CALIBRATION OF THE GRAVITY MODEL USING INTER-URBAN TRUCK DATA IN B.C.

by

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ABSTRACT

This thesis concerns a survey of inter-regional or inter-urban commercial truck traffic at weigh scales in B. C. and how parts of the information collected can be used to calibrate a gravity model of the type proposed by the Federal Highways Administration (U. S. A.). The results of the calibration of both the 27 and 31 node models are compared with previous calibration efforts in an intra-urban context.

There is a relatively detailed presentation of the design and completion of this type of survey. Also, the role of the gravity model of trip distribution in the planning process is explained.

A new method of determining the inter-zonal impedance is used. This impedance is based on trip cost and takes into account such things as type of terrain (level, rolling, mountainous).

The results indicate that the calibration was successful. The use of the gravity model of trip distribution would appear to be an appropriate technique in the analysis of inter-urban commercial truck traffic.

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ACKNOWLEDGEMENT

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1. INTRODUCTION

1.1 PROBLEM

Transportation planning is concerned with the movement of people and goods; more specifically, with the provision of facilities by which the efficiency of this movement is maximized. The ultimate goal of the transportation planning process is to predict the impact of future demand levels on proposed transportation systems. Using a systems approach in this process enables evaluation of alternative transportation systems or alternative sets of improvements to the existing transportation system; the objective being to select the best alternative with respect to the goals and objectives of the people.

This systems approach to transportation planning involves the use of several groups of mathematical models:

1. Trip Generation
2. Trip Distribution
3. Modal Split and
4. Network Assignment

The use of these models generally involves four phases:

1. Inventory of the current system. This is accomplished by surveys of one form or another,
2. Analysis of existing conditions and calibration of forecasting techniques,
3. Forecasting future conditions and
4. Analysis of the impacts of future transportation systems for evaluation and feedback.

One of the primary purposes, if not the primary purpose, of an inter-city road system is to enable economic interchange between areas. In the planning of inter-regional or inter-city transportation networks, trucks (often due to a lack of data) are given much less consideration than cars. Analysis and design have emphasised automobile traffic with trucks assumed to be some percentage of the total stream with the same origin/destination (O/D) characteristics. The traditional traffic models (trip distribution, etc.) have not been applied to goods movement. The reasons for this neglect could be lack of survey techniques and/or lack of interest. In any case, it is a mistake to plan a highway network without giving full consideration to goods movement.

This thesis combines previous knowledge--gravity model theory and inter-city travel costs--with new information obtained from the application of an old survey technique--roadside interview--to a new problem (inter-city goods movement). The findings indicate that the data provided by this survey can be used in the gravity model to analyse inter-city truck traffic with good results.

A significant contribution to the field of transportation engineering/planning is the result. Planning and design of highway systems can now be based on truck as well as car traffic using analytical methods such as the gravity model. Previously this valuable tool had not been applied in this context.

This thesis is concerned with the use of inter-city truck traffic data to calibrate the gravity model of trip distribution. The calibration is based on data of truck trips between cities in British Columbia. That is, a model of internal-internal trips. The gravity model used can be represented by the following formula as discussed in detail in section 3.3:

$$T_{ij} = \frac{P_i A_j F_{ij} K_{ij}}{\sum_{x=1}^{n} A_x F_{ix} K_{ix}}$$

where:

T_{ij} = the number of trips from zone i to zone j.

P_i = trips produced by zone i.

A_j = trips attracted by zone j.

F_{ij} = the friction factor for travel time between zone i and j.

K_{ij} = socio-economic adjustment factor between zones i and j.

n = the number of zones.

The design and use of the roadside interview form of survey is discussed with emphasis on its ability to provide a base year O/D table. This analysis also used a new type of impedance which was developed by D. F. Townsend (2). Generalized trip cost replaces distance or time.

1.2 HYPOTHESIS

The question, at which the research is directed, is whether traditional planning techniques such as the gravity model of trip distribution can be developed so that the design of road networks between cities is more sensitive to truck traffic. The hypothesis is that the origin/destination data from a roadside survey of trucks can be used to calibrate a gravity model of inter-urban truck traffic in B. C. The use of data from a roadside survey to calibrate a gravity model is an important element of this thesis.

The main variables are the number of trips and interzonal impedance such as travel cost or trip length. Impedance can be defined as that which causes or tends to cause a reduction in the number of trips or interaction between zones. Examples are cost, distance, relief, separation by water and political boundaries.

Due to the large diversity in commodities carried and the lack of a commonly accepted general-purpose commodity classification system, all trips are treated using the same model. This ignores the high degree of regional specialization common in basic resource economies. The trip length would tend to be determined by the location of areas environmentally suitable to the production and consumption of the commodity. An example of this is the soil and climate conditions necessary for fruit production and population groupings of a sufficient size to maintain a viable market. As a result, the gravity model's assumption of a correlation between spatial separation and number of trips is questionable.

A similar problem occurs when the model is used to analyse work trips in an urban area. The choice of residential location and place of work, which determine the work trip length are determined by many factors including the environmental conditions of the nodal areas (3). The "socio-economic" factor K is intended to allow for this effect. However, it is noted that a certain amount of controversy surrounds this factor (Catanese; pg. 209-240).

1.3 DATA

The main source of data is a survey done by the Department of Highways of British Columbia during July and August of 1974. This survey, which the author helped design and conduct, involved interviewing truck drivers at certain weigh scales. One survey form was completed for each truck that stopped at a scale. The interviews were conducted for approximately one week (5 days) at selected scales. The information collected was used to produce an O-D table of weekly (5 day) inter-city truck traffic.

The data on interzonal travel costs is that developed by D. F. Townsend (2) for the purpose of relating investment in highway facilities to reduction in truck (heavy) operating costs. These figures are sensitive to the effects of:

1. Surface finish (pavement or gravel),
2. Legally restricted speeds (urban areas),
3. Road width,
4. Type of terrain (flat, rolling, mountainous),
5. Traffic flow volumes, and
6. Ferry delays.

While this work was done using 1971 information it is felt that the results are suitable for use in this calibration exercise. Only relative travel costs between zones are relevant for the gravity model. If the interzonal impedances were in the same proportion at the time of the survey as those calculated for 1971, then the use of this data in calibration is valid. This is felt to be the case in this instance.

1.4 METHODOLOGY

The question of whether or not the gravity model of trip distribution is suitable for application in this situation is answered in a relative context. The model's ability to reproduce the base year trip table is compared with that of other, more conventional calibration efforts.

