	0.1041667
03:00	0.1250000
03:30	0.1458333
04:00	0.1666667
04:30	0.1875000
05:00	0.2083333
05:30	0.2291667
06:00	0.2500000
06:30	0.2708333
07:00	0.2916667
07:30	0.3125000
08:00	0.3333333
08:30	0.3541667
09:00	0.3750000
09:30	0.3958333
10:00	0.4166667
10:30	0.4375000
11:00	0.4583333
11:30	0.4791667
12:00	0.5000000
12:30	0.5208333
13:00	0.5416667
13:30	0.5625000
14:00	0.5833333
14:30	0.6041667
15:00	0.6250000
15:30	0.6458333
16:00	0.6666667
16:30	0.6875000
17:00	0.7083333

15:00	0.6250000
01:00	0.0416667
02:15	0.0937500
00:30	0.0208333

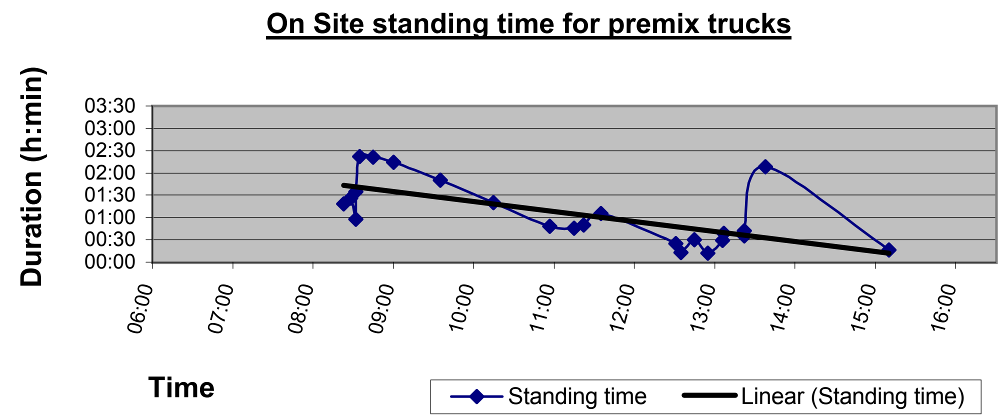
06:00	0.2500000
07:00	0.2916667
08:00	0.3333333
02:00	0.0833333
16:30	0.6875000
03:00	0.1250000
03:30	0.1458333

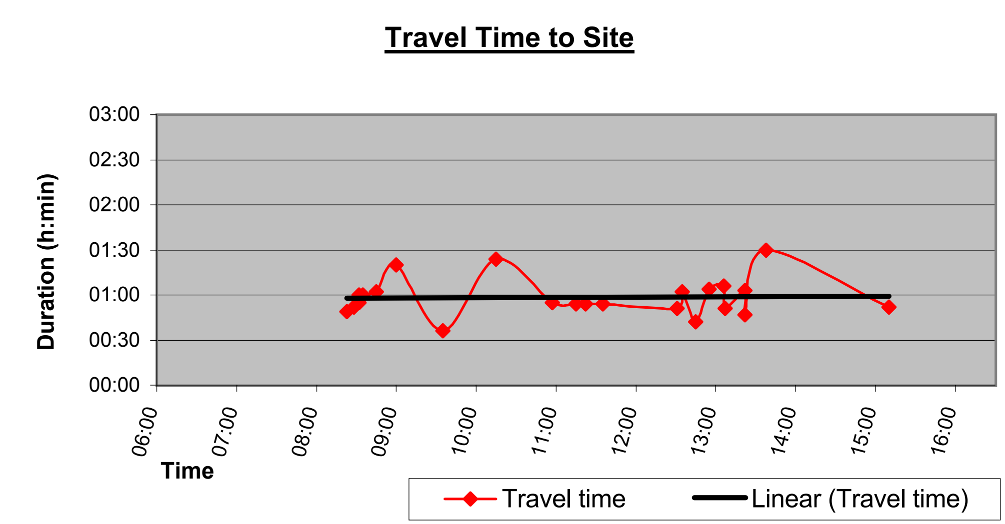
Date	10/4/2002	Med 5.0				
No.	Ticket No.	Time despatched	Time on site h:min	Time off site h:min	Travel Time h:min	On Site Time h:min
1	301	07:34	08:23	09:41	00:49	01:18
2	303	07:36	08:28	09:54	00:52	01:26
3	300	07:32	08:32	09:30	01:00	00:58
4	304	07:37	08:32	10:07	00:55	01:35
5	302	07:35	08:35	10:57	01:00	02:22
6	306	07:43	08:45	11:06	01:02	02:21
7	305	07:40	09:00	11:14	01:20	02:14
8	319	08:59	09:35	11:25	00:36	01:50
9	316	08:51	10:15	11:35	01:24	01:20
10	328	10:02	10:57	11:45	00:55	00:48
11	330	10:21	11:15	12:01	00:54	00:46
12	332	10:28	11:22	12:12	00:54	00:50
13	334	10:41	11:35	12:40	00:54	01:05
14	342	11:40	12:31	12:56	00:51	00:25
15	339	11:33	12:35	12:48	01:02	00:13
16	348	12:03	12:45	13:15	00:42	00:30
17	345	11:51	12:55	13:07	01:04	00:12
18	347	12:00	13:06	13:35	01:06	00:29
19	350	12:16	13:07	13:46	00:51	00:39
20	351	12:19	13:22	13:57	01:03	00:35
21	353	12:35	13:22	14:04	00:47	00:42
22	349	12:08	13:38	15:46	01:30	02:08
23	354	14:18	15:10	15:26	00:52	00:16

Avg on site time: 01:05
Avg travel time: 00:58
Avg total trip time 03:02

Note: Travel time is for one way trip

N3 Old Barn





Production	0 t BTB	396.8 t MED
Mat returned:	t BTB	1.71 t MED
Remark:		
Production rate:	54.0 t/hr	

Med 5.0

Date 11/4/2002

No.	Ticket No.	Time despatched	Time on site h:min	Time off site h:min	Travel Time h:min	On Site Time h:min
1	387	09:02	09:40	10:26	00:38	00:46
2	386	08:59	09:42	10:41	00:43	00:59
3	385	08:57	09:43	12:16	00:46	02:33
4	389	09:08	10:00	12:24	00:52	02:24
5	392	09:14	10:12	12:52	00:58	02:40
6	391	09:12	10:19	12:59	01:07	02:40
7	393	09:17	10:35	13:05	01:18	02:30
8	388	09:06	12:04	12:35	02:58	00:31
9						
10						
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12						
13						
14						
15						
16						
17						
18						
19						
20						
21						
22						
23						

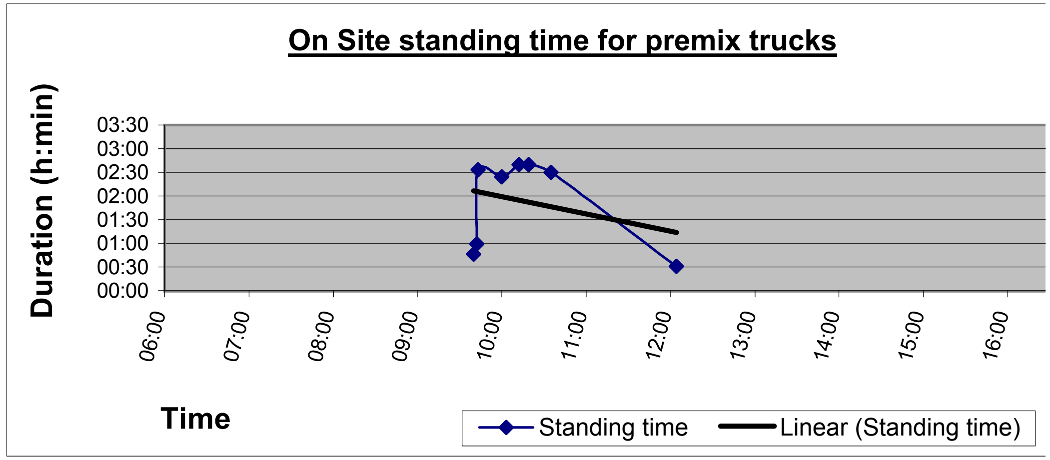
Avg on site time: 01:52

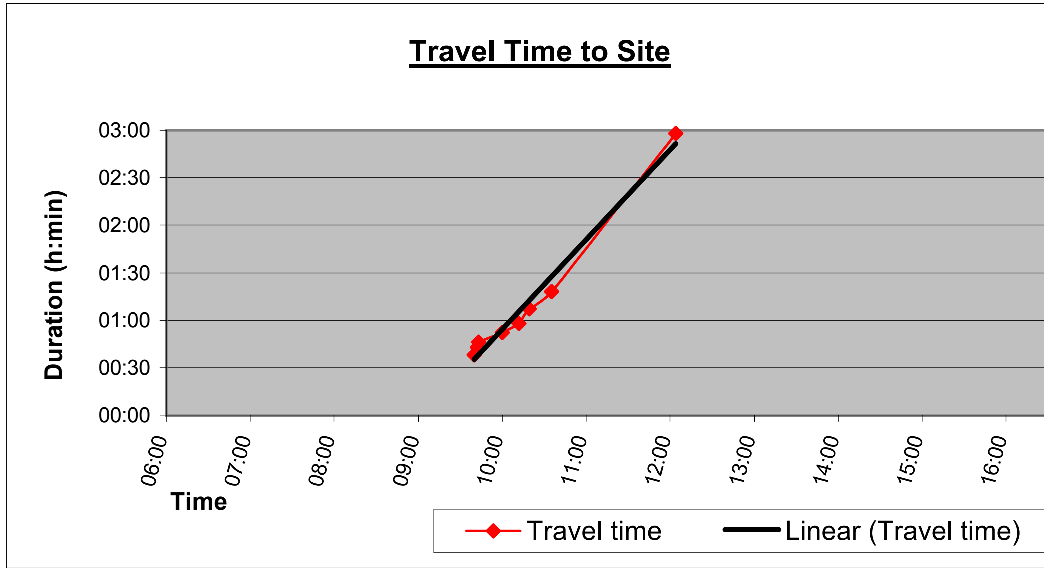
Avg travel time: 01:10

Avg total trip time 04:12

Note: Travel time is for one way trip

N3 Old Barn





Production 0 t BTB 150.4 t MED

Mat returned: 0 t BTB 13.96 t MED

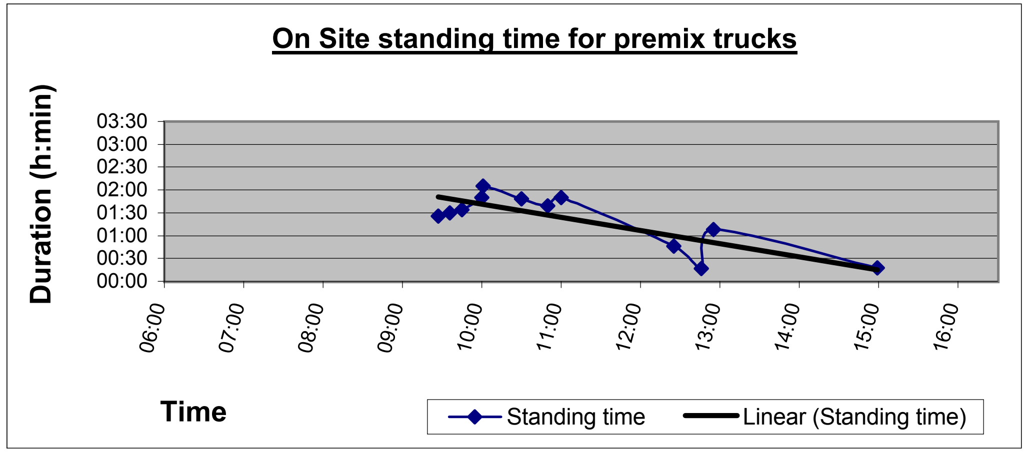
Remark: Paving Northbound lane.

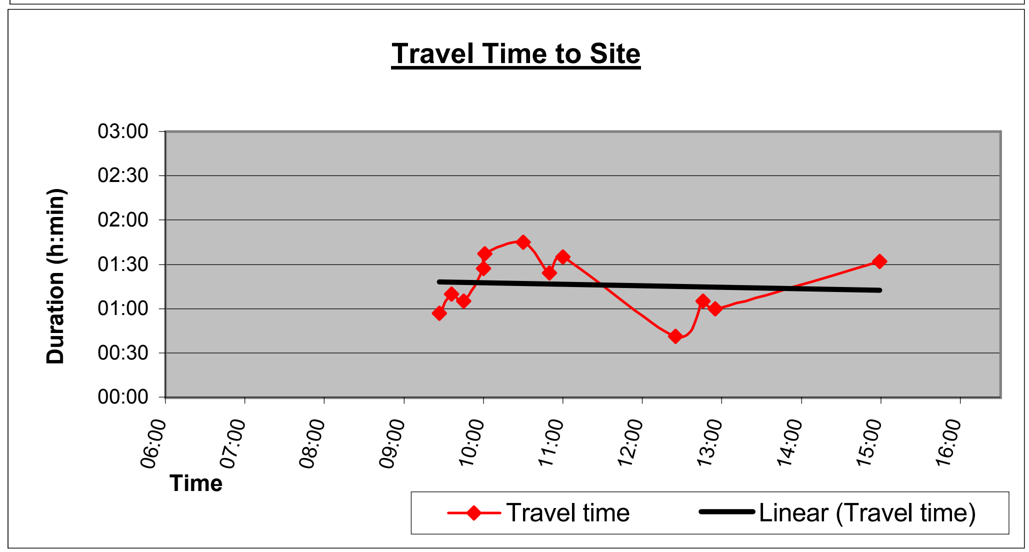
Production rate: 48.1 t/hr

		Med 5.0				
Date		12/4/2002				
No.	Ticket No.	Time despatched	Time on site h:min	Time off site h:min	Travel Time h:min	On Site Time h:min
1	428	08:30	09:27	10:53	00:57	01:26
2	426	08:26	09:36	11:06	01:10	01:30
3	431	08:40	09:45	11:19	01:05	01:34
4	429	08:33	10:00	11:50	01:27	01:50
5	425	08:24	10:01	12:06	01:37	02:05
6	433	08:45	10:30	12:18	01:45	01:48
7	435	09:26	10:50	12:29	01:24	01:39
8	434	09:25	11:00	12:50	01:35	01:50
9	439	11:44	12:25	13:11	00:41	00:46
10	438	11:41	12:46	13:03	01:05	00:17
11	441	11:55	12:55	14:03	01:00	01:08
12	442	13:27	14:59	15:17	01:32	00:18
13						
14						
15						
16						
17						
18						
19						
20						
21						
22						
23						
		Avg on site time:				01:20
		Avg travel time:			01:16	
		Avg total trip time				03:53

Note: Travel time is for one way trip

N3 Old Barn





Production	0 t BTB	0 t MED
Mat returned:	0 t BTB	177.0 t MED

Remark: Breakdown at plant. Last truck supplied from Eikenhof. Longer distance

Production rate: 30.3 t/hr

Med 5.0

Date 12/4/2002

No.	Ticket No.	Time despatched	Time on site h:min	Time off site h:min	Travel Time h:min	On Site Time h:min
1	428	08:30	09:27	10:53	00:57	01:26
2	426	08:26	09:36	11:06	01:10	01:30
3	431	08:40	09:45	11:19	01:05	01:34
4	429	08:33	10:00	11:50	01:27	01:50
5	425	08:24	10:01	12:06	01:37	02:05
6	433	08:45	10:30	12:18	01:45	01:48
7	435	09:26	10:50	12:29	01:24	01:39
8	434	09:25	11:00	12:50	01:35	01:50
9	439	11:44	12:25	13:11	00:41	00:46
10	438	11:41	12:46	13:03	01:05	00:17
11	441	11:55	12:55	14:03	01:00	01:08
12	442	13:27	14:59	15:17	01:32	00:18
13						
14						
15						
16						
17						
18						
19						
20						
21						
22						
23						