Statistical measures form the basis of the conclusions reached in this thesis. From the available statistics two are chosen for analytical purposes:

1. Trip length (cost) distribution comparison by means of the chi-squared goodness-of-fit test, and
2. The root mean square error (RMSE) which measures the dispersion between the calibrated and the actual number of trips between each pair of zones.

The values of these two variables are used to compare the 31 and 27 node models developed in this analysis.

The comparison of these truck models with other calibration efforts had to be done on the basis of average trip length (cost) difference because the two above-noted statistics were not reported.

1.5 SUMMARY

This chapter briefly outlines transportation planning and at what area of the transportation planning process this research is directed. The project is described in general terms. The objective is to convey an understanding of how this work relates to the whole field of transportation planning. The rest of the thesis details each element of the work along with the results and implications for practical application and future research.

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2. TRIP DISTRIBUTION MODELS

This chapter discusses the different models of trip distribution. The theory, advantages and weaknesses of the models are presented. The rational behind focusing on the gravity model in this analysis is presented below.

There are four major methods of trip distribution in the planning process:

1. Fratar-Method Growth-Factor Model
2. Intervening Opportunities Model
3. Competing Opportunities Model
4. Gravity Model

The main emphasis of this thesis is on the gravity model for a number of reasons including the following:

1. Highway network improvements are not considered in the Fratar model. There is no direct provision for travel time changes.
2. The distance ranking of zones from the zone of origin in the intervening opportunities model can change with selective improvements to the road system.
3. One significant study (3) found that the competing opportunities model was difficult to calibrate and gave results inferior to both the gravity and intervening opportunities models. This was a substantial study using data from Washington, D. C.

2.1 FRATAR-METHOD GROWTH-FACTOR MODEL (2)

This model is based on the assumption that the future trip distribution pattern is proportional to that of the base year modified by the growth factors of the zones under consideration (4).

The trip interchange between any two zones in the forecast year is directly proportional to the growth factors of the two zones and inversely proportional to the average attracting pull of all other zones on the zone of origin (1).

$$T_{ij} = t_{ij} F_i F_j \frac{\sum_{x=1}^{n} t_{ix}}{\sum_{x=1}^{n} t_{ix} F_x}$$

subject to:

$$F_i^k = \frac{T_i}{\sum_{j=1}^{n} T_{ij}^k}$$

and

$$F_j^k = \frac{T_j}{\sum_{i=1}^{n} T_{ij}^k}$$

where:

k = the iteration.

t_{ij} = base year trips between zone i and j.

T_{ij} = prediction year trips between zone i and j.

t_i = base year trip productions in zone i.

t_j = base year trip attractions to zone j.

T_i = forecast year trip productions in zone i.

T_j = forecast year trip attractions to zone j.

F_i = growth factor for zone i = T_i/t_i.

F_j = growth factor for zone j = T_j/t_j.

n = the number of zones in the study area.

The final (prediction-year) trip distribution pattern is obtained by an iterative procedure starting with the base-year pattern. This model does not have a separate calibration phase.

2.2 INTERVENING OPPORTUNITIES MODEL

The basic hypothesis of this model is that the number of trips from an origin zone to a destination zone is directly proportional to the number of opportunities (destinations) in the destination zone and inversely proportional to the number of intervening opportunities or destinations between the zone of origin and the zone of destination being considered (4). The model can be expressed by an equation of the form:

$$T_{ij} = C_i \; O_i \; (\exp(-LV_j)-\exp(-LV_{j+1}))$$

where:

T_{ij} = trips from zone 1 to zone j.

O_i = number of trip origins in zone i.

V_j = total destinations considered up to zone j.

V_{j+1} = total destinations considered up to and including zone j.

L = a constant probability of a destination being accepted if it is considered.

C_i = a constant for zone i which is determined by requiring that the constraint, $\sum_{j=1}^{n} T_{ij} = O_i$, be satisfied.

The calibration procedure generates a value or values of L from a set of base year O/D data. Calibration is usually done using an iterative technique which is terminated when the computed mean trip length for each zone is in satisfactory agreement with the actual mean trip length (1).

Studies by Ruiter and Pyers (7, 6) indicate, in one case, the need to use multiple conditional probability measures L and in the other, a poor correspondence between the two trip-length frequency distributions.

2.3 COMPETING OPPORTUNITIES MODEL

This model's basic assumption is that the probability that a trip originating in a given district and ending in another district is given by the ratio of destination opportunities within the destination district to all destination opportunities within the same time zone up to and including the destination district in question (5). The model can be expressed by an equation of the form (5):

$$T_{ij} = T_i \frac{A_j / A_x}{\sum_n (A_j / A_x)}$$

where:

T_{ij} = the trips from zone i to zone j.

T_i = the number of origins (productions) in zone i.

A_j = the number of destinations (attractions) in zone j.

A_x = the total number of destinations from zone of origin i within the time band containing the zone of destination.

n = the number of time zones or bands.

The suggested method of calibration is adjustment of the time band intervals until agreement is obtained between the O/D trip length frequency distribution and that generated by the model (5).

The results of a study by Heanue and Pyers (3) indicate that the model is difficult to calibrate and that it produces inferior results to the gravity model.

2.4 GRAVITY MODEL

The gravity model of trip distribution is described in detail in chapter 3.

This analysis is based on the gravity model for a number of reasons including the following:

a) The gravity model, while simple in concept, is sensitive to changes in travel time or cost.

b) Relative to other models the use of the gravity model has been well documented. This information is used to evaluate the model's performance in its application.

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3. THE GRAVITY MODEL OF TRIP DISTRIBUTION

Now that the research is focused on the use of the gravity model, this chapter presents a more detailed description of the gravity model in the transportation planning process. The theory, application and calibration of the model are explained. Also, statistics used to evaluate the quality of the calibration are presented.

3.1 TRIP DISTRIBUTION IN THE PLANNING PROCESS

Inherent in the (transportation) planning process is an appraisal of alternative plans; ranking being on the basis of fulfillment of community goals and objectives. A simplified model of the (transportation) planning process is shown in Figure 3-1.

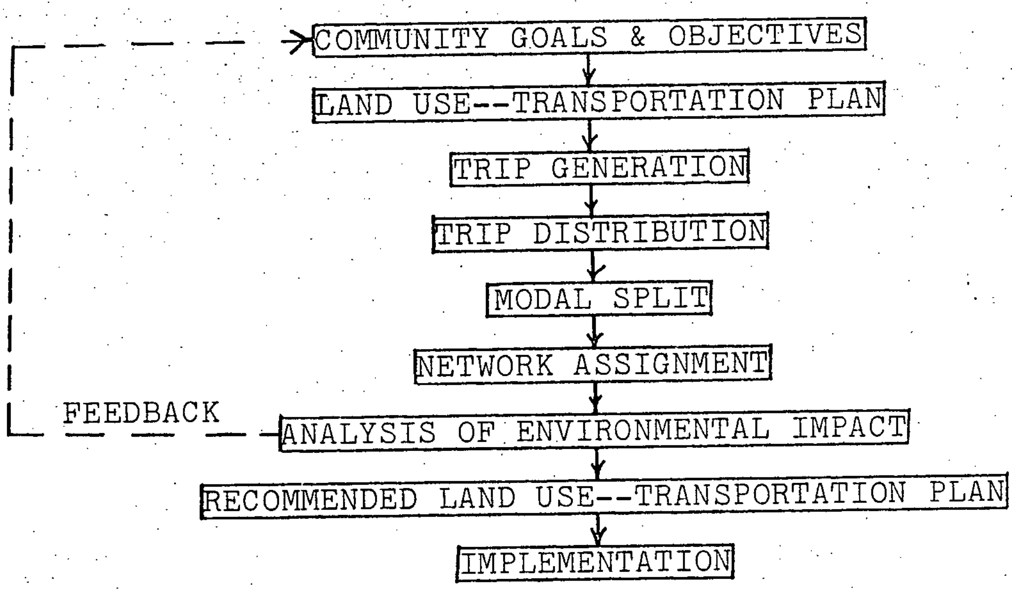

FIGURE 3-1. THE PLANNING PROCESS

It is now generally recognized that both present and future traffic patterns are a function of:

1. The social and economic characteristics of the people who make trips;

2. The pattern of land use in an area, including the location and intensity of use; and

3. The type and extent of transportation facilities available in an area. (1)

An essential part of any systematic planning based on these relationships is a method of estimating the zonal trip interchange of alternative plans. This capability is provided by various mathematical formulas known as "trip distribution models". The most common is the "gravity model" as detailed by the Federal Highways Administration. (1)

3.2 GRAVITY MODEL THEORY

The theory of the gravity model is based on the concept of gravitational force advanced by Isaac Newton in 1686. This law states that the force of attraction (gravity) between two quantities of matter is directly proportional to the product of their masses and inversely proportional to the square of the distance between them. Mathematically it is expressed as follows:

$$F \propto \frac{M_1 M_2}{D^2}$$

where: F = the gravitational force
M_1 = mass of body #1
M_2 = mass of body #2
D = distance between 1 and 2.

Basically, the gravity model says that trip interchanges between zones depends on the relative attraction of each of the zones and on some function of the zonal spatial separation (1). The mathematical formulation is (3):

$$T_{ij} = \frac{P_i A_j / d_{ij}^b}{\sum_{k=1}^{n} A_k / d_{ik}^b}$$

where: P_i = trips produced by zone i.
A_j = trips attracted by zone j.
d_{ij} = spatial separation between i & j.
b = an empirically determined exponent expressing the average effect of area-wide separation on trip interchange between zones.

The problem with this formulation is the determination of the value of the exponent. It must be found empirically by trial and error.

An analysis of the results of the research and application of this early form of gravity model indicates four significant findings (1):

1. Spatial separation between zones appears to be best measured by "over the road" driving time plus some measure of terminal time in the zones at each end of the trip.

2. The exponent of travel-time appears to be inversely proportional to the importance of the trip.

3. For most trip purposes the exponent of travel-time generally increases as the time interval increases.

4. The exponent of travel-time alone, does not completely explain the propensity for travel between two points. Travel patterns can also be affected by various zonal social and economic linkages.

3.3 GRAVITY MODEL APPLICATION

The revised gravity model formula which is now used in practice is (3):

$$T_{ij} = c_i \; P_i \; A_j \; F_{ij} \; K_{ij} \qquad (3.3.1)$$

where: T_{ij}; P_i; and A_j are previously defined.

F_{ij} = friction factor for travel time between zones i and j.

$$c_i = \frac{1}{\sum_{x=1}^{n} A_x \; F_{ix} \; K_{ix}}$$ = a constant for any origin zone i

The friction factors (F_{ij}) are a measure of the impedance to interzonal travel due to the spatial separation between zones (1). The relationship between the F factors and interzonal impedance (cost, time, distance) is:

$$F_{ij} \propto t_{ij}^{-b}$$

where: F_{ij} and b are previously defined.

t_{ij} = a measure of the interzonal impedance or spatial separation such as travel cost, time, or distance.

Note that research has found B to be a function of t (4;p. 304).

These factors are found by a process of trial and adjustment using the base year data. In addition to being more accurate, this revised formula's (3.3.1) computational requirements are greatly simplified. There is no inverse exponential to calculate. During calibration there is a process available where the F factors are assumed to be an exponential function (smoothing function) of the interzonal impedances. If this assumption is made, the calibration of the model produces the parameters of the smoothing function as output instead of a list of friction factors.

The K factor is a specific zone-to-zone adjustment factor to allow for the incorporation of the effect on travel patterns of social and economic linkages not otherwise accounted for in the gravity model formulation (2).

The value of c_i is established by requiring that the number of trips originating from zone i be equal to P_i. This ensures that when all trip interchanges (T_{ij}) have been computed the row sum for each zone equals the total number of trips produced (productions) by each zone (P_i).

But, there is no guarantee that the attraction totals (column sums of T_{ij}) are equal to the total number of trips attracted (attractions) to each zone (A_j). An iterative procedure (attraction balancing iterations) is used to make the necessary adjustments. After each iteration adjusted attraction factors are calculated from the following formula (3):

$$A_j^k = \frac{A_j}{C_j^{k-1}} A_j^{k-1} \qquad (3.3.2)$$

where: A_j^k = adjusted attraction factor for iteration k.

C_j^k = actual attraction total (column sum of T_{ij})

A_j = desired attraction total.

3.4 CALIBRATION OF THE GRAVITY MODEL

Calibration consists of using the base year O/D data to produce the friction factors (F) and where necessary the socio-economic factors (K_{ij}). To produce friction factors as output the model requires three basic inputs:

1. The base year O/D table giving the number of trips between each pair of zones.

2. A table giving, for each zone, the total number of trips produced in a zone (row sum) as well as the total number of trips attracted by that zone (column sum). These are, respectively, the P's and A's of the gravity model formula.

3. A table containing a measure of the zonal spatial separation between each pair of zones. The values, in this table could represent the total driving plus terminal time, the total travel cost, the out-of-pocket cost, or the distance between zones.