Avg on site time: 01:20

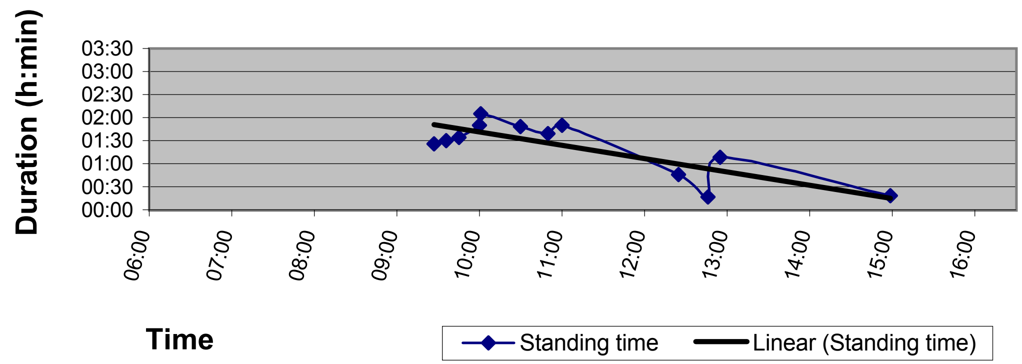
Avg travel time: 01:16

Avg total trip time 03:53

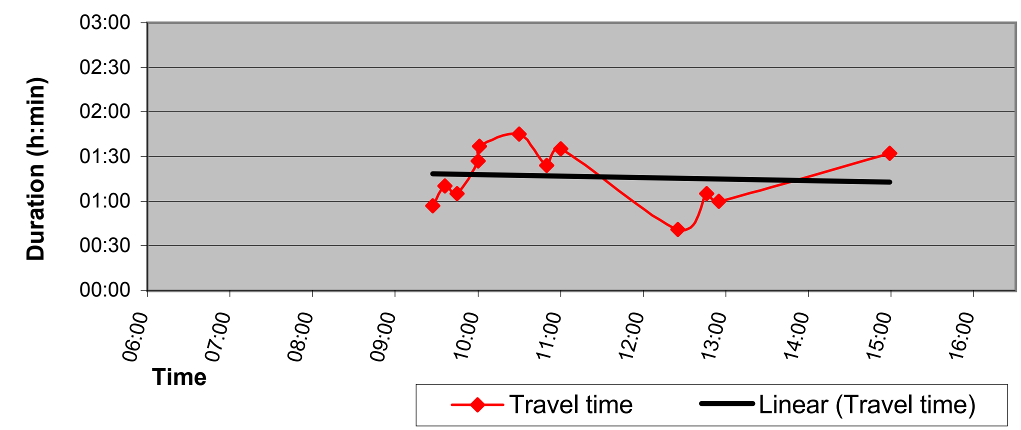
Note: Travel time is for one way trip

N3 Old Barn

On Site standing time for premix trucks



Travel Time to Site



Production	0 t BTB	0 t MED
Mat returned:	0 t BTB	177.0 t MED

Remark: Breakdown at plant. Last truck supplied from Eikenhof. Longer distance

Production rate: 30.3 t/hr

N3 Old Barn

Med 5.0

Date 12/4/2002

No.	Ticket No.	Time despatched	Time on site h:min	Time off site h:min	Travel Time h:min	On Site Time h:min
1	428	08:30	09:27	10:53	00:57	01:26
2	426	08:26	09:36	11:06	01:10	01:30
3	431	08:40	09:45	11:19	01:05	01:34
4	429	08:33	10:00	11:50	01:27	01:50
5	425	08:24	10:01	12:06	01:37	02:05
6	433	08:45	10:30	12:18	01:45	01:48
7	435	09:26	10:50	12:29	01:24	01:39
8	434	09:25	11:00	12:50	01:35	01:50
9	439	11:44	12:25	13:11	00:41	00:46
10	438	11:41	12:46	13:03	01:05	00:17
11	441	11:55	12:55	14:03	01:00	01:08
12	442	13:27	14:59	15:17	01:32	00:18
13						
14						
15						
16						
17						
18						
19						
20						
21						
22						
23						

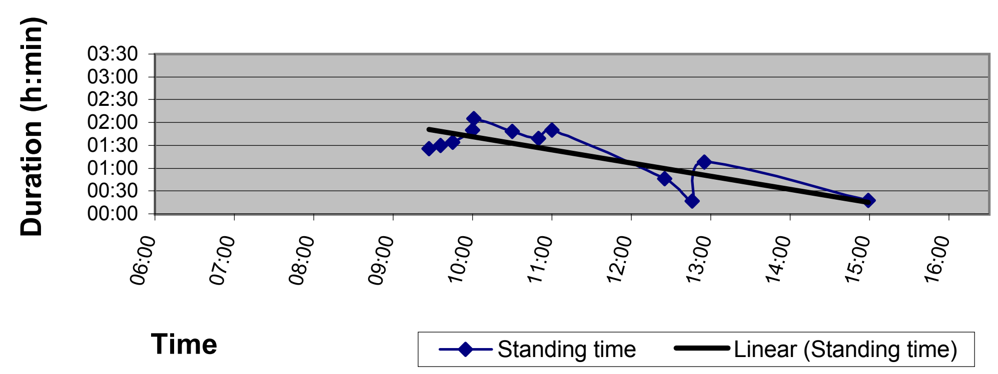
Avg on site time: 01:20

Avg travel time: 01:16

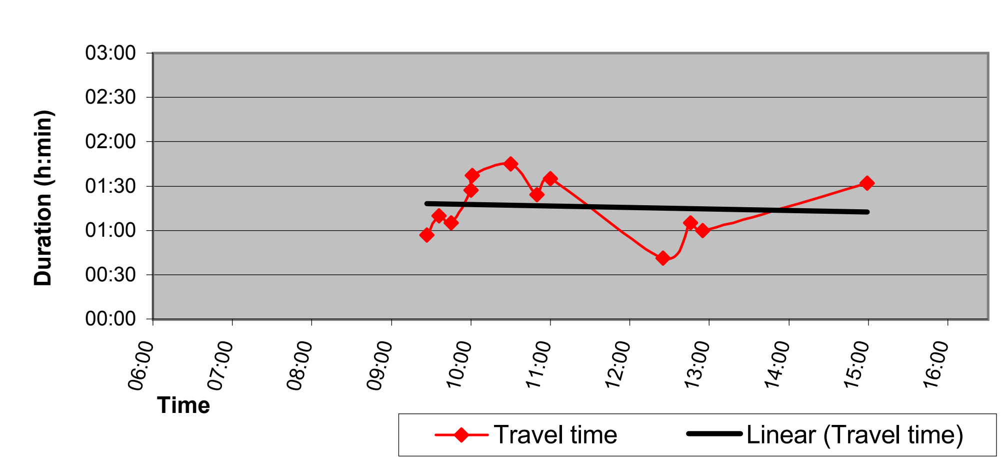
Avg total trip time 03:53

Note: Travel time is for one way trip

On Site standing time for premix trucks



Travel Time to Site



Production 0 t BTB 0 t MED

Mat returned: 0 t BTB 177.0 t MED

Remark: Breakdown at plant. Last truck supplied from Eikenhof. Longer distance

Production rate: 30.3 t/hr

Med 5.0

Date 15/4/2002

No.	Ticket No.	Time despatched	Time on site h:min	Time off site h:min	Travel Time h:min	On Site Time h:min
1	455	07:51	08:32	10:57	00:41	02:25
2	454	07:49	08:37	11:14	00:48	02:37
3	456	07:53	08:45	11:33	00:52	02:48
4	457	07:55	08:51	11:43	00:56	02:52
5	458	08:13	09:05	11:56	00:52	02:51
6	460	08:19	09:15	12:12	00:56	02:57
7	462	08:31	09:32	13:25	01:01	03:53
8	459	08:15	09:45	13:25	01:30	03:40
9	469	10:01	10:57	13:30	00:56	02:33
10						
11						
12						
13						
14						
15						
16						
17						
18						
19						
20						
21						
22						
23						

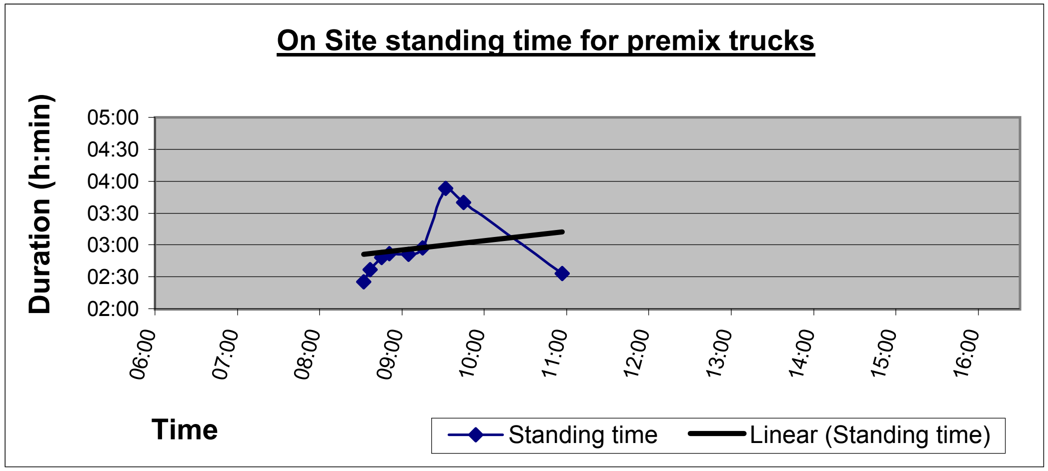
Avg on site time: 02:57

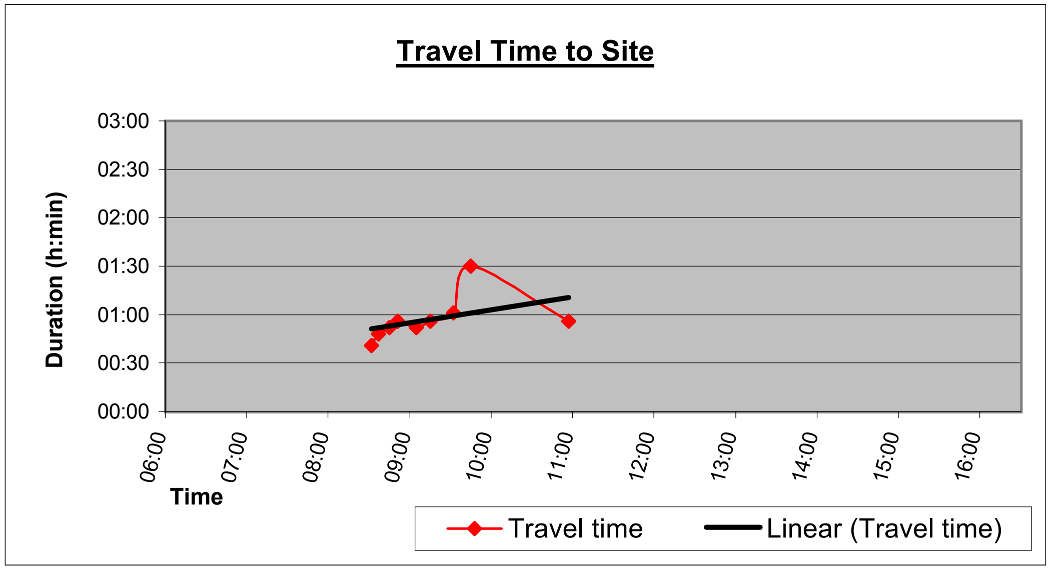
Avg travel time: 00:56

Avg total trip time 04:51

Note: Travel time is for one way trip

N3 Old Barn





Production 0 t BTB 167.7 t MED

Mat returned: 39.6 t BTB 0.0 t MED

Remark: Breakdown on site: milling machine. Trucks waiting on site.

Production rate: 41.7 t/hr

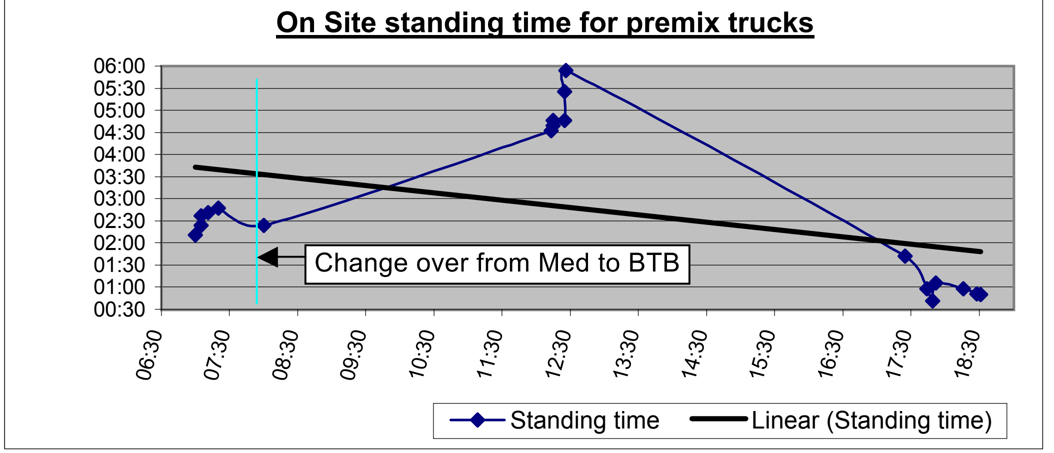
	Med 5.0					
Date	16/4/2002		BTB			

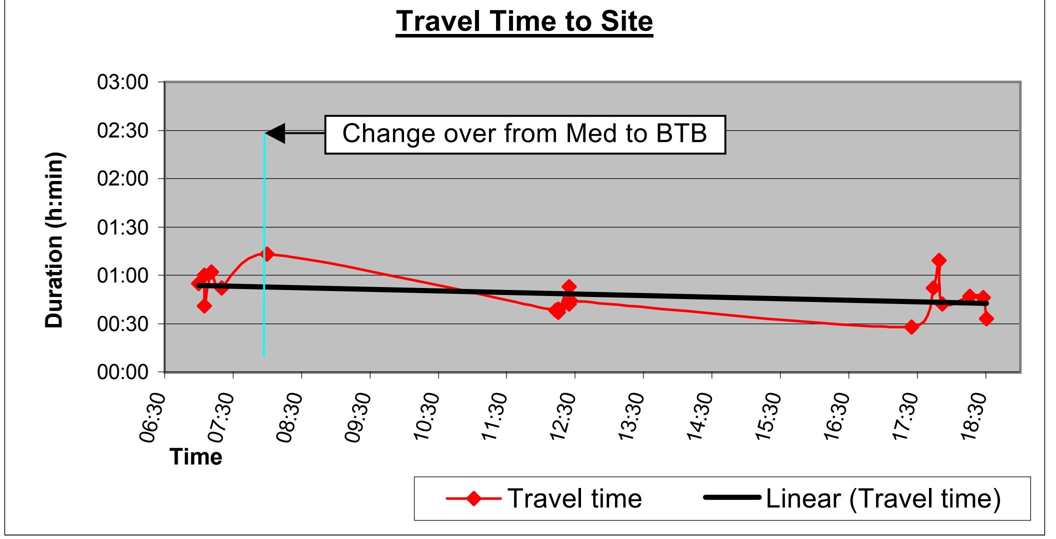
	Ticket No.	Time despatched	Time on site h:min	Time off site h:min	Travel Time h:min	On Site Time h:min
1	483	06:05	07:00	09:11	00:55	02:11
2	484	06:05	07:05	09:29	01:00	02:24
3	486	06:24	07:05	09:42	00:41	02:37
4	485	06:09	07:11	09:52	01:02	02:41
5	487	06:28	07:20	10:07	00:52	02:47
6	490	06:47	08:00	10:24	01:13	02:24
7	505	11:35	12:13	16:45	00:38	04:32
8	506	11:36	12:15	16:54	00:39	04:39
9	507	11:38	12:15	17:01	00:37	04:46
10	504	11:32	12:25	17:11	00:53	04:46
11	510	11:43	12:25	17:50	00:42	05:25
12	509	11:42	12:26	18:20	00:44	05:54
13	526	16:57	17:25	19:07	00:28	01:42
14	525	16:52	17:44	18:42	00:52	00:58
15	524	16:40	17:49	18:30	01:09	00:41
16	527	17:10	17:52	18:58	00:42	01:06
17	529	17:29	18:16	19:14	00:47	00:58
18	530	17:42	18:28	19:19	00:46	00:51
19	531	17:58	18:31	19:21	00:33	00:50
20						
21						
22						
23						

Avg on site time:		02:44
Avg travel time:	00:48	
Avg total trip time		04:20

Note: Travel time is for one way trip

N3 Old Barn





Production	280.5 t BTB	120.1 t MED
Mat returned:	12.2 t BTB	7.9 t MED
Remark:	Trial section with cement as stabalizer done	
Production rate:	34.1 t/hr	

BTB 4.1

Date 17/4/2002

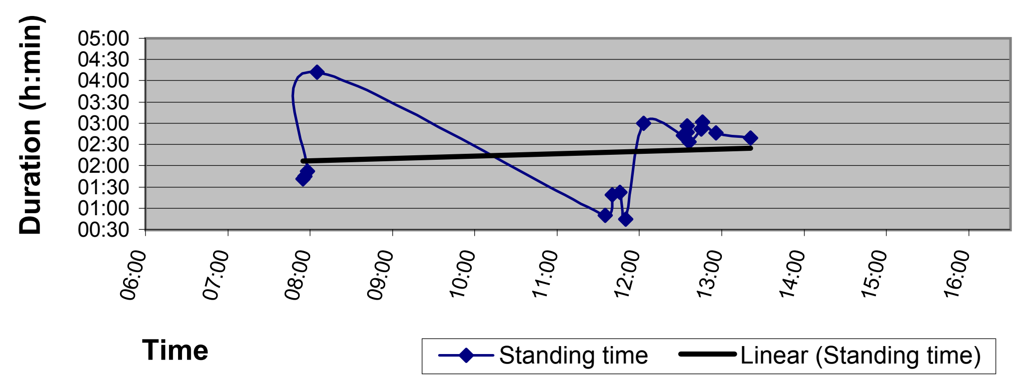
No.	Ticket No.	Time despatched	Time on site h:min	Time off site h:min	Travel Time h:min	On Site Time h:min
1	534	07:08	07:55	09:36	00:47	01:41
2	533	07:06	07:56	09:41	00:50	01:45
3	535	07:17	07:58	09:50	00:41	01:52
4	536	07:21	08:05	12:17	00:44	04:12
5	548	10:57	11:35	12:25	00:38	00:50
6	549	10:59	11:40	12:59	00:41	01:19
7	552	11:08	11:46	13:08	00:38	01:22
8	550	11:02	11:50	12:34	00:48	00:44
9	553	11:10	12:03	15:03	00:53	03:00
10	555	11:15	12:32	15:15	01:17	02:43
11	560	11:26	12:35	15:22	01:09	02:47
12	563	11:37	12:35	15:31	00:58	02:56
13	558	11:21	12:36	15:10	01:15	02:34
14	565	11:44	12:45	15:37	01:01	02:52
15	568	12:04	12:46	15:48	00:42	03:02
16	567	12:01	12:56	15:42	00:55	02:46
17	569	12:12	13:21	16:00	01:09	02:39
18						
19						
20						
21						
22						
23						