Calibration is started by assuming an initial set of factors (F), usually equal to 1.0. These values together with input values of P and A are used in equations (3.3.1) and 3.3.2) to produce a gravity model distribution of trip interchanges. This set of estimated trip interchanges is compared with the actual trip interchanges as given by the O/D table. Since the gravity model calculations use data directly from field surveys to express all parameters except the assumed friction factors, any difference between the two trip length frequency distributions are due principally to a poor assumption as to the initial value of these friction factors (1). The F factors are adjusted iteratively until the two sets of trip interchanges are in close agreement. Mathematically the procedure can be represented as follows (3):

$$F_r^{k+1} = F_r^k \frac{T_r}{T_r^k} \qquad (3.4.1)$$

where: r = the set of zonal interchanges which by virtue of having the same impedance, have the same F factor.

T_r = the desired total trips for group r.

T_r^k = the total trip interchange for group r obtained using equations (3.3.1) & (3.3.2) and friction factor F_r^k.

F_r^k = the friction factor associated with group r in calibration iteration k. Initial estimates of F_r may be supplied as data or simply assumed to be 1.0.

A further refinement can be affected by requiring that the friction factors represent ordinates of a smooth curve of the type (3):

$$F_r = aI_r^b \, e^{-cI_r} \qquad (3.4.2)$$

where: a, b, & c are constants produced by fitting the points from equation (3.4.1) to equation (3.4.2)

I_r = the impedance for group r

In chapter five of Catanese, a discussion is presented concerning the use of the socio-economic factor K in the gravity model. The argument for exclusion of the K factor in favor of a concentration of effort on the F factor is based on a number of things:

1. There are relatively large errors of measurement associated with the F factors. Studies (2; pg. 213) found that the coefficient of variation of the F term was in every instance greater than one and averaged closer to five.

2. At this point no evidence exists to shed light on what the magnitude of the error of measurement of the K factor might be (2: pg. 214).

3. There is at least a strong suspicion that the K factor and the friction factor are correlated (2; pg. 214).
4. The error in the output of a model resulting from the error of measurement associated with each of the input variables increases rapidly as measurement error increases, especially if the input variables are correlated. That is, as the complexity of the

> model increases the more the errors of measurement accumulate. The gains in correctness of specification in a more complex model can be offset by the compounding of measurement errors (2; pg. 213).

Accordingly, it can be concluded that in order to justify their inclusion the K factors would have to provide a "substantial" increase in the predictive ability of the model. The exact amount of this "substantial" increase cannot be calculated as there is yet no way to determine the error of measurement in the K factors.

The main objective of this thesis is to develop a set of friction factors for inter-city truck traffic in B. C.

3.5 EVALUATING THE MODEL CALIBRATION

Base year values can be compared with calibrated model simulations using several tests. The two tests used here are (3):

1. The Chi-squared goodness-of-fit test is used to compare the base year and calibrated trip length distributions. The statistical measure can be obtained from the formula (3):

$$\chi^2 = \sum_{k=t_{min}}^{t_{max}} (t_k^c - t_k^a)^2 / t_k^a$$

where: t_k^c = calibrated # of trips for impedance value 1.

t_k^a = actual # of trips for impedance value k.

t_{min} = minimum impedance value

t_{max} = maximum impedance value

2. The root mean square error (RSME) is a measure of the difference between calibrated and actual O-D values.

It is defined by (3):

$$RSME = \sqrt{MSE}$$

$$MSE = \sum_{i=1}^{n} \sum_{j=1}^{n} (T^c_{ij} - T^a_{ij})^2 / n^2$$

Where: T^c_{ij} = calibrated trip interchange between zones i and j.

T^a_{ij} = actual trip interchange between zones i and j.

n = the number of zones.

The purpose of these tests is to evaluate how well the calibrated model is able to simulate base year data (i.e. the data from the O/D survey).

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4. THE SURVEY

The gravity model cannot be calibrated without data that has been collected in a survey. This chapter describes in detail the survey used to obtain the data in this thesis. A great deal of credit must go to those who did the Western Canada Truck Origin-Destination Survey in 1973.

The chapter includes a discussion of the results of the survey and a critique outlining the problems of this survey in relation to its use in the gravity model.

4.1 PURPOSE OF THE SURVEY

The main objective of the commercial trucking survey in B. C. is to determine the volumes of truck traffic on provincial highways. The patterns of flow are to be established and analyzed on the basis of origin/destination, commodity type, weight, truck configuration, license class, and capacity utilization. This survey emphasizes inter-regional flows in B. C. Compatibility with similar surveys in other provinces is also an objective. This enables results to be compiled on an inter-provincial basis.

4.2 SURVEY DESIGN

There are two basic methods of obtaining information of the above-noted type.

1. Questionnaires mailed to and completed by appropriate parties.

2. Roadside Interviews.

For various reasons including:

1. The availability of resources and suitable interview sites;

2. The nature of the information desired such as completeness with respect to the amount of private carrier traffic;

3. The results of previous surveys of a similar purpose;

it was decided to use the roadside interview form of survey at permanent weight scales. This limits the survey to vehicles with a registered gross vehicle weight (RGVW) greater than 12,000 lbs. because lighter trucks do not have to report to the scales.

The structure of the B. C. survey is greatly influenced by that of the Western Canada Truck Origin-Destination Survey. Discussions were held with representatives from the federal and provincial governments involved in the Western Canada survey to determine various details of planning and operations involved in that survey. They provided valuable insights on how to organize and run surveys of this type. (e.g. emphasize training and be an equal opportunity employer)

During all stages of planning, contact was made with personnel of the Weigh Scale Branch of the Department of Transport and Communications of B. C. The operation of a weigh scale was observed to see how much time the interview could take without causing undue delay and to see if the interview could be done while the truck was being weighed.

As a result, the interview form was of simple design so that it could be interpreted and completed in two minutes or less. The data collected was such that it had the potential of serving the needs of many interested parties such as the Ministry of Transport (Ottawa), the Department of Transport and Communications of B. C., and the Department of Highways of B. C. The interviews could be conducted while the truck was being weighed. A minimum of two interviewers was necessary at each scale while the survey was in progress.

The questionnaire was constructed to allow coding to take place on the form itself and to allow the coding to be keypunched onto cards directly from the forms. This localized information and reduced coding paperwork and time. The data was thereby mechanized with greater simplicity and accuracy.

The coding system in use was compatible (albeit in some cases at different levels of aggregation) with those used in previous, similar surveys.

4.3 THE INTERVIEW FORM & INTERVIEWER/CODER MANUAL

A copy of the interviewer form (questionnaire) and interviewer/coder manual are in Appendicies I and II.

The manual is intended to explain to the interviewer how to complete the questionnaire and to enable the coder to code the data collected by the interviewer. Having one manual suitable for both interviewer and coder simplifies paperwork and gives both people a more complete picture of the whole survey process.