Avg on site time:		02:17
Avg travel time:	00:53	
Avg total trip time		04:04

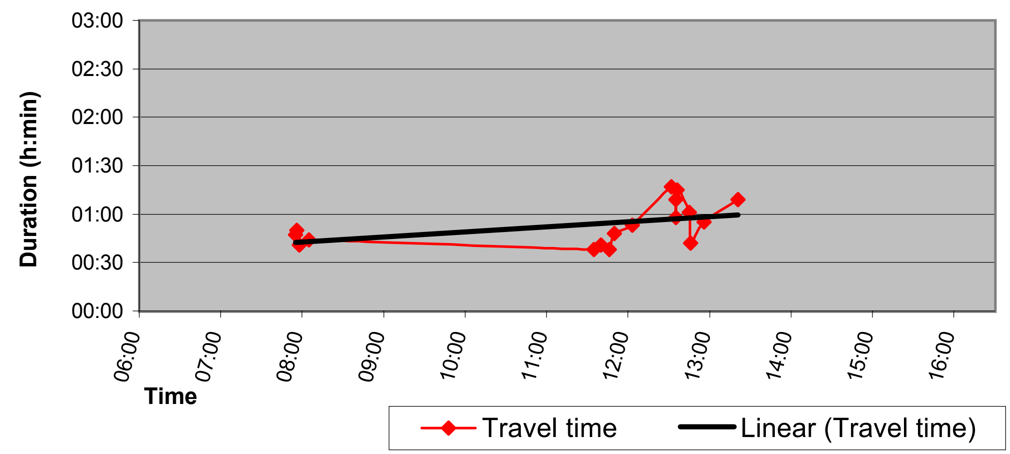
Note: Travel time is for one way trip

N3 Old Barn

On Site standing time for premix trucks



Travel Time to Site



Production 291.2 t BTB 0 t MED
Mat returned: 12.2 t BTB 177.0 t MED
Remark: Longer travelling times due to increased distance to delivery point
Production rate: 59.4 t/hr

BTB 4.1

Date 18/4/2002

No.	Ticket No.	Time despatched	Time on site h:min	Time off site h:min	Travel Time h:min	On Site Time h:min
1	589	08:37	09:22	10:16	00:45	00:54
2	590	08:38	09:24	10:25	00:46	01:01
3	591	08:40	09:24	10:35	00:44	01:11
4	592	08:42	09:25	10:44	00:43	01:19
5	595	08:49	09:29	11:41	00:40	02:12
6	593	08:46	09:37	11:05	00:51	01:28
7	594	08:48	09:38	10:52	00:50	01:14
8	603	10:17	11:07	11:48	00:50	00:41
9	604	10:27	11:10	12:02	00:43	00:52
10	606	10:32	11:20	12:10	00:48	00:50
11	605	10:30	11:30	11:55	01:00	00:25
12	608	10:43	11:30	12:34	00:47	01:04
13	612	10:54	11:34	12:46	00:40	01:12
14	613	11:05	11:41	12:54	00:36	01:13
15	611	10:51	11:45	13:06	00:54	01:21
16	607	10:34	11:49	12:32	01:15	00:43
17	616	11:22	12:00	13:13	00:38	01:13
18	615	11:20	12:15	13:23	00:55	01:08
19	617	11:35	12:25	13:40	00:50	01:15
20	618	11:38	12:25	13:31	00:47	01:06
21	622	11:52	12:25	13:45	00:33	01:20
22	620	11:42	12:39	14:18	00:57	01:39
23						

Avg on site time: 01:09

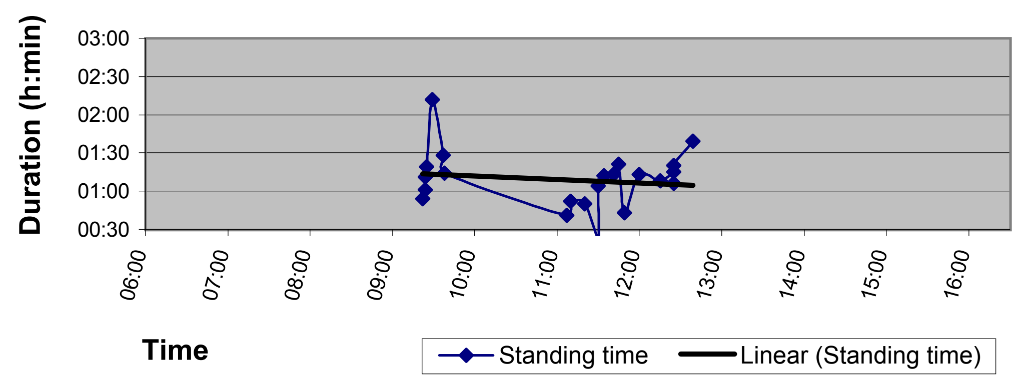
Avg travel time: 00:47

Avg total trip time 02:44

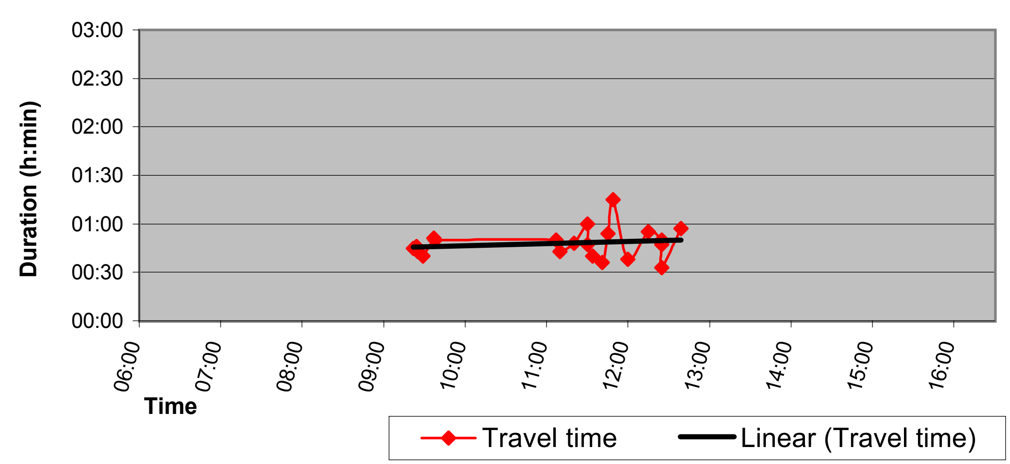
Note: Travel time is for one way trip

N3 Old Barn

On Site standing time for premix trucks



Travel Time to Site



Production 395.1 t BTB 0 t MED

Mat returned: 5.1 t BTB 0.0 t MED

Remark: Mix required on site later due to mist.

Production rate: 80.1 t/hr

BTB 4.1

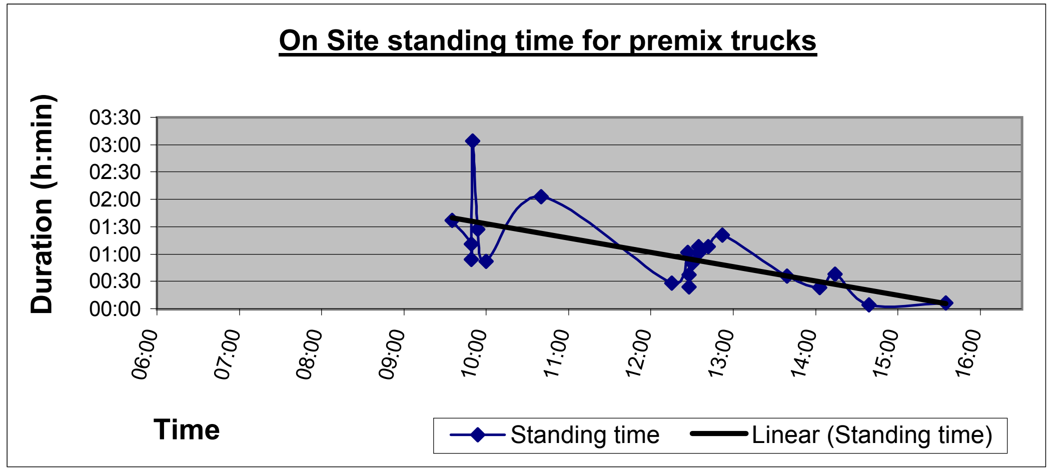
Date 19/4/2002

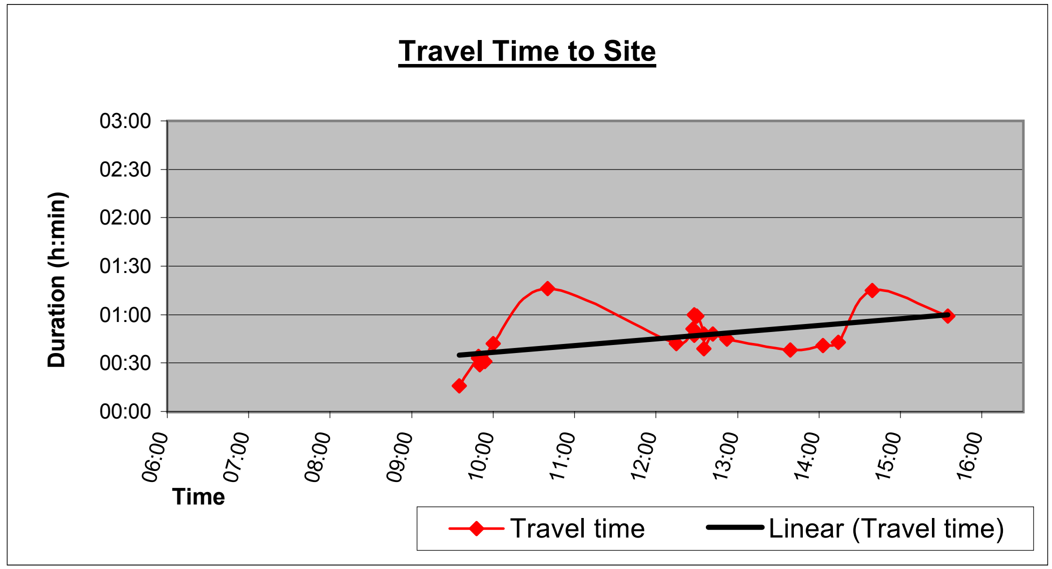
No.	Ticket No.	Time despatched	Time on site h:min	Time off site h:min	Travel Time h:min	On Site Time h:min
1	638	09:19	09:35	11:12	00:16	01:37
2	635	09:15	09:49	11:00	00:34	01:11
3	636	09:16	09:49	10:43	00:33	00:54
4	639	09:21	09:50	12:54	00:29	03:04
5	640	09:23	09:54	11:21	00:31	01:27
6	637	09:18	10:00	10:52	00:42	00:52
7	641	09:24	10:40	12:43	01:16	02:03
8	653	11:33	12:15	12:43	00:42	00:28
9	654	11:36	12:27	13:29	00:51	01:02
10	651	11:28	12:28	13:05	01:00	00:37
11	656	11:41	12:28	12:52	00:47	00:24
12	652	11:31	12:30	13:20	00:59	00:50
13	657	11:47	12:35	13:43	00:48	01:08
14	661	11:56	12:35	13:36	00:39	01:01
15	660	11:54	12:42	13:50	00:48	01:08
16	662	12:07	12:52	14:13	00:45	01:21
17	666	13:01	13:39	14:15	00:38	00:36
18	668	13:22	14:03	14:26	00:41	00:23
19	672	13:31	14:14	14:52	00:43	00:38
20	669	13:24	14:39	14:43	01:15	00:04
21	676	14:36	15:35	15:41	00:59	00:06

Avg on site time:		00:59
Avg travel time:	00:45	
Avg total trip time		02:30

Note: Travel time is for one way trip

N3 Old Barn





Production	400.7 t BTB	0 t MED
Mat returned:	3.2 t BTB	0.0 t MED
Remark:		
Production rate:	65.7 t/hr	

BTB 4.1

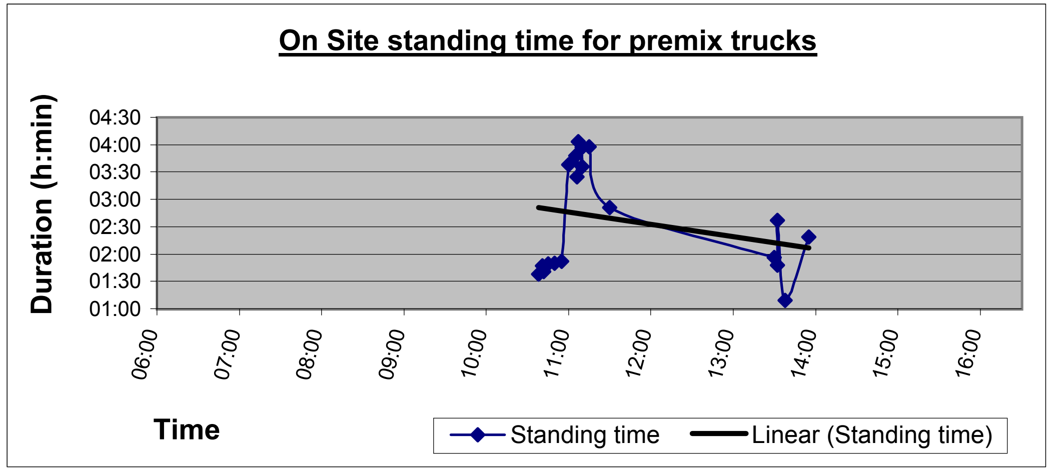
Date 20/4/2002

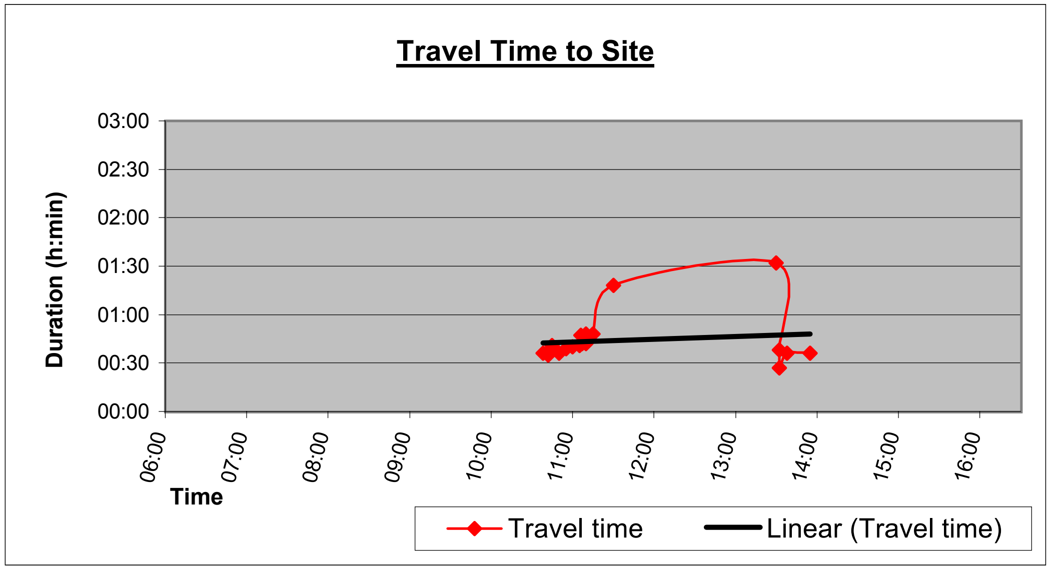
No.	Ticket No.	Time despatched	Time on site h:min	Time off site h:min	Travel Time h:min	On Site Time h:min
1	680	10:02	10:38	12:16	00:36	01:38
2	682	10:05	10:41	12:28	00:36	01:47
3	683	10:07	10:42	12:23	00:35	01:41
4	681	10:04	10:45	12:34	00:41	01:49
5	685	10:14	10:50	12:40	00:36	01:50
6	686	10:16	10:55	12:47	00:39	01:52
7	688	10:20	11:00	14:38	00:40	03:38
8	690	10:24	11:05	14:53	00:41	03:48
9	687	10:19	11:06	14:31	00:47	03:25
10	691	10:25	11:07	15:10	00:42	04:03
11	689	10:22	11:10	14:46	00:48	03:36
12	693	10:28	11:10	15:07	00:42	03:57
13	692	10:27	11:15	15:13	00:48	03:58
14	684	10:12	11:30	14:21	01:18	02:51
15	696	11:58	13:30	15:26	01:32	01:56
16	695	12:54	13:32	15:20	00:38	01:48
17	698	13:05	13:32	16:09	00:27	02:37
18	697	13:02	13:38	14:47	00:36	01:09
19	701	13:19	13:55	16:14	00:36	02:19

Avg on site time:		02:36
Avg travel time:	00:44	
Avg total trip time		04:05

Note: Travel time is for one way trip

N3 Old Barn





Production	362.9 t BTB	0 t MED
Mat returned:	11.6 t BTB	0.0 t MED
Remark:		
Production rate:	64.8 t/hr	

BTB 4.1

Date 22/04/2002

No.	Ticket No.	Time despatched	Time on site h:min	Time off site h:min	Travel Time h:min	On Site Time h:min
1	706	08:49	09:35	11:36	00:46	02:01
2	707	08:50	09:27	11:15	00:37	01:48
3	708	08:52	09:32	11:31	00:40	01:59
4	709	08:53	09:31	11:23	00:38	01:52
5	710	08:54	09:40	11:44	00:46	02:04
6	711	08:55	09:41	12:39	00:46	02:58
7	712	08:57	09:45	12:41	00:48	02:56
8	713	08:58	09:52	12:50	00:54	02:58
9	714	09:48	10:46	13:08	00:58	02:22
10	715	09:53	10:50	13:13	00:57	02:23
11	716	09:58	11:00	13:25	01:02	02:25
12	719	10:19	11:20	13:36	01:01	02:16
13	722	10:45	11:55	13:36	01:10	01:41
14	728	12:06	12:44	14:08	00:38	01:24
15	729	12:08	12:51	14:33	00:43	01:42
16	730	12:29	13:15	14:38	00:46	01:23
17	731	12:31	13:30	14:46	00:59	01:16
18	734	12:58	13:48	14:52	00:50	01:04
19	738	13:31	14:20	15:00	00:49	00:40
20	739	13:37	14:56	15:09	01:19	00:13
21	741	14:09	15:00	15:12	00:51	00:12

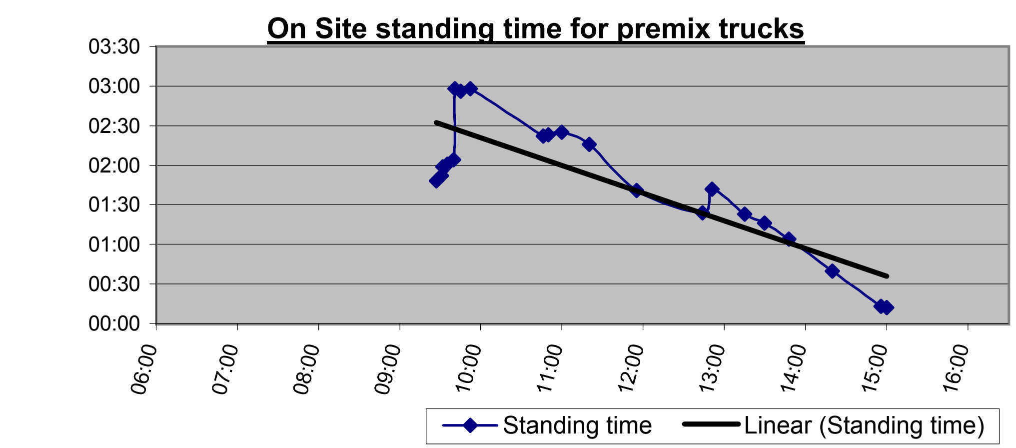
Avg on site time: 01:47

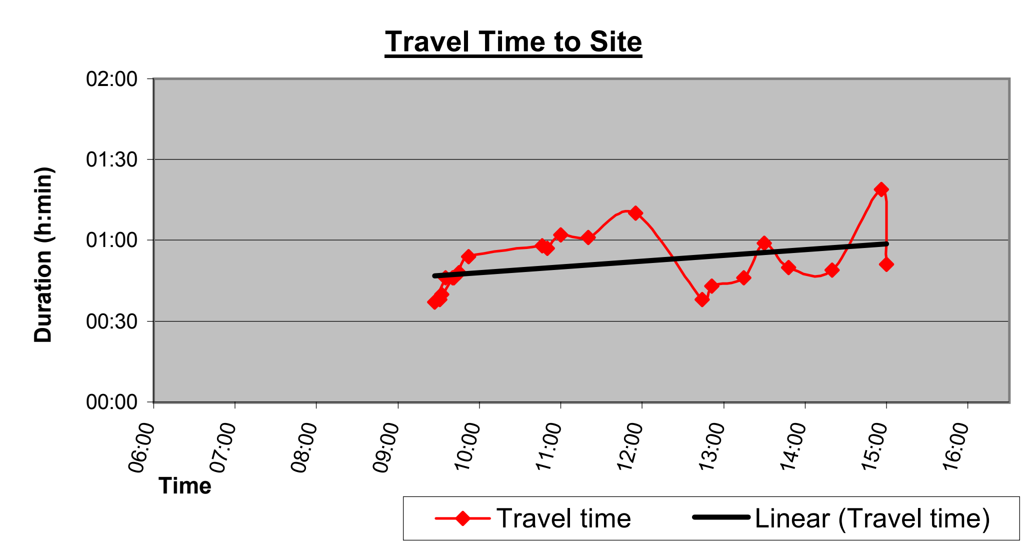
Avg travel time: 00:51

Avg total trip time 03:30

Note: Travel time is for one way trip

N3 Old Barn





Production 391.2 t BTB 0 t MED

Mat returned: 0.0 t BTB 0.0 t MED

Remark:

Production rate: 68.0 t/hr

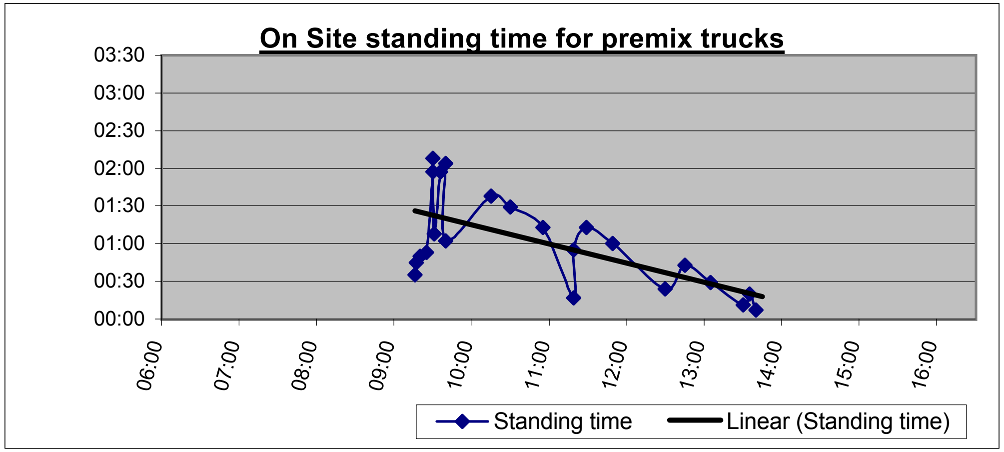
BTB 4.1

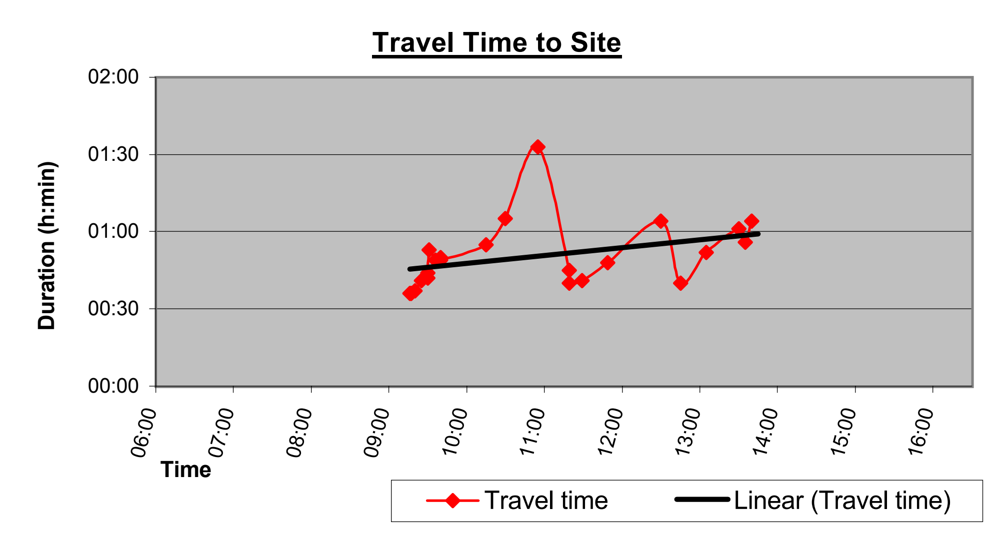
Date 23/04/2002

No.	Ticket No.	Time despatched	Time on site h:min	Time off site h:min	Travel Time h:min	On Site Time h:min
1	759	08:40	09:16	09:51	00:36	00:35
2	760	08:41	09:17	10:02	00:36	00:45
3	761	08:43	09:20	10:10	00:37	00:50
4	762	08:44	09:25	10:18	00:41	00:53
5	763	08:46	09:30	11:27	00:44	01:57
6	765	08:48	09:30	11:38	00:42	02:08
7	758	08:38	09:31	10:39	00:53	01:08
8	764	08:47	09:36	11:33	00:49	01:57
9	766	08:50	09:40	11:44	00:50	02:04
10	767	08:51	09:40	10:42	00:49	01:02
11	769	09:20	10:15	11:53	00:55	01:38
12	771	09:25	10:30	11:59	01:05	01:29
13	770	09:22	10:55	12:08	01:33	01:13
14	780	10:34	11:19	11:36	00:45	00:17
15	781	10:39	11:19	12:14	00:40	00:55
16	782	10:48	11:29	12:42	00:41	01:13
17	784	11:01	11:49	12:49	00:48	01:00
18	786	11:26	12:30	12:54	01:04	00:24
19	793	12:05	12:45	13:28	00:40	00:43
20	796	12:13	13:05	13:34	00:52	00:29
21	797	12:29	13:30	13:41	01:01	00:11
22	801	12:39	13:35	13:55	00:56	00:20
23	800	12:36	13:40	13:47	01:04	00:07
24	802	12:50	13:45	15:02	00:55	01:17
25	803	14:23				

Avg on site time: 01:01
Avg travel time: 00:50
Avg total trip time 02:42
Note: Travel time is for one way trip

N3 Old Barn





Production	469.9 t BTB	0 t MED
Mat returned:	3.8 t BTB	0.0 t MED
Remark: Paving Northbound lane		
Production rate:	81.5 t/hr	

BTB 4.1

Date 24/04/2002

No.	Ticket No.	Time despatched	Time on site h:min	Time off site h:min	Travel Time h:min	On Site Time h:min
1	831	08:37	09:16	10:31	00:39	01:15
2	832	08:39	09:19	10:57	00:40	01:38
3	830	08:36	09:25	11:29	00:49	02:04
4	834	08:43	09:29	11:04	00:46	01:35
5	835	08:44	09:30	11:21	00:46	01:51
6	833	08:41	09:31	11:16	00:50	01:45
7	836	08:46	09:37	11:31	00:51	01:54
8	845	10:37	11:32	11:56	00:55	00:24
9	850	11:02	11:55	12:09	00:53	00:14
10	849	10:56	12:05	13:13	01:09	01:08
11	855	11:32	12:10	13:29	00:38	01:19
12	852	11:11	12:15	13:23	01:04	01:08
13	856	11:37	12:15	13:37	00:38	01:22
14	860	11:58	12:48	13:43	00:50	00:55
15	858	11:54	12:50	13:47	00:56	00:57
16	861	12:01	12:50	13:52	00:49	01:02
17	862	12:09	12:55	13:58	00:46	01:03
18	868	12:54	13:49	14:12	00:55	00:23
19	871	13:03	14:00	14:59	00:57	00:59
20	882	14:13	14:52	15:16	00:39	00:24
21	886	14:21	15:00	16:11	00:39	01:11
22	890	15:45	16:39	16:56	00:54	00:17

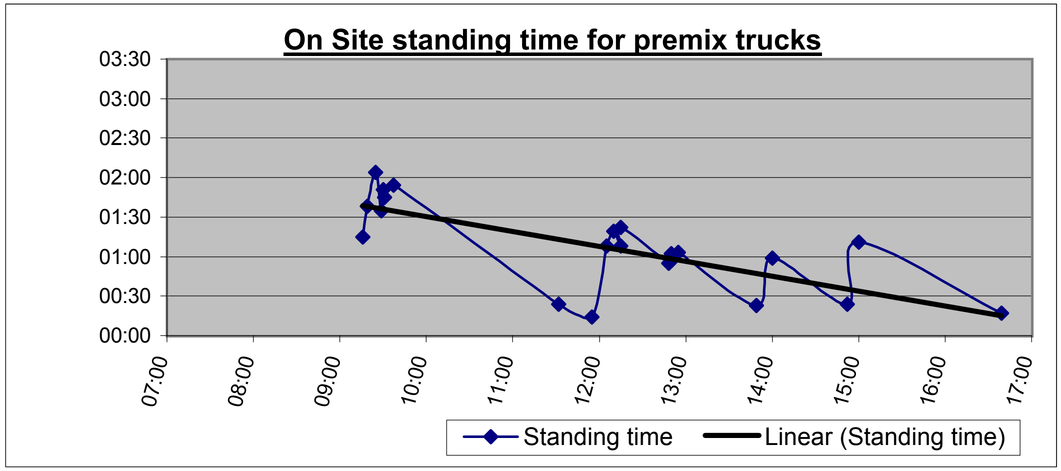
Avg on site time: 01:07

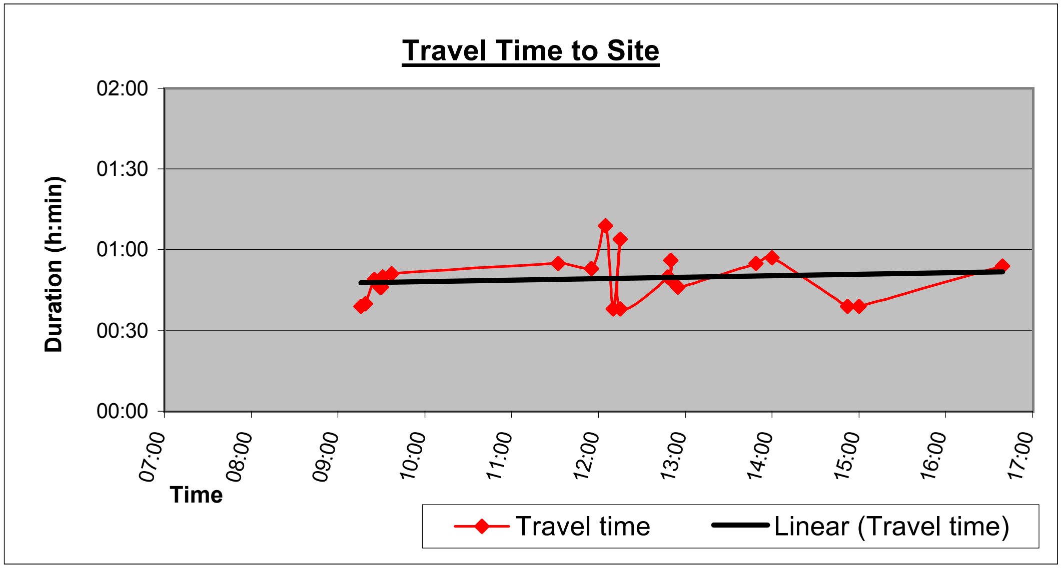
Avg travel time: 00:49

Avg total trip time 02:46

Note: Travel time is for one way trip

N3 Old Barn





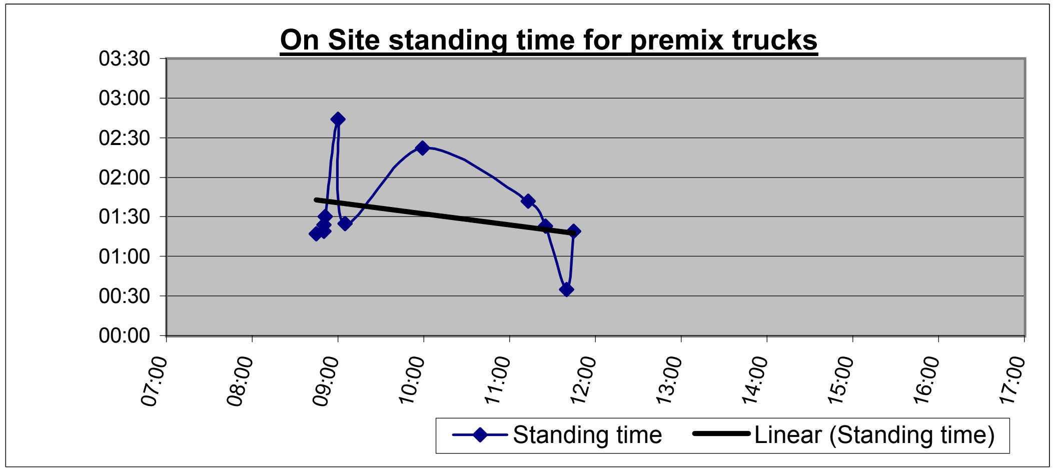
Production	451.8 t BTB	0 t MED
Mat returned:	7.2 t BTB	0.0 t MED
Remark:	Last truck ordered only at 15h30,extra to finish section.	
Production rate:	58.9 t/hr	