The purpose of the sequence number is to allow indexing of each record (or FORTRAN record) on magnetic tape to its corresponding card and questionnaire.

The interviewers are told to write the response in the space provided on the form; the coding being done later in the office. This decreased the time required for each interview and allowed the information to be recorded.

The origins and destinations in B.C., Alberta, Saskatchewan, Manitoba, Ontario, Quebec, and the Yukon and North-West Territories were coded using Statistics Canada's STANDARD GEOGRAPHICAL CLASSIFICATION system EXCEPT for the first two numbers denoting province, which have been dropped. Other areas were coded as explained in the interviewer/Coder Manual in the Appendix.

4.4 OPERATIONAL ASPECTS

A copy of the schedule that was used during the survey is in the Appendix. The survey locations are shown in Figure 4.4.1.

Duncan and Parksville were used for training purposes although valid data was collected at these points. The remaining five weeks of interviews were concentrated along Highway No. 1 and the Alberta border. It was intended to conduct surveys at the Pacific scale (at the U. S. border on HWY. No. 15) but the scale broke down the week before the survey was scheduled to go there.

Interviews were completed at each scale for one week (5 days), where possible. A 24 hour survey was done at each scale for at least one day, where possible. At some scales, due to a lack of weigh scale operators, it was not possible to operate continuously for 24 hours (3-8 hour shifts). As can be seen from the schedule in the Appendix, the survey crews operated in two-person shifts, lasting eight hours.

Some scales, such as the Kamloops North scale, were located in an industrial area. At these places, commercial truck traffic was very heavy with a high percentage of local (under 30 kilometers) trips. This survey ignored these local trips.

No allowance was made in the survey for strikes or natural disasters such as road or bridge washouts. These events would no doubt affect the results but it was very difficult, if not impossible, to account for their effect.

There was a slight problem in the beginning with the meaning of the categories last origin and next destination. Their purpose was to try to determine if the truck made intermediate stops (to load or unload cargo) between its original origin and final destination. In most cases, only trucks without intermediate stops (depending on where the stops were) would be able to choose a different route if one was available.

The original origin was the point where the vehicle combination started from and the point where it was going to was the final destination. As an example, consider a semi-trailer being hauled from Vancouver to Merritt. The semi-trailer starts in Vancouver and goes through Princeton to Merritt, but in Princeton the driver drops the semi-trailer, leaving it to be picked up by another tractor. A second tractor takes the semi-trailer to Merritt. When the questionnaire is completed at Laidlaw, the original and last origin is Vancouver; the next and final destination is Princeton.

The coding of commodities provided some minor problems. There were many instances where the truck carried more than one kind of cargo. In these cases, the code for the cargo that comprised the greater part of the load was used.

4.5 RESULTS

About 10,000 trucks were recorded. About 3-5% of the results had the O/D or weight part of the survey missing. The reason for this was that empty trucks were not usually weighed (empty logging trucks were not even required to report to the scale). They just slowed down so the scale operator could see that the truck was empty. In some of these cases, the interviewers did not have enough time to stop the truck and direct it across the scale. This problem was partially solved using traffic cones. Also, if the trucks were backed up causing congestion, some vehicles were let through without interviews. In both these cases, the trucks were recorded on a separate sheet.

4.6 SURVEY CRITIQUE

In general, very little fault can be found with the survey. It provides excellent O/D data for gravity model calibration as well as being a valuable source of information on axle-load distributions for pavement and structural design.

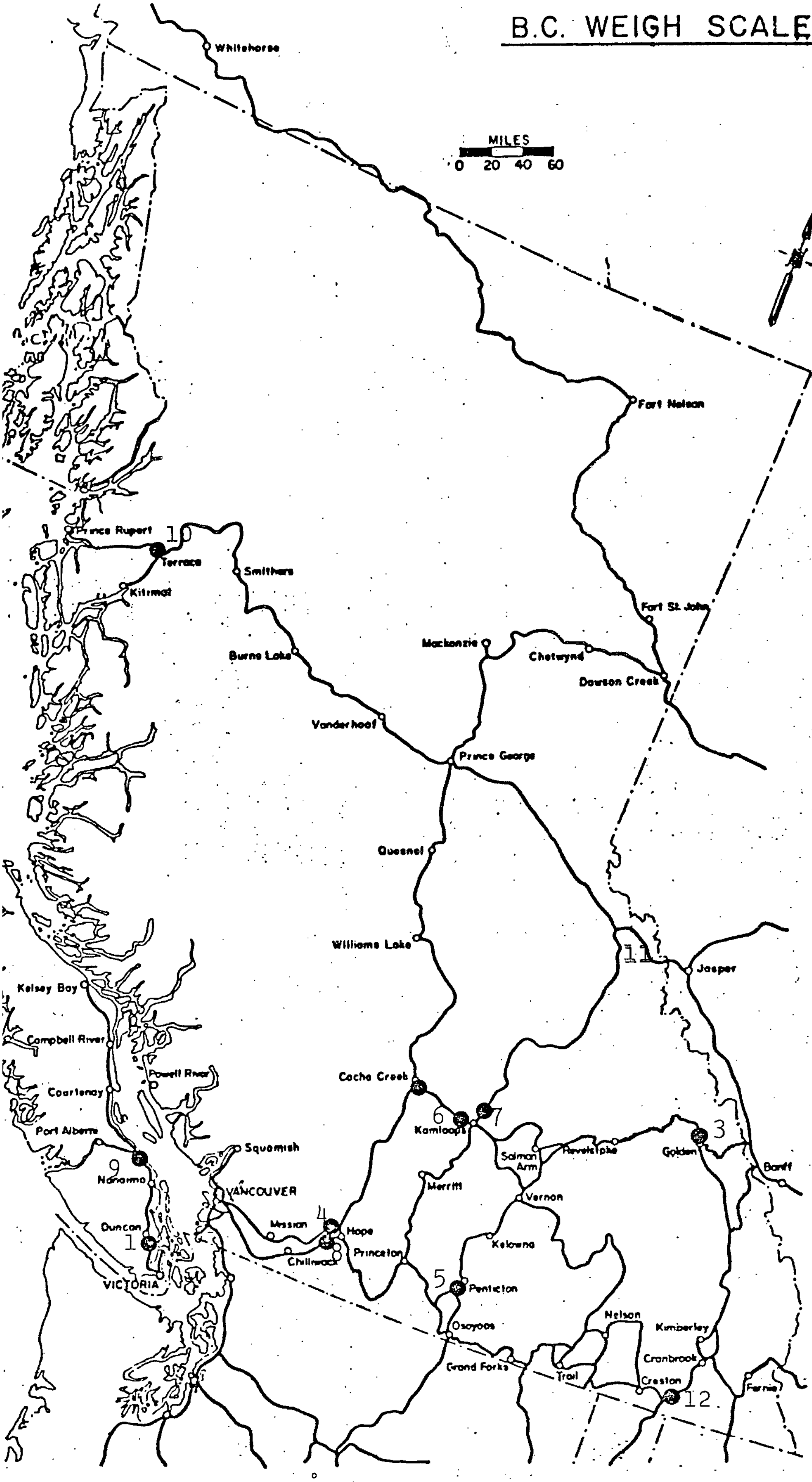
The selection of survey locations depends on the purpose(s) of the survey. When the survey was scheduled there was not any thought given to its use in trip distribution models. In the future, locations could be selected to provide better information for a gravity model of internal traffic.