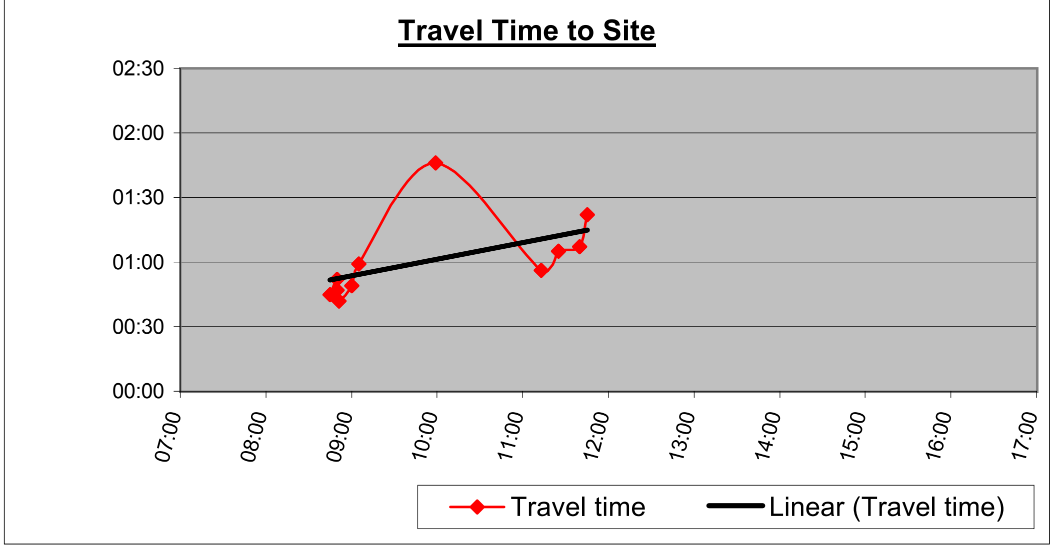
BTB 4.1

Date 25/04/2002

N3 Old Barn

No.	Ticket No.	Time despatched	Time on site h:min	Time off site h:min	Travel Time h:min	On Site Time h:min
1	897	08:00	08:45	10:02	00:45	01:17
2	896	07:58	08:50	10:09	00:52	01:19
3	898	08:03	08:50	10:14	00:47	01:24
4	900	08:09	08:51	10:21	00:42	01:30
5	901	08:11	09:00	11:44	00:49	02:44
6	899	08:06	09:05	10:30	00:59	01:25
7	902	08:13	09:59	12:21	01:46	02:22
8	915	10:17	11:13	12:55	00:56	01:42
9	916	10:20	11:25	12:48	01:05	01:23
10	919	10:33	11:40	12:15	01:07	00:35
11	917	10:23	11:45	13:04	01:22	01:19





Avg on site time: 01:32

Avg travel time: 01:00

Avg total trip time 03:34

Note: Travel time is for one way trip

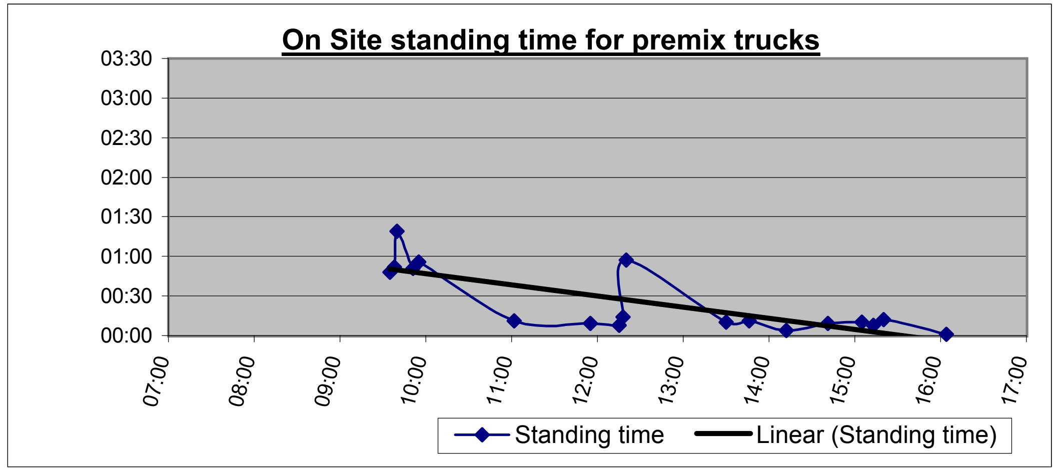
Production	216.5 t BTB	0 t MED
Mat returned:	10.5 t BTB	0.0 t MED
Remark:		
Production rate:	50.2 t/hr	

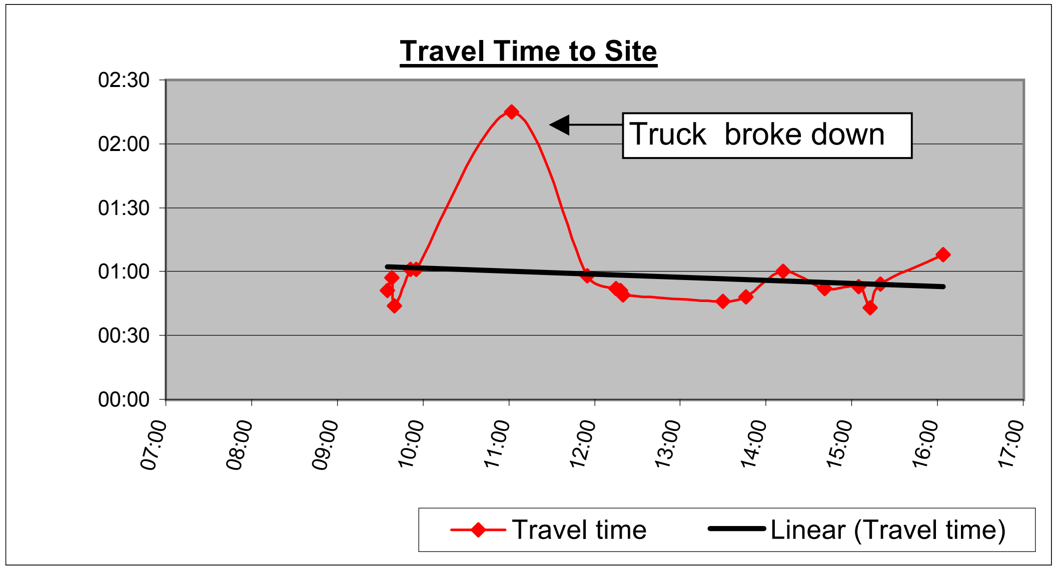
BTB 4.1

Date 30/04/2002

No.	Ticket No.	Time despatched	Time on site h:min	Time off site h:min	Travel Time h:min	On Site Time h:min
1	1038	08:44	09:35	10:23	00:51	00:48
2	1037	08:41	09:38	10:30	00:57	00:52
3	1042	08:56	09:40	10:59	00:44	01:19
4	1040	08:50	09:51	10:42	01:01	00:51
5	1041	08:54	09:55	10:51	01:01	00:56
6	1039	08:47	11:02	11:13	02:15	00:11
7	1055	10:57	11:55	12:04	00:58	00:09
8	1060	11:23	12:15	12:23	00:52	00:08
9	1061	11:27	12:18	12:32	00:51	00:14
10	1062	11:31	12:20	13:17	00:49	00:57
11	1080	12:44	13:30	13:40	00:46	00:10
12	1083	12:58	13:46	13:57	00:48	00:11
13	1084	13:12	14:12	14:16	01:00	00:04
14	1092	13:49	14:41	14:50	00:52	00:09
15	1094	14:12	15:05	15:15	00:53	00:10
16	1098	14:30	15:13	15:21	00:43	00:08
17	1097	14:26	15:20	15:32	00:54	00:12
18	1105	14:56	16:04	16:05	01:08	00:01

N3 Old Barn





Avg on site time:	00:25
Avg travel time:	00:57
Avg total trip time	02:20

Note: Travel time is for one way trip

Production	365.0 t BTB	0 t MED
Mat returned:	5.6 t BTB	0.0 t MED
Remark:	Note: 1039: Breakdown next to road.	
Production rate:	57.0 t/hr	

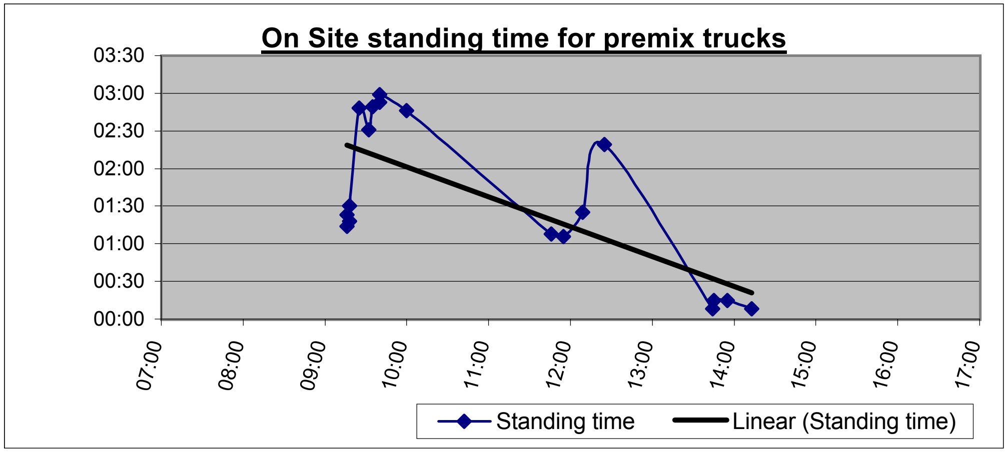
BTB 4.1

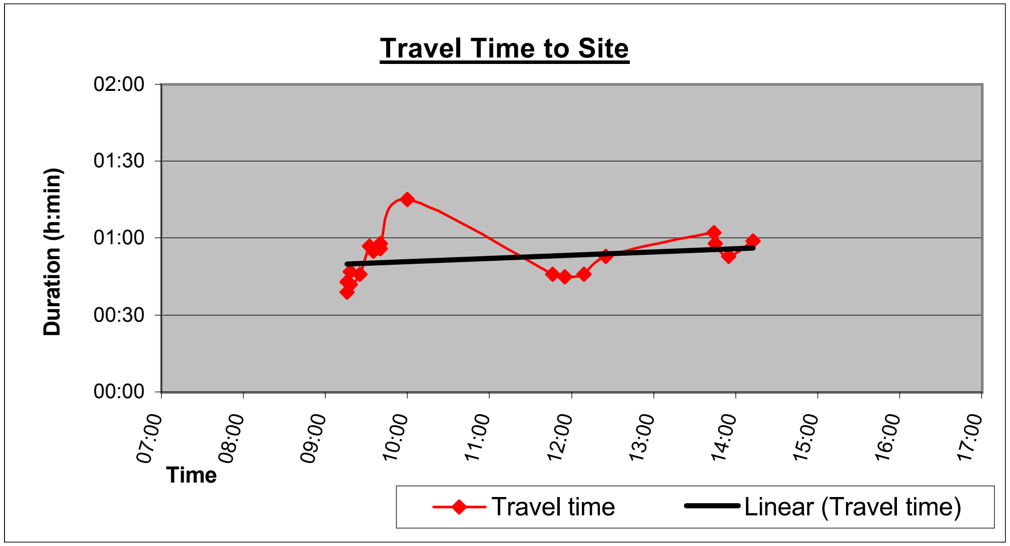
Date 1/5/2002

No.	Ticket No.	Time despatched	Time on site h:min	Time off site h:min	Travel Time h:min	On Site Time h:min
1	1117	08:33	09:16	10:30	00:43	01:14
2	1120	08:37	09:16	10:39	00:39	01:23
3	1116	08:31	09:18	10:36	00:47	01:18
4	1119	08:36	09:18	10:48	00:42	01:30
5	1121	08:39	09:25	12:13	00:46	02:48
6	1118	08:35	09:32	12:03	00:57	02:31
7	1122	08:40	09:35	12:24	00:55	02:49
8	1123	08:42	09:40	12:33	00:58	02:53
9	1124	08:44	09:40	12:39	00:56	02:59
10	1125	08:45	10:00	12:46	01:15	02:46
11	1147	11:00	11:46	12:54	00:46	01:08
12	1150	11:10	11:55	13:01	00:45	01:06
13	1151	11:23	12:09	13:34	00:46	01:25
14	1152	11:32	12:25	14:44	00:53	02:19
15	1165	12:42	13:44	13:52	01:02	00:08
16	1166	12:47	13:45	14:00	00:58	00:15
17	1167	13:02	13:55	14:10	00:53	00:15
18	1171	13:14	14:13	14:21	00:59	00:08

Avg on site time: 01:36
Avg travel time: 00:52
Avg total trip time 03:20
Note: Travel time is for one way trip

N3 Old Barn





Production 340.5 t BTB 0 t MED
Mat returned: 6.9 t BTB 0.0 t MED
Remark:
Production rate: 62.3 t/hr

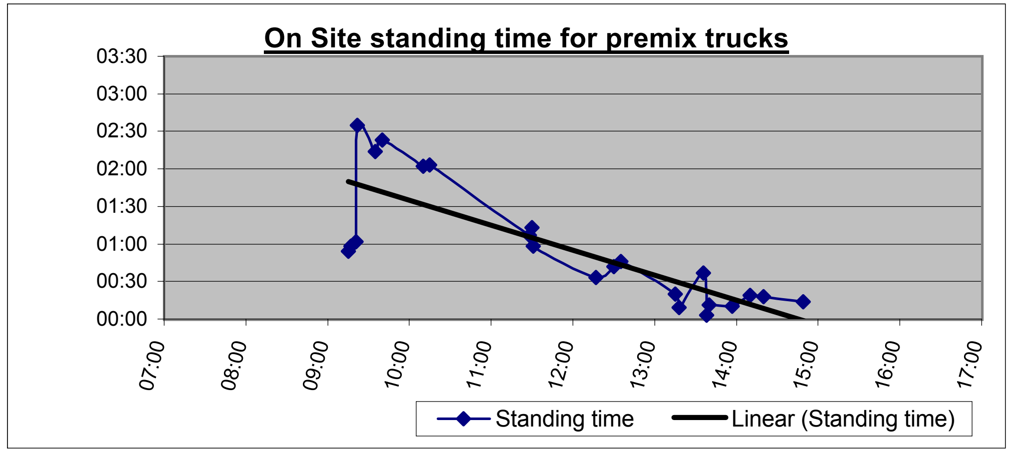
BTB 4.1

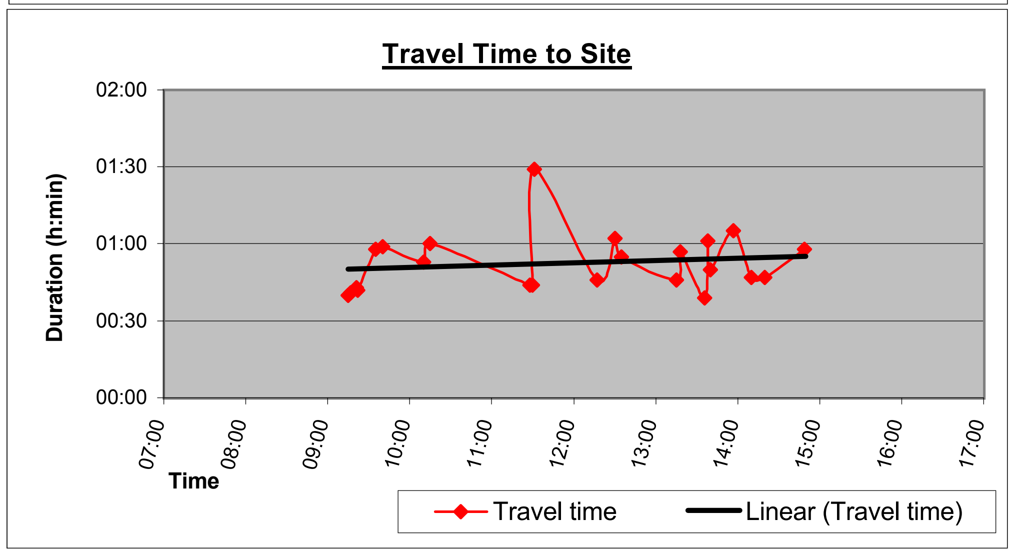
Date 2/5/2002

No.	Ticket No.	Time despatched	Time on site h:min	Time off site h:min	Travel Time h:min	On Site Time h:min
1	1186	08:35	09:15	10:09	00:40	00:54
2	1187	08:36	09:17	10:15	00:41	00:58
3	1189	08:38	09:21	10:23	00:43	01:02
4	1190	08:40	09:22	11:57	00:42	02:35
5	1188	08:37	09:35	11:49	00:58	02:14
6	1191	08:41	09:40	12:03	00:59	02:23
7	1196	09:17	10:10	12:12	00:53	02:02
8	1195	09:15	10:15	12:18	01:00	02:03
9	1217	10:44	11:28	12:35	00:44	01:07
10	1218	10:46	11:30	12:43	00:44	01:13
11	1206	10:02	11:31	12:29	01:29	00:58
12	1225	11:31	12:17	12:50	00:46	00:33
13	1224	11:28	12:30	13:12	01:02	00:42
14	1228	11:40	12:35	13:21	00:55	00:46
15	1236	12:29	13:15	13:35	00:46	00:20
16	1233	12:21	13:18	13:27	00:57	00:09
17	1247	12:57	13:36	14:13	00:39	00:37
18	1239	12:37	13:38	13:41	01:01	00:03
19	1245	12:50	13:40	13:51	00:50	00:11
20	1246	12:52	13:57	14:07	01:05	00:10
21	1251	13:23	14:10	14:29	00:47	00:19
22	1253	13:33	14:20	14:38	00:47	00:18
23	1257	13:51	14:49	15:03	00:58	00:14
24	1258	14:00	14:50	14:51	00:50	00:01

Avg on site time: 00:54
Avg travel time: 00:52
Avg total trip time 02:39
Note: Travel time is for one way trip

N3 Old Barn





Production	500.9 t BTB	0 t MED
Mat returned:	0.0 t BTB	0.0 t MED
Remark:		
Production rate:	86.4 t/hr	

BTB 4.1

Date 3/5/2002

No.	Ticket No.	Time despatched	Time on site h:min	Time off site h:min	Travel Time h:min	On Site Time h:min
1	1272	08:20	09:00	13:12	00:40	04:12
2	1274	08:24	09:00	10:14	00:36	01:14
3	1275	08:26	09:02	10:22	00:36	01:20
4	1271	08:18	09:30	14:39	01:12	05:09
5	1283	09:38	10:20	14:50	00:42	04:30
6	1284	09:40	10:20	14:56	00:40	04:36
7	1298	10:32	11:29	15:05	00:57	03:36
8	1301	10:49	11:29	15:16	00:40	03:47
9	1300	10:45	11:40	15:25	00:55	03:45
10	1305	11:02	12:00	15:46	00:58	03:46
11	1323	12:36	13:22	15:54	00:46	02:32
12	1340	14:29	15:10	16:01	00:41	00:51
13	1345	15:08	16:02	16:11	00:54	00:09
14	1347	15:26	16:06	16:17	00:40	00:11
15	1348	15:29	16:09	16:23	00:40	00:14
16	1349	15:37	16:28	16:32	00:51	00:04
17	1350	16:02	16:40	16:47	00:38	00:07
18	1351	16:04	16:48	16:56	00:44	00:08
19	1352	16:23	17:09	17:17	00:46	00:08
20	1353	16:55	17:30	17:45	00:35	00:15

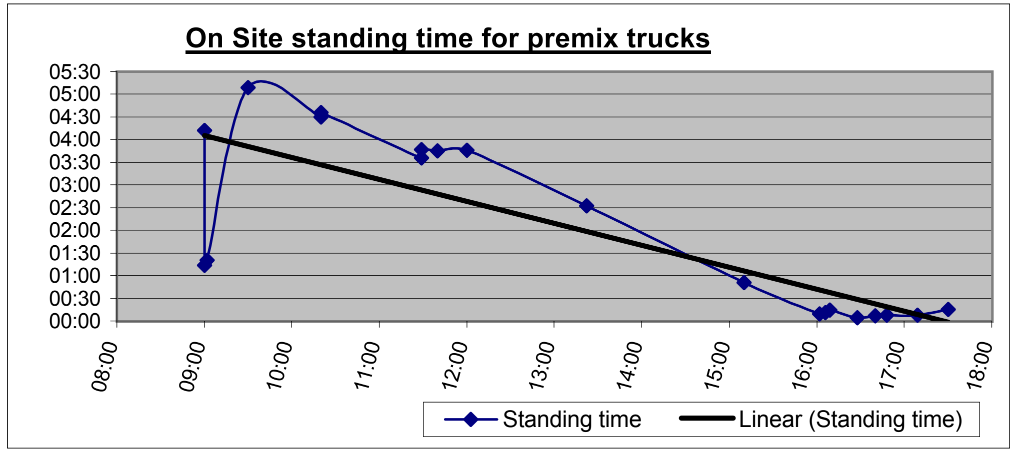
Avg on site time: 02:01

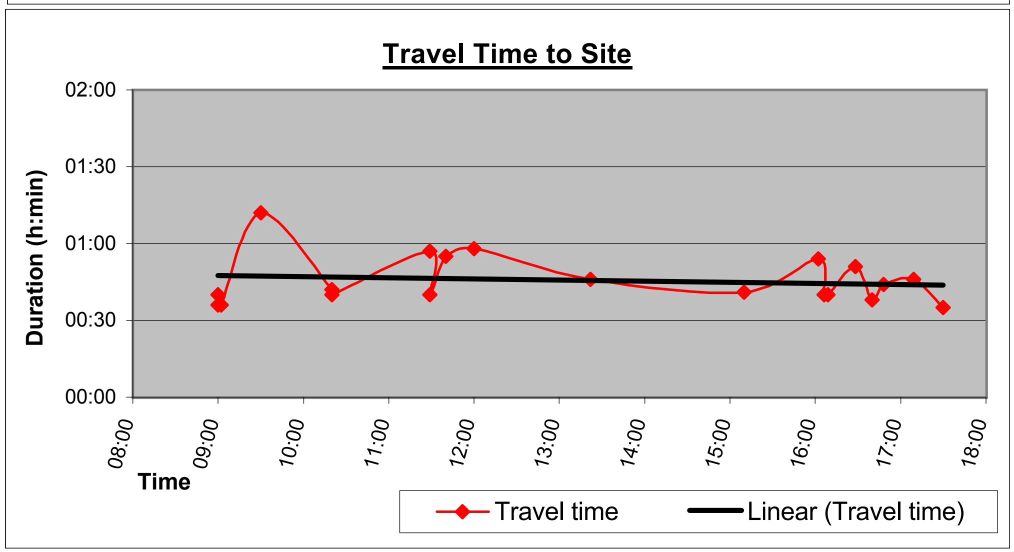
Avg travel time: 00:45

Avg total trip time 03:32

Note: Travel time is for one way trip

N3 Old Barn





Production	375.5 t BTB	0 t MED
Mat returned:	1.9 t BTB	0.0 t MED
Remark:	Start Northbound lane: consultants change to mill shoulder then pave South bound lane.	
Production rate:	42.9 t/hr	

Med 5.0

Date 4/5/2002

No.	Ticket No.	Time despatched	Time on site h:min	Time off site h:min	Travel Time h:min	On Site Time h:min
1	1362	08:15	09:00	10:26	00:45	01:26
2	1363	08:17	09:04	10:38	00:47	01:34
3	1361	08:13	09:07	11:11	00:54	02:04
4	1365	08:20	09:10	11:29	00:50	02:19
5	1366	08:21	09:10	13:03	00:49	03:53
6	1364	08:18	09:20	12:20	01:02	03:00
7	1397	11:03	11:45	13:18	00:42	01:33
8	1399	11:12	12:01	13:25	00:49	01:24
9	1401	11:18	12:15	13:33	00:57	01:18
10	1409	12:05	12:55	14:04	00:50	01:09
11	1411	12:14	12:57	14:18	00:43	01:21
12	1417	12:35	13:35	14:27	01:00	00:52
13	1419	13:01	14:10	14:45	01:09	00:35

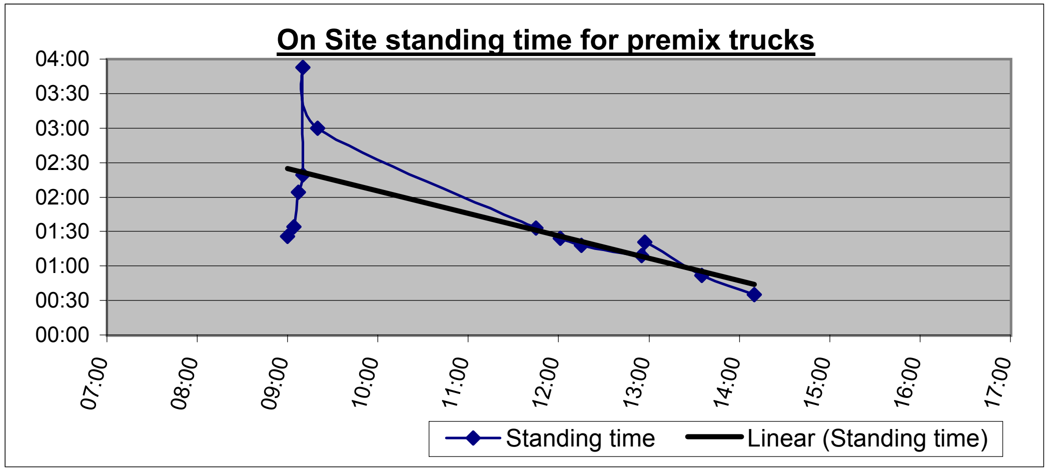
Avg on site time: 01:43

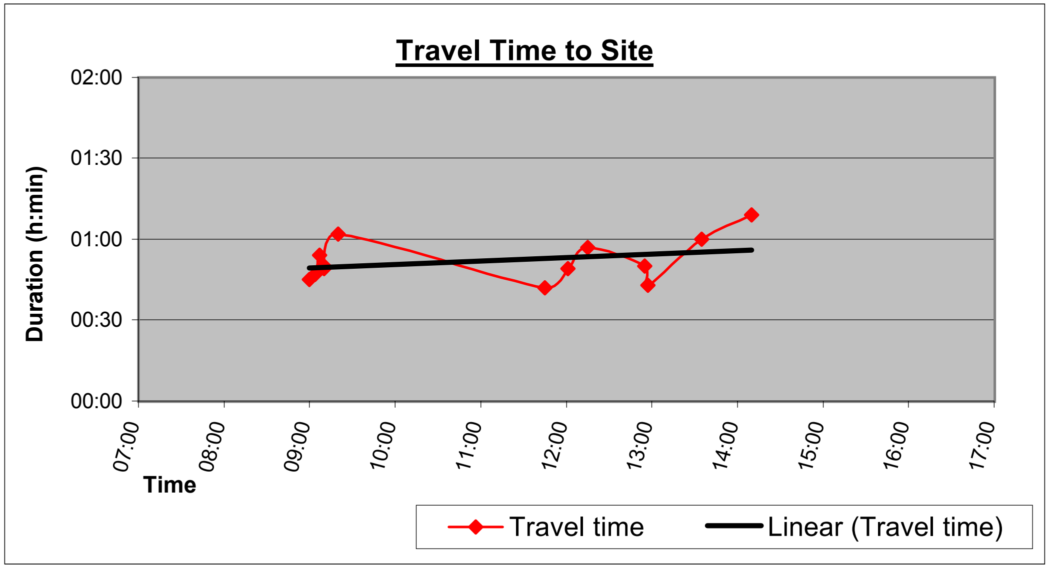
Avg travel time: 00:52

Avg total trip time 03:27

Note: Travel time is for one way trip

N3 Old Barn





Production	0.0 t BTB	260.62 t MED
Mat returned:	0.0 t BTB	0.0 t MED

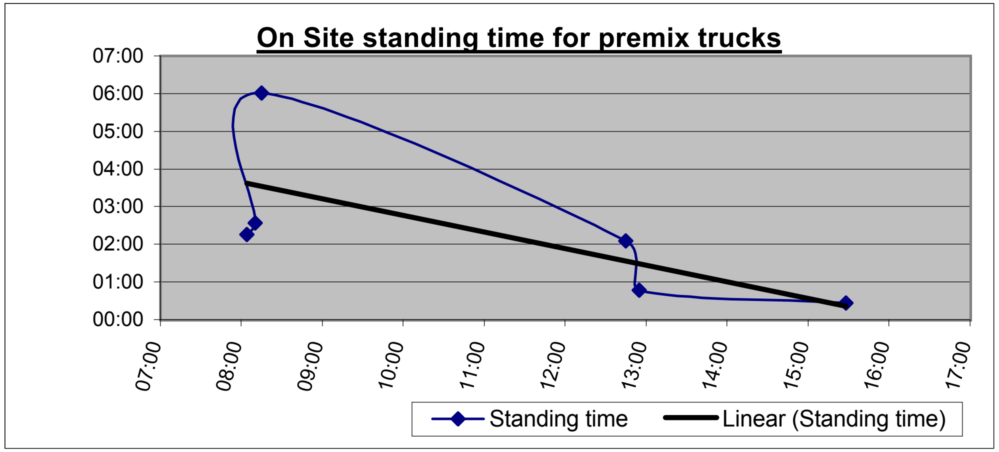
Remark: Working on intersections: Slow work.

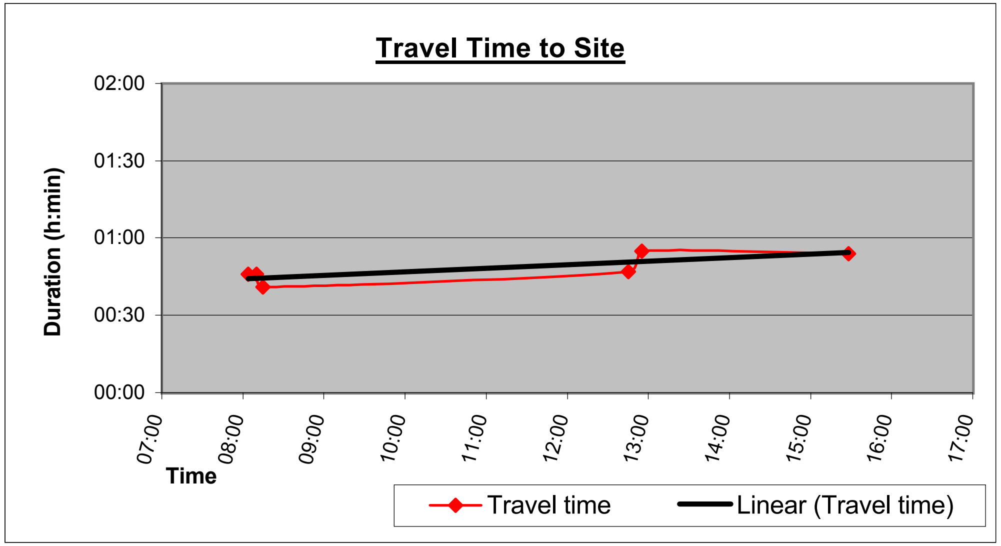
Production rate: 45.3 t/hr

Med 5.0

Date 6/5/2002

No.	Ticket No.	Time despatched	Time on site h:min	Time off site h:min	Travel Time h:min	On Site Time h:min
1	1441	07:18	08:04	10:20	00:46	02:16
2	1442	07:24	08:10	10:44	00:46	02:34
3	1444	07:34	08:15	14:16	00:41	06:01
4	1473	11:58	12:45	14:50	00:47	02:05
5	1474	12:00	12:55	13:42	00:55	00:47
6	1497	14:34	15:28	15:55	00:54	00:27





Avg on site time: 02:21

Avg travel time: 00:48

Avg total trip time 03:58

Note: Travel time is for one way trip

Production 0.0 t BTB 91.14 t MED

Mat returned: 0.0 t BTB 1.6 t MED

Remark: Working on bridge / inter-change: slow work in pieces.

Production rate: 11.6 t/hr

Med 5.0

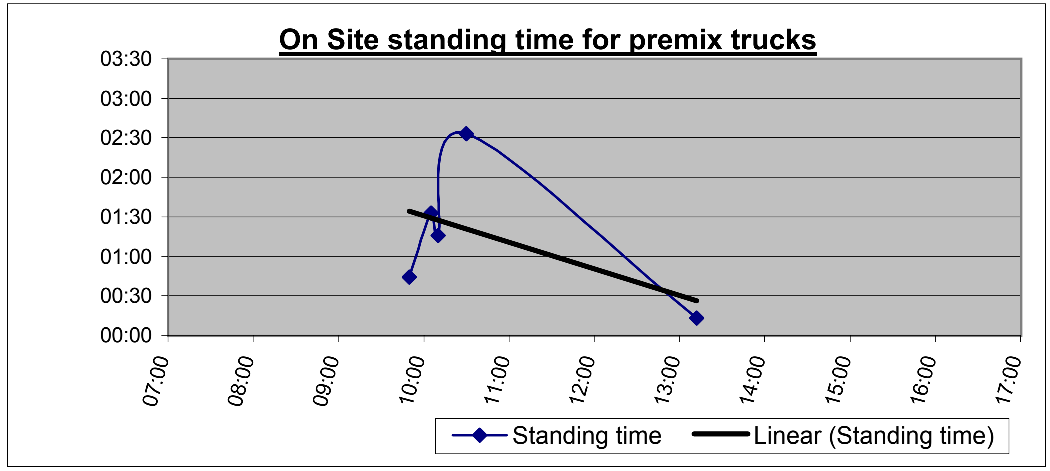
Date 7/5/2002

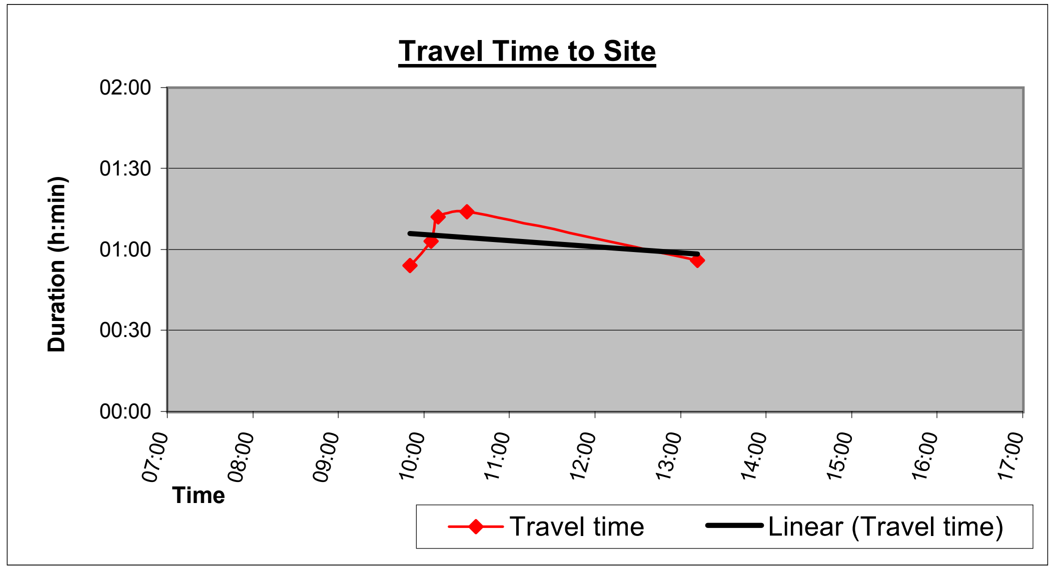
No.	Ticket No.	Time despatched	Time on site h:min	Time off site h:min	Travel Time h:min	On Site Time h:min
1	1514	08:56	09:50	10:34	00:54	00:44
2	1516	09:02	10:05	11:38	01:03	01:33
3	1515	08:58	10:10	11:26	01:12	01:16
4	1517	09:16	10:30	13:03	01:14	02:33
5	1538	12:16	13:12	13:25	00:56	00:13

Avg on site time: 01:15
Avg travel time: 01:03
Avg total trip time 03:23

Note: Travel time is for one way trip

N3 Old Barn





Production 0.0 t BTB 84.76 t MED
Mat returned: 0.0 t BTB 2.3 t MED
Remark: Milling and then paving on inter-section: slow work
Production rate: 23.7 t/hr