There are two minor points that should be mentioned:

a) Three columns instead of two should have been provided for registered gross vehicle weight, tare weight and actual gross vehicle weight. Coding methods plus a format change program overcame this problem.

b) At each location the survey should be conducted for a 24 hour period. This greatly simplifies factoring up the data.

B.C. WEIGH SCALE LOCATIONS



1. DUNCAN
2. FERNIE
3. GOLDEN
4. HAIG
5. KALEDEN
6. KAMLOOPS
7. KAMLOOPS NORTH
8. LAIDLAW-HUNTER CREEK
9. PARKSVILLE
10. TERRACE
11. TETE JAUNE CACHE
12. YAHK

4.4.1 SURVEY LOCATIONS

REFERENCES

1. "Western Canada Truck Origin-Destination Survey", Trimac, Ministry of Transport, Ottawa, 1973.

5. RESULTS OF GRAVITY MODEL CALIBRATION

In the previous chapters the elements of this research, such as selection of the gravity model and the design of the survey, were discussed. In this chapter detailed descriptions of the actual input data and model are given. The form and content of the models are carefully presented to aid in understanding the details of the analysis. Also, the results of the calibration are documented.

5.1 DATA PREPARATION

In order to make efficient use of Townsend's (1) travel-cost network the gravity model's zones of origin and destination are made to correspond to the nodes of his network. The gravity model is calibrated using internal (i.e. within B. C.) truck traffic data between these nodes or urban areas. The nodes or urban areas are (in alphabetical order):

1. BURNS LAKE (BL)
2. CACHE CREEK (CC)
3. CAMPBELL RIVER (CR)
4. CLINTON (C)
5. COURTENAY (C)
6. CRANBROOK (Cb)
7. CRESTON (Cs)
8. FERNIE (F)
9. GOLDEN (G)
10. GRAND FORKS (GF)
11. GREENWOOD (GR)
12. HAZELTON (H)
13. HOPE (H)
14. KAMLOOPS (K)
15. KELOWNA (K)
16. KEREMEOS (Ke)
17. KIMBERLEY (K)
18. KINNAIRD-CASTLEGAR (K-C)
19. KITIMAT (K)
20. LYTTON (L)
21. MERRITT (M)
22. NANAIMO (N)
23. NELSON (N)
24. OSOYOOS (O)
25. PENTICTON (P)
26. PRINCE GEORGE (PG)
27. PRINCE RUPERT (PR)
28. PRINCETON (P)
29. QUESNEL (Q)
30. RADIUM HOT SPRINGS (R)
31. REVELSTOKE (R)
32. ROSSLAND-TRAIL (R-T)
33. SALMO (S)
34. SALMON ARM (SA)
35. SMITHERS (S)
36. TERRACE (T)
37. VANCOUVER (V)
38. VANDERHOOF (V)
39. VERNON (V)
40. VICTORIA (Vi)
41. WILLIAMS LAKE (WL)

The node locations and link impedances are shown in Figure 5.1.1.

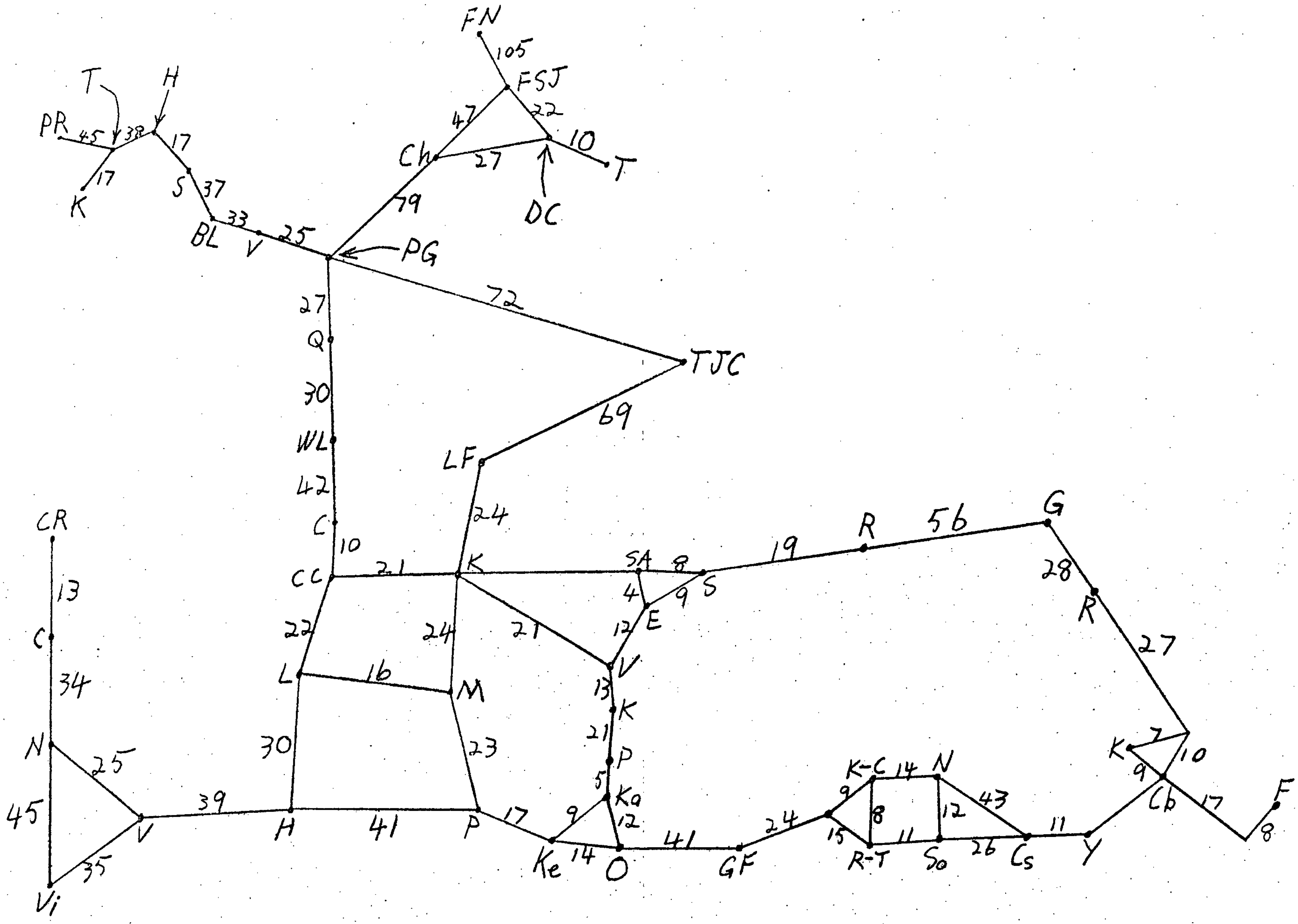


Figure 5.1.1 Node Locations & Inter-Nodal Impedances($)

For each survey location three O/D tables were produced (one per 8 hr. shift) containing the total number of trips interviewed. Then using the schedule (Appendix IV), each table was factored-up to obtain the total weekly (5 day; 24 hrs./day) traffic for that shift at that scale. Adding the three factored-up tables (one table per shift) gives the total weekly traffic, between each O/D, that goes through each scale. The scale locations where surveys were completed are (in alphabetical order):

1. DUNCAN
2. FERNIE
3. GOLDEN
4. HAIG
5. KALEDEN
6. KAMLOOPS
7. KAMLOOPS NORTH
8. LAIDLAW-HUNTER CREEK
9. PARKSVILLE
10. TERRACE
11. TETE JAUNE CACHE
12. YAHK

To obtain the total weekly traffic between each O/D the results from each scale must be combined such that trips are counted once and only once (elimination of double-counting, etc.). At the same time, efficiency requires maximum possible data usage (i.e. whole groups of data should not be ignored because of the possibility of double-counting some O/D combinations). To accomplish this, a separate formula must be developed for each O/D combination. This must be done manually using a road map containing the node and scale locations.

These equations are used to merge the factored-up results at each scale giving the total number of truck trips per week between each pair of nodes (O/D). An example of one formula is:

$$T = \frac{H + L + Y}{2} + \frac{K + G}{4}$$

Where:

T = total trips/week from Vancouver to Cranbrook

= value of T (Vancouver, Cranbrook) in the final O/D table.

H = trips/week from Vancouver to Cranbrook recorded at Haig.

L = trips/week from Vancouver to Cranbrook recorded at Laidlaw-Hunter Ck.

Y = trips/week from Vancouver to Cranbrook recorded at Yahk.

K = trips/week from Vancouver to Cranbrook recorded at Kamloops.

G = trips/week from Vancouver to Cranbrook recorded at Golden.

Tables of the factors used to derive total weekly trips at each scale and of the formulas used to combine the results at each scale are in Appendix V and VI respectively.

The impedance values used are those of Townsend (1). Appendix III contains the part of his thesis dealing with these costs. The sum of the travel-cost on the links of the cheapest path between each pair of nodes in Townsend's network divided by ten is the value of the impedance used in model calibration. The travel costs between the nodes on Vancouver Island are derived by the author using Townsend's algorithm. The intra-nodal impedances are set at a value (semi-arbitrarily chosen as 60) greater than the largest value of inter-nodal impedance.

Townsend's method of calculating the travel cost along each link can be summarised as follows:

1. Determine miles (D) of surfaces, paved (P) and gravel (G).
2. Determine miles of legally restricted speeds (L).
3. Determine widths of various sections, convert to factors (W) as in Table XI (Appendix III).
4. Count the total number of times the road rises or falls 100 feet from contour maps. Convert to factors for speed (H) and fuel consumption (N) according to Table XII (Appendix III).
5. Take traffic flow from published counts, convert to factors (V) according to Table XIII (Appendix III).
6. Determine ferry delays (Y).
7. Set base speeds at 50 mph for P, and 38 mph for G.
8. Total D-legal D= $(D_p + D_g)$.
9. Legal D ÷ 20 mph = time over legal D
10. 50 (W_p) (V) (H) = speed over paved, allowing for W, and V.
11. 38 (W_g)(V)(H) = speed over gravel, allowing for W, H, and B.
12. D_p/(Step 10) = time over paved section.
13. D_g/(Step 11) = time over gravel section.
14. Sum of steps 9, 12, and 13 = link time
15. D/(link time) = average running speed.
16. Find consumption at average running speed, see Table XIV (Appendix III).
17. Add extra grade factor (Table XII in Appendix III) to

consumption (Table XIV in Appendix III) to get average consumption.

18. (Total D)(Average Consumption) = fuel consumed.

19. (Fuel consumed)($0.40) = fuel cost on link.

20. (Step 14) + Y = total link time.

21. (Link time)($7.50 per hr.) = driver and truck cost on link.

22. (D_p + legal D)(paved repair costs) = repair costs on paved.

23. (D_g)(gravel repair cost) = repair cost on gravel sections.

24. Sum of Steps 19, 21, 22, and 23

= <u>TOTAL LINK COST</u>

The nodal (zonal) production and attractions used are the row sums and column sums, respectively, of the O/D table.

5.2 CALIBRATION OF THE 31 NODE MODEL

The model input and output is included in Appendix VII. Figures 5.2.1, 5.2.2, and 5.2.3 show the scatter plots, the trip <u>cost</u> distributions, and the smoothing function (3.4.2) parameters respectively. <u>Note</u> that the figures are labelled in terms of trip "length". In this exercise these labels are really trip cost in ten dollar units (e.g. if the abscissa scale reading is a trip "length" of 21.0 this is interpreted as a trip cost of $210).

Tables of the friction and socio-economic factors are included in Appendix VII.

The nodes included in this calibration are (in numerical order):

1. CRANBROOK
2. NELSON
3. KINNAIRD-CASTLEGAR
4. ROSSLAND-TRAIL
5. GRAND FORDS
6. OSOYOOS
7. KEREMEOS
8. PRINCETON
9. PENTICTON
10. HOPE
11. VANCOUVER
12. VICTORIA
13. NANAIMO
14. COURTENAY
15. CAMPBELL RIVER
16. MERRITT
17. LYTTON
18. REVELSTOKE
19. CACHE CREEK
20. CLINTON
21. KAMLOOPS
22. KELOWNA
23. VERNON
24. GOLDEN
25. SALMON ARM
26. WILLIAMS LAKE
27. QUESNEL
28. PRINCE RUPERT
29. KITIMAT
30. TERRACE
31. SMITHERS

The total number of weekly truck trips in this calibration after factoring-up at each scale and summing (with the derived formulas) across all scales is 4067.