Med 5.0

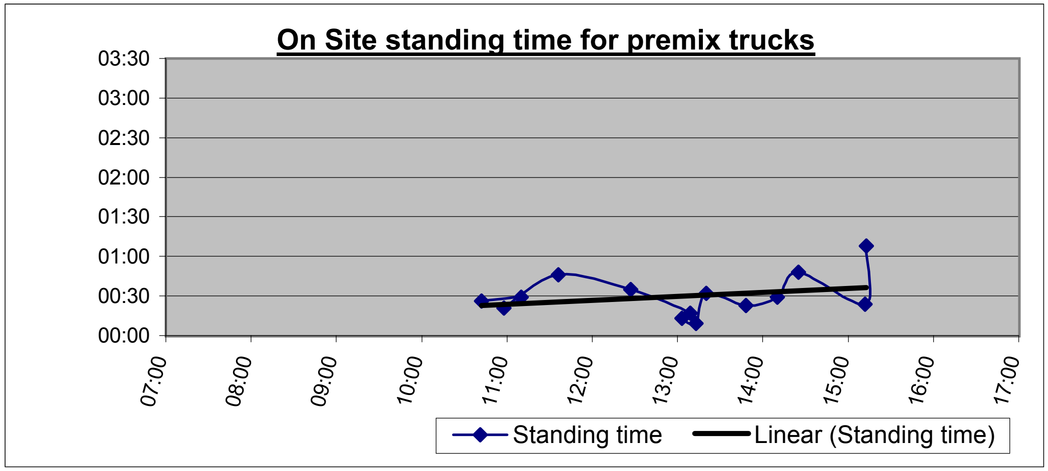
Date 8/5/2002

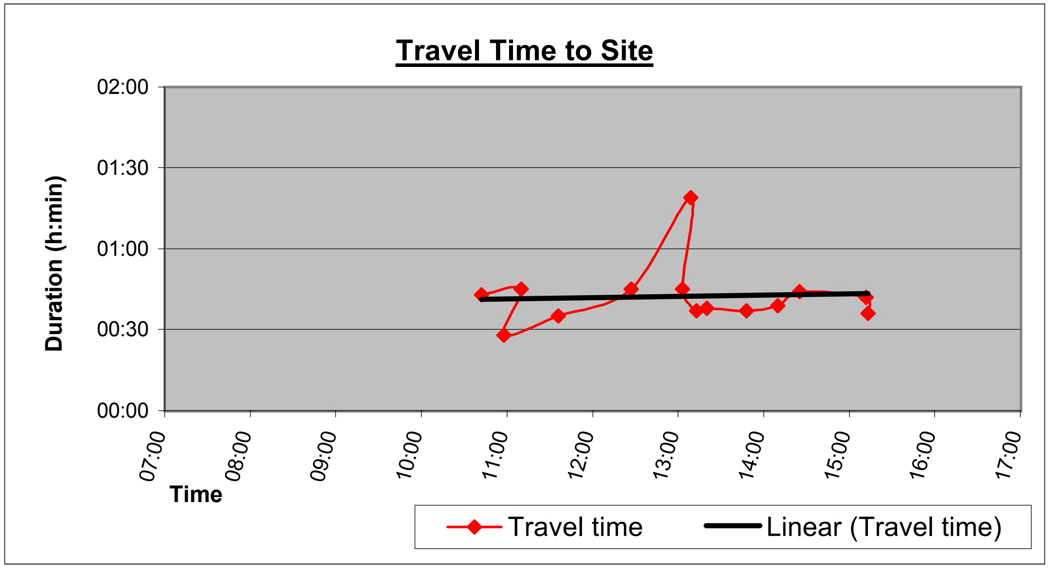
No.	Ticket No.	Time despatched	Time on site h:min	Time off site h:min	Travel Time h:min	On Site Time h:min
1	1588	09:59	10:42	11:08	00:43	00:26
2	1591	10:25	11:10	11:39	00:45	00:29
3	1592	10:30	10:58	11:19	00:28	00:21
4	1599	11:01	11:36	12:22	00:35	00:46
5	1606	11:42	12:27	13:02	00:45	00:35
6	1608	11:50	13:09	13:26	01:19	00:17
7	1618	12:18	13:03	13:16	00:45	00:13
8	1619	12:36	13:13	13:22	00:37	00:09
9	1620	12:42	13:20	13:52	00:38	00:32
10	1627	13:11	13:48	14:11	00:37	00:23
11	1630	13:31	14:10	14:39	00:39	00:29
12	1631	13:41	14:25	15:13	00:44	00:48
13	1645	14:30	15:12	15:36	00:42	00:24
14	1646	14:37	15:13	16:21	00:36	01:08

Avg on site time: 00:30
Avg travel time: 00:42
Avg total trip time 01:54

Note: Travel time is for one way trip

N3 Old Barn





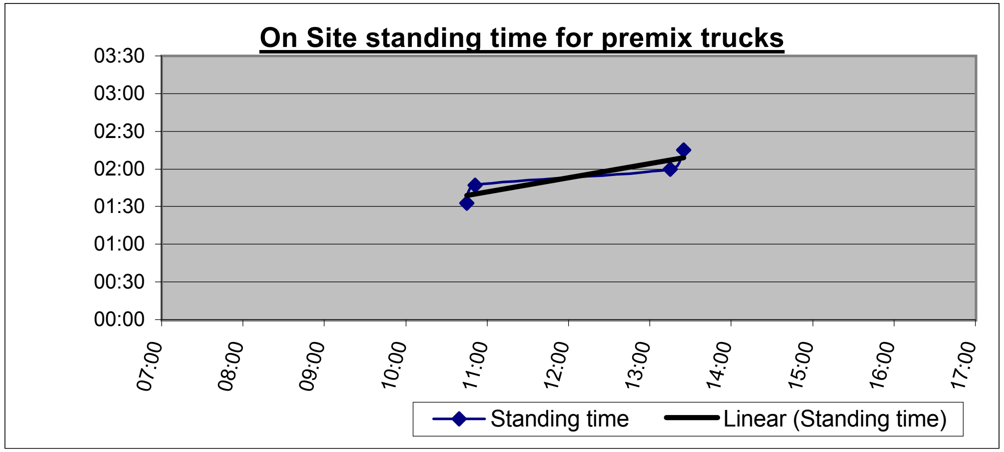
Production 0.0 t BTB 242.0 t MED
Mat returned: 0.0 t BTB 13.6 t MED
Remark: Milling and then paving on N3 at Vosloorus bridge
Production rate: 42.8 t/hr

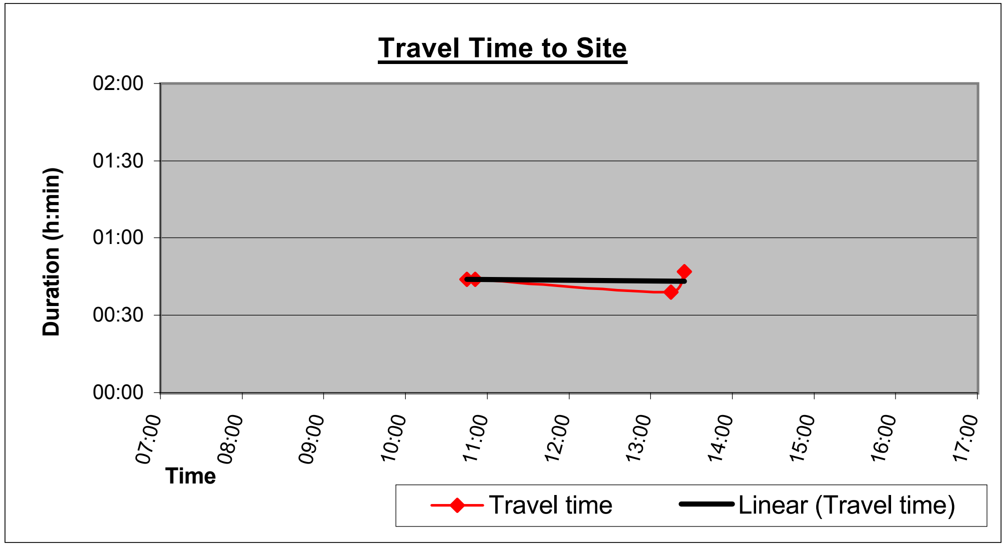
Med 5.0

Date 10/5/2002

No.	Ticket No.	Time despatched	Time on site h:min	Time off site h:min	Travel Time h:min	On Site Time h:min
1	1777	10:01	10:45	12:18	00:44	01:33
2	1779	10:07	10:51	12:38	00:44	01:47
3	1806	12:36	13:15	15:15	00:39	02:00
4	1807	12:38	13:25	15:40	00:47	02:15

N3 Old Barn





Avg on site time: 01:53

Avg travel time: 00:43

Avg total trip time 03:20

Note: Travel time is for one way trip

Production 0.0 t BTB 95.4 t MED

Mat returned: 0.0 t BTB 11.6 t MED

Remark: Working on intersection on bridge: slow work.

Production rate: 19.4 t/hr

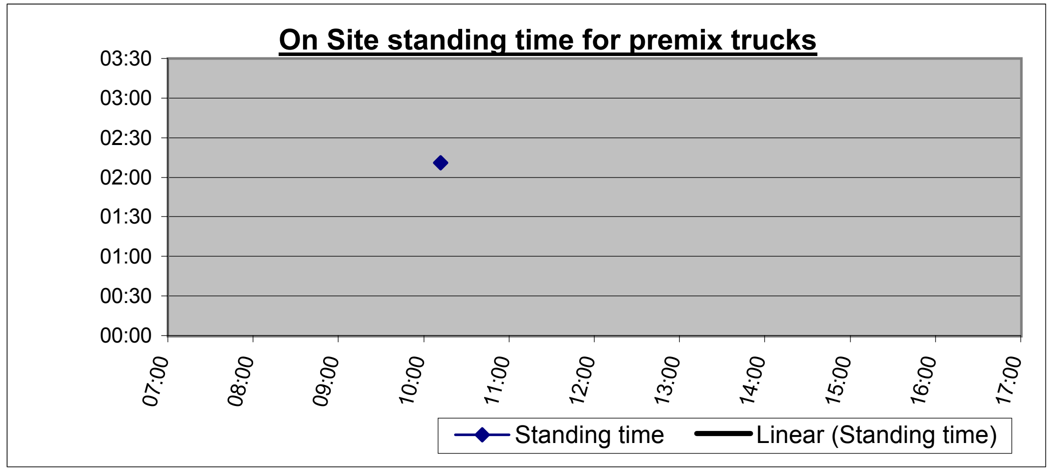
Med 5.0

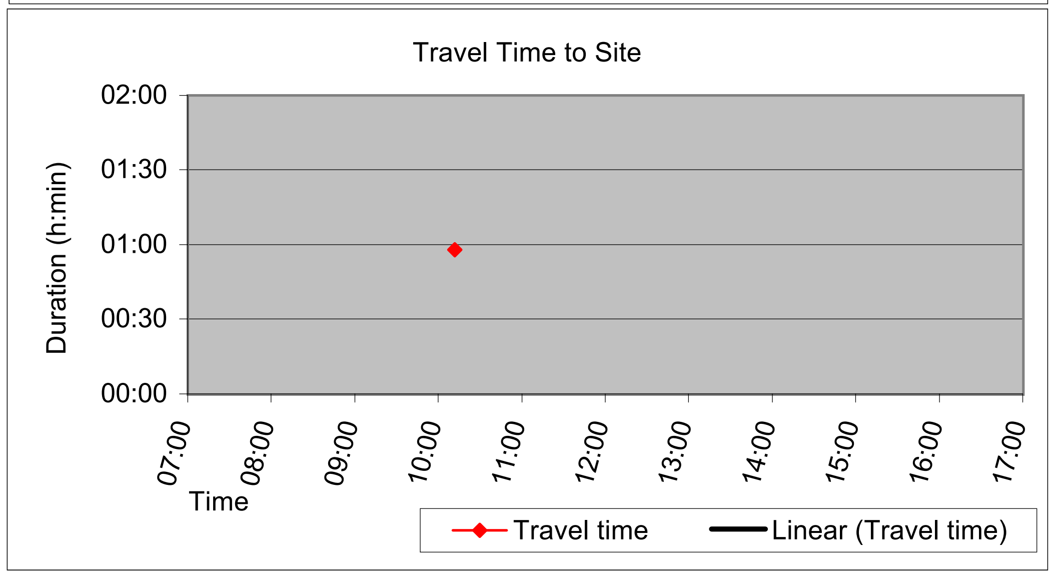
Date 13/5/2002

No.	Ticket No.	Time despatched	Time on site h:min	Time off site h:min	Travel Time h:min	On Site Time h:min
1	1891	09:14	10:12	12:23	00:58	02:11

Avg on site time: 02:11
Avg travel time: 00:58
Avg total trip time 04:07
Note: Travel time is for one way trip

N3 Old Barn





Production	0.0 t BTB	4.0 t MED
Mat returned:	0.0 t BTB	t MED
Remark:	Paver breakdown: 3 trucks returned.	
Production rate:	1.8 t/hr	

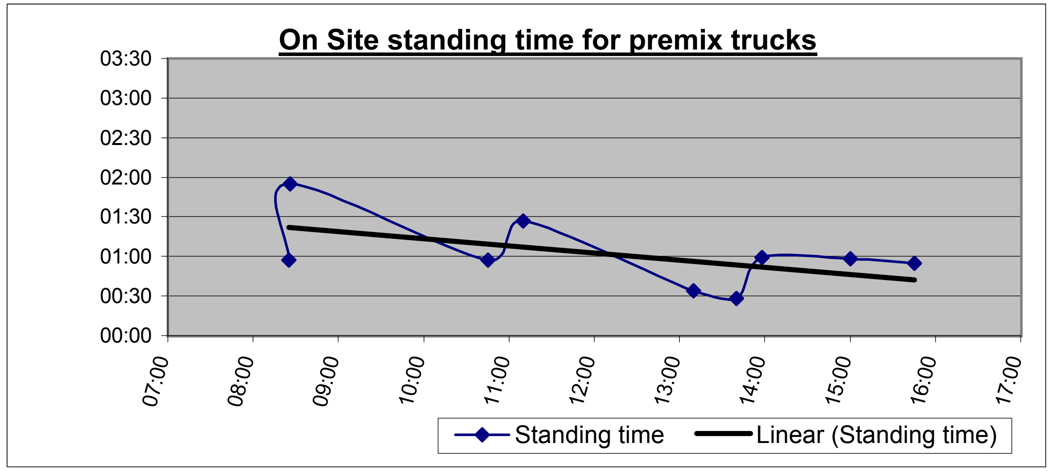
Med 5.0

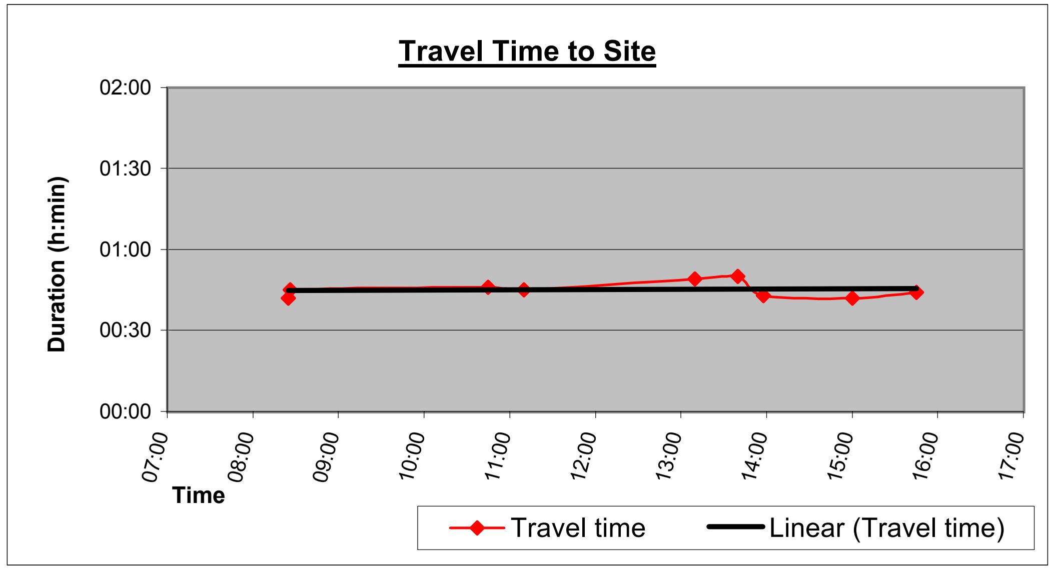
Date 14/5/2002

No.	Ticket No.	Time despatched	Time on site h:min	Time off site h:min	Travel Time h:min	On Site Time h:min
1	1975	07:43	08:25	09:22	00:42	00:57
2	1974	07:41	08:26	10:21	00:45	01:55
3	2002	09:59	10:45	11:42	00:46	00:57
4	2007	10:25	11:10	12:37	00:45	01:27
5	2027	12:21	13:10	13:44	00:49	00:34
6	2034	12:50	13:40	14:08	00:50	00:28
7	2038	13:15	13:58	14:57	00:43	00:59
8	2049	14:18	15:00	15:58	00:42	00:58
9	2057	15:01	15:45	16:40	00:44	00:55

Avg on site time: 01:01
Avg travel time: 00:45
Avg total trip time 02:31
Note: Travel time is for one way trip

N3 Old Barn





Production	0.0 t BTB	171.7 t MED
Mat returned:	0.0 t BTB	0.0 t MED
Remark:	Working on intersection on bridge: slow work.	
Production rate:	20.8 t/hr	

Med 5.0

Date 15/5/2002

No.	Ticket No.	Time despatched	Time on site h:min	Time off site h:min	Travel Time h:min	On Site Time h:min
1	2063	07:18	08:00	10:33	00:42	02:33
2	2081	09:17	09:55	11:04	00:38	01:09
3	2079	09:08	09:56	11:22	00:48	01:26
4	2082	09:24	10:08	12:32	00:44	02:24
5	2083	09:32	10:08	12:23	00:36	02:15
6	2092	09:56	10:35	13:36	00:39	03:01
7	2090	09:51	11:10	13:07	01:19	01:57
8	2131	12:46	13:23	14:33	00:37	01:10
9	2143	13:51	14:30	14:47	00:39	00:17
10	2154	14:28	15:10	15:45	00:42	00:35

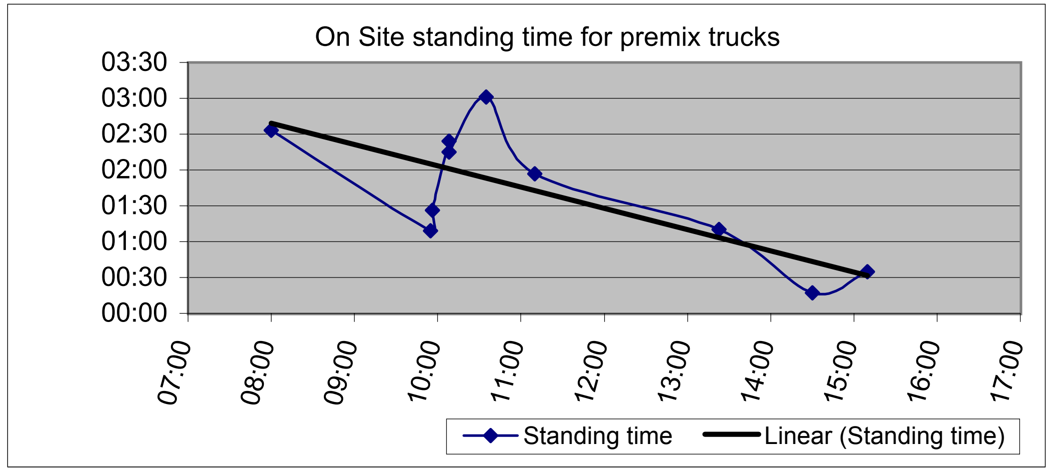
Avg on site time: 01:40

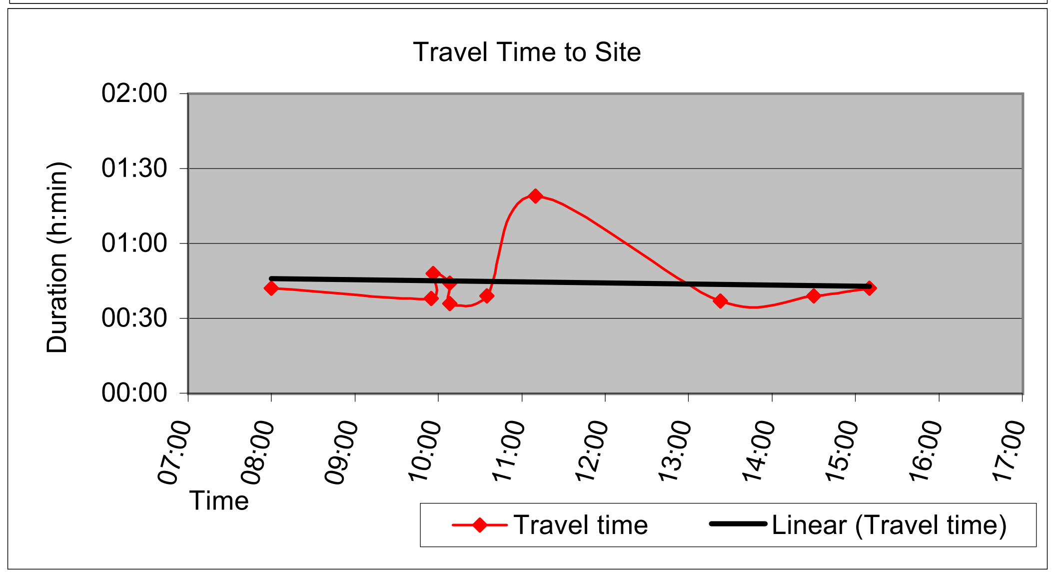
Avg travel time: 00:44

Avg total trip time 03:09

Note: Travel time is for one way trip

N3 Old Barn





Production	0.0 t BTB	171.7 t MED
Mat returned:	0.0 t BTB	0.0 t MED

Remark: Working on intersection on bridge: slow work.

Production rate: 22.2 t/hr

Med 5.0

Date 16/5/2002

No.	Ticket No.	Time despatched	Time on site h:min	Time off site h:min	Travel Time h:min	On Site Time h:min
1	2171	06:45	07:20	08:51	00:35	01:31
2	2172	06:48	07:25	09:40	00:37	02:15
3	2174	06:52	07:25	10:23	00:33	02:58
4	2197	09:11	09:55	11:40	00:44	01:45
5	2198	09:20	10:00	12:44	00:40	02:44
6	2213	10:54	11:34	13:46	00:40	02:12
7	2233	12:21	12:58	14:16	00:37	01:18
8	2238	12:50	13:30	14:39	00:40	01:09
9	2256	14:11	14:40	15:38	00:29	00:58
10	2255	14:07	14:55	16:00	00:48	01:05

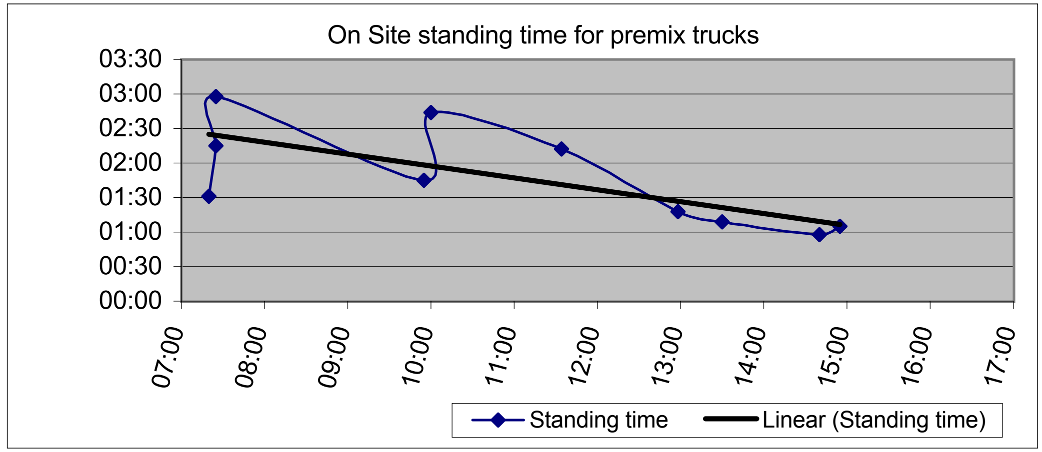
Avg on site time: 01:47

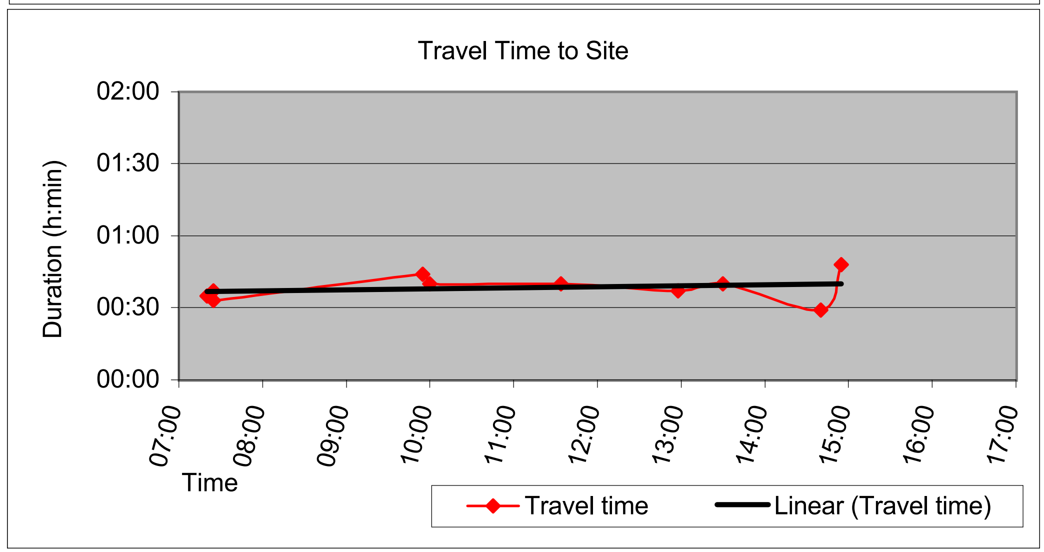
Avg travel time: 00:38

Avg total trip time 03:04

Note: Travel time is for one way trip

N3 Old Barn





Production	0.0 t BTB	203.3 t MED
Mat returned:	0.0 t BTB	0.0 t MED
Remark:	Working on intersection on bridge: slow work.	
Production rate:	23.5 t/hr	

PLANT TO PAVER, THE TRANSPORT OF ASPHALT

In the construction of any new road that has an asphalt surface, the surfacing will be produced at an asphalt plant that might be some distance away from the actual road. It is only on a few larger contracts that the mobile plant would be erected next to the road to supply the asphalt to the specific project.

As in any production process the continuous flow of material is crucial for a high production rate. This is then also the case with paving operations, where the paver has to be supplied with a constant stream of hot asphalt, not only for production considerations, but also to ensure a better final product. The reason for this is that if there is a constant flow of material, a smoother final surface is produced due to the paver that is running with less stop-start sequences that negatively affect the smoother finish on the road.

It is in the light of the above-mentioned facts that a study was undertaken on the Old Barn project on the N3, to evaluate what steps could be taken to achieve a consistent rate of delivery from the plant to the paver. Much Asphalt was the supplier of the asphalt to this project and the asphalt plant is located in Benoni, approximately 40km from the plant.

This project entailed the milling of existing deteriorated wearing course asphalt on marked out sections of the N3 national route. The work was done on both the north- as well as the southbound lanes. The majority of the work being carried out is in the left lane, where the heavy vehicles drive in the slower lane, and where the biggest deterioration has occurred.

The work for each day would start off with each section being cordoned of for the diversion of traffic. A typical day on site starts out at 7h30, and the construction team must be off the road by 16h00 in the afternoon, otherwise lane-closure penalties apply. No work was allowed to be carried out on public holidays or school holidays as well as the days preceding the holidays, due to the increased amount of traffic on this route that have to be accommodated.

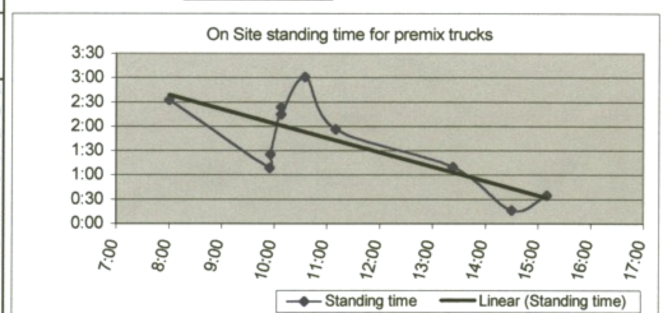
The study started with an analysis of the weighbridge tickets for a specific day, which was summarized and represented graphically. This would give an indication of the time the vehicles took to travel to site, as well as the time spend on site. All this information would be sorted and graphs drawn up and certain calculations done to determine average production rates and standing time on site. An example of a typical daily summary sheet is shown below:

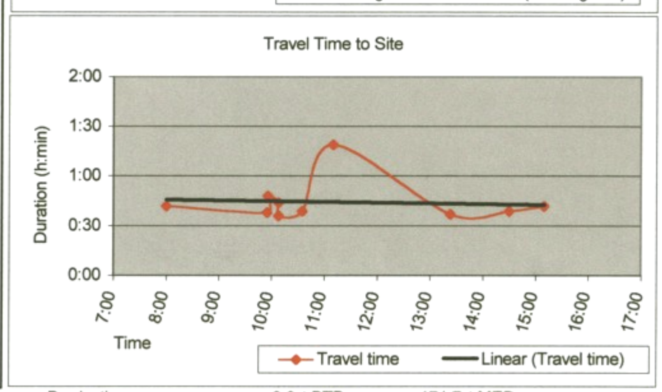
Med 5.0

Date 15/5/2002

No.	Ticket No.	Time despatched	Time on site h:min	Time off site h:min	Travel Time h:min	On Site Time h:min
1	2063	7:18	8:00	10:33	0:42	2:33
2	2081	9:17	9:55	11:04	0:38	1:09
3	2079	9:08	9:56	11:22	0:48	1:26
4	2082	9:24	10:08	12:32	0:44	2:24
5	2083	9:32	10:08	12:23	0:36	2:15
6	2092	9:56	10:35	13:36	0:39	3:01
7	2090	9:51	11:10	13:07	1:19	1:57
8	2131	12:46	13:23	14:33	0:37	1:10
9	2143	13:51	14:30	14:47	0:39	0:17
10	2154	14:28	15:10	15:45	0:42	0:35

N3 Old Barn





Avg on site time: 1:40
Avg travel time: 0:44
Avg total trip time 3:09
Note: Travel time is for one way trip

Production 0.0 t BTB 171.7 t MED
Mat returned: 0.0 t BTB 0.0 t MED
Remark: Working on intersection on bridge: slow work.
Production rate: 22.2 t/hr

Fig. 1 – A Typical daily summary sheet

This was done for every day that production took place on the project. At the end of the project these results were analyzed to see if there was any typical trends pertaining to the type of work being carried out or any occurrences that took place. The vehicle logsheets were used as a method of verification of the data that was gathered. A time study was also undertaken on a few days to verify some of the results.

There were some definite trends that were identifiable:

- On a normal production day the standing time on site would decrease as the day progresses. This would mean that the first vehicles delivering asphalt on site would spend a longer amount of time on site, than they would on the return trip to the paver. This can be explained due to the paving process taking time to start-up, and the production team getting into the flow of the process. This was the case when there were no other delays or problems experienced.
- If the paver was moved or work was carried out on different sections, there would be a second "start-up" phase and an extension of the time the vehicles spend on site.

The timely delivery of the asphalt to the site, and a high production rate depended on a variety of factors. The following were identified:

- The distance traveled to the specific point on the contract. The easy access to the site as well as the route taken by the trucks determined the time they traveled to site.
- The amount of vehicles delivering asphalt to the specific project.
- The type of work that was carried out; if work was done on an intersection the production rate would be lower than working on straight sections.
- Any breakdowns experienced by the asphalt plant, the transporter trucks or paving equipment would cause a delay in the process.

It is interesting to note that it was determined that there would normally be a correct number of vehicles for a specific type of work being carried out, and that the demands would vary from day to day with the amount of work carried out and the type of operation being preformed. There is no fixed amount of vehicles that would cater for all occasions. The obvious assumption would be to have as many vehicles as possible assigned to the project. This is not the case. If a project would be flooded with vehicles, there is a risk of the asphalt becoming cold before it is paved due to the vehicles spending an excessive amount of time on site, and standing time is created by not sending the vehicles at an interval. Additionally to that, there is the higher risk that in the case of a paver breakdown or work stoppage, the amount of material that have to be returned to the plant will be a lot larger – with cost implications and disputes flowing from that.

The asphalt plant operator actually has quite a predicament on his hands. He will typically be supplying asphalt to various contacts, and also various compositions of mixtures. The crux of the matter is that most contractors would like to receive their asphalt as early as possible in the day to start their production. For the asphalt producing plant it is not so easy. Orders are placed the previous afternoon at 16h00, and only confirmed the next morning. From the time of confirming the order, each customer expects his work to receive priority and be on site as soon as possible. Fortunately if a plant is equipped with proper hot-storage facilities, it enables the plant to start producing the typical asphalt mixes in advance and store them for dispatching as and when required. There is a limited time that the asphalt can be stored to ensure the temperature does not drop too low, so even in this practice there is a risk involved for the manufacturing plant.

As in all production processes the importance of planning could not be underestimated. Proper information constitutes planning on valid facts. The more accurate the information relating to the needs from the paving contractor is in terms of tonnage required, time required and the rate at which it is required, the better the planning at the plant can be executed.

It was found that the only information that would normally be received by the plant would be the tonnage required, and no consideration was given to the type of work that was carried out. This would result in cases where work would be done on intersections and bridge-decks that the amount of vehicles assigned to the project would be too high. These vehicles could well be used better elsewhere. The plant would claim standing time charges for the trucks standing at the paver, waiting to discharge and return to the plant. As with any construction claim for additional payment, this is never a preferred way to do business and can damage a relationship between the customer and the client.

In the end it all comes down to communication and an open relationship between the supplier and his client. In the past a practice has developed whereby the paving foremen “inflate” their orders for the following day, to ensure that they receive the proper quantity of material they expect, and then just simply canceling the balance of the order that they never required from the beginning.

It is practices like this that doesn’t bode well for relationships between the asphalt supplier and the paver. The reality is that work being carried out unproductively by either the paving team or wastage on the part of the asphalt plant is not desirable. In the long term this pushes up the prices that clients have to pay for their products.

A conscious effort should be made to improve the relationship between the asphalt plant and the construction team, to ensure openness and honesty that would benefit all in the long term. It does not only take technology, but the right people behind the technology to make any process successful.

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