The average trip cost from the survey data is \$91.08. The average trip cost of iteration #3 is \$87.72 (chi-squared statistic = 1558). This is a difference of -3.7%. However, the fourth iteration gave a value of chi-squared = 1529 and an average trip cost difference of -8.3%.

	AVG. TRIP COST	CHI-SQUARE	% DIFFERENCE
Survey	\$91.08	----	----
Iteration #3	\$87.72	1558	-3.7
Iteration #4	\$85.30	1529	-8.3

TABLE 5.2.1 CALIBRATION STATISTICS

5.3 CALIBRATION OF THE 27 NODE MODEL

In this calibration the nodes on Vancouver Island have been eliminated. The model input and output is included in Appendix VIII. Figures 5.3.1, 5.3.2, and 5.3.3 show the scatter plots, the trip cost distributions, and the smoothing function (3.4.2) parameters respectively. Note that the figures are labelled in terms of trip "length". In this exercise, these labels are really trip cost in ten dollar units (ex. if the abscissa scale reading is a trip "length" of 21.0 this is interpreted as a trip cost of $210).

Tables of the friction and socio-economic factors are included in Appendix VIII.

The nodes included in this calibration are (in numerical order):

1. CRANBROOK
2. NELSON
3. KINNAIRD-CASTLEGAR
4. ROSSLAND-TRAIL
5. GRAND FORKS
6. OSOYOOS
7. KEREMEOS
8. PRINCETON
9. PENTICTON
10. HOPE
11. VANCOUVER
12. MERRITT
13. LYTTON
14. REVELSTOKE
15. CACHE CREEK
16. CLINTON
17. KAMLOOPS
18. KELOWNA
19. VERNON
20. GOLDEN
21. SALMON ARM
22. WILLIAMS LAKE
23. QUESNEL
24. PRINCE RUPERT
25. KITIMAT
26. TERRACE
27. SMITHERS

The total number of weekly truck trips in this calibration after factoring-up at each scale and summing (with the derived formulas) across all scales is 3313.

The average trip cost from the survey data is $98.02. The average trip cost of iteration #9 is $102.07 (chi-squared statistic = 917). This is a difference of +4.1%. However, the fifth iteration gave a value of chi-squared = 893 and an average trip cost difference of +5.5%.

	AVG. TRIP COST	CHI-SQUARE	% DIFFERENCE
Survey	$ 98.02	---	----
Iteration #5	$103.42	893	+5.5
Iteration #9	$102.07	917	+4.1

TABLE 5.3.1 CALIBRATION STATISTICS

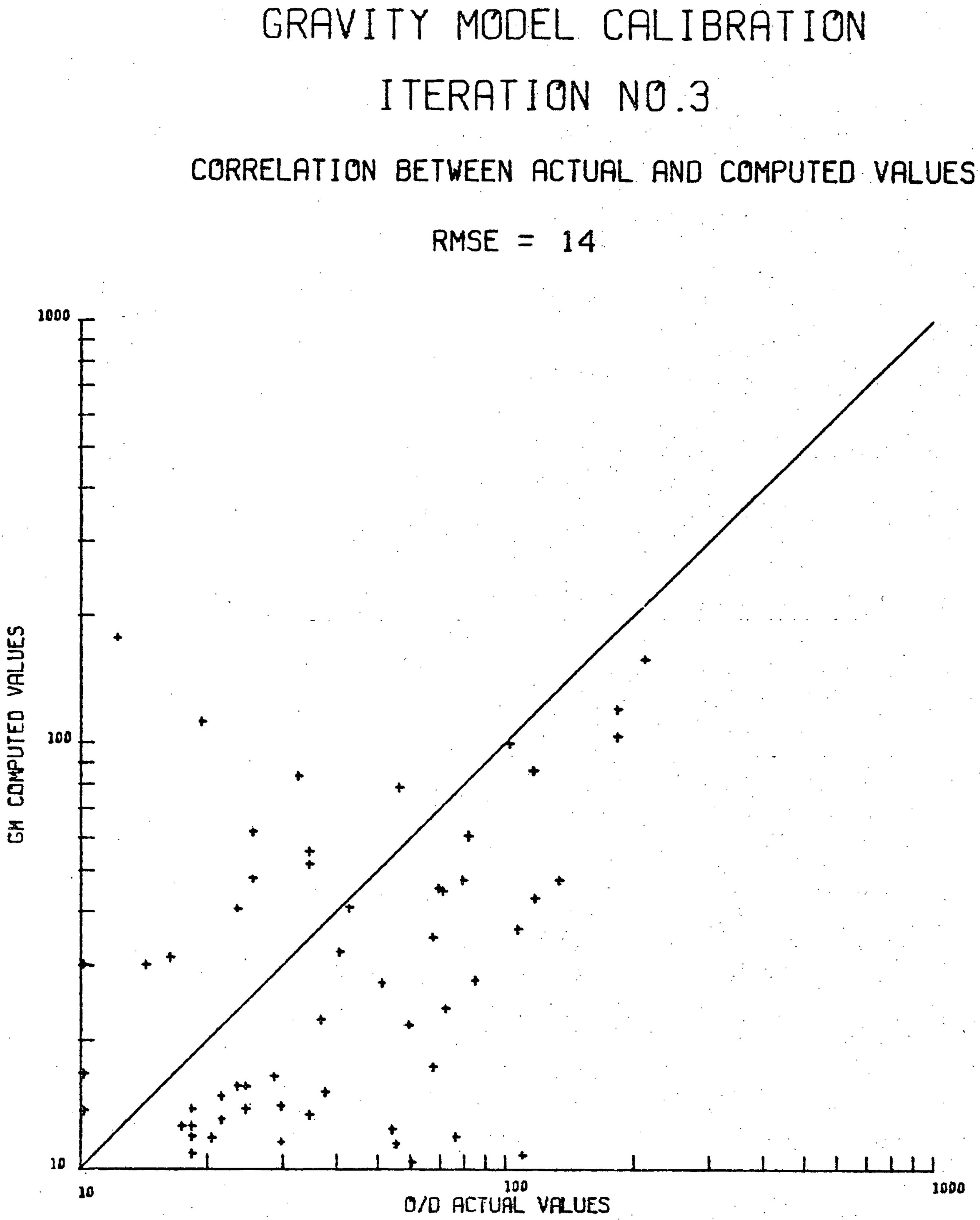


Figure 5.2.1(a) Scatter Plot--Iteration #3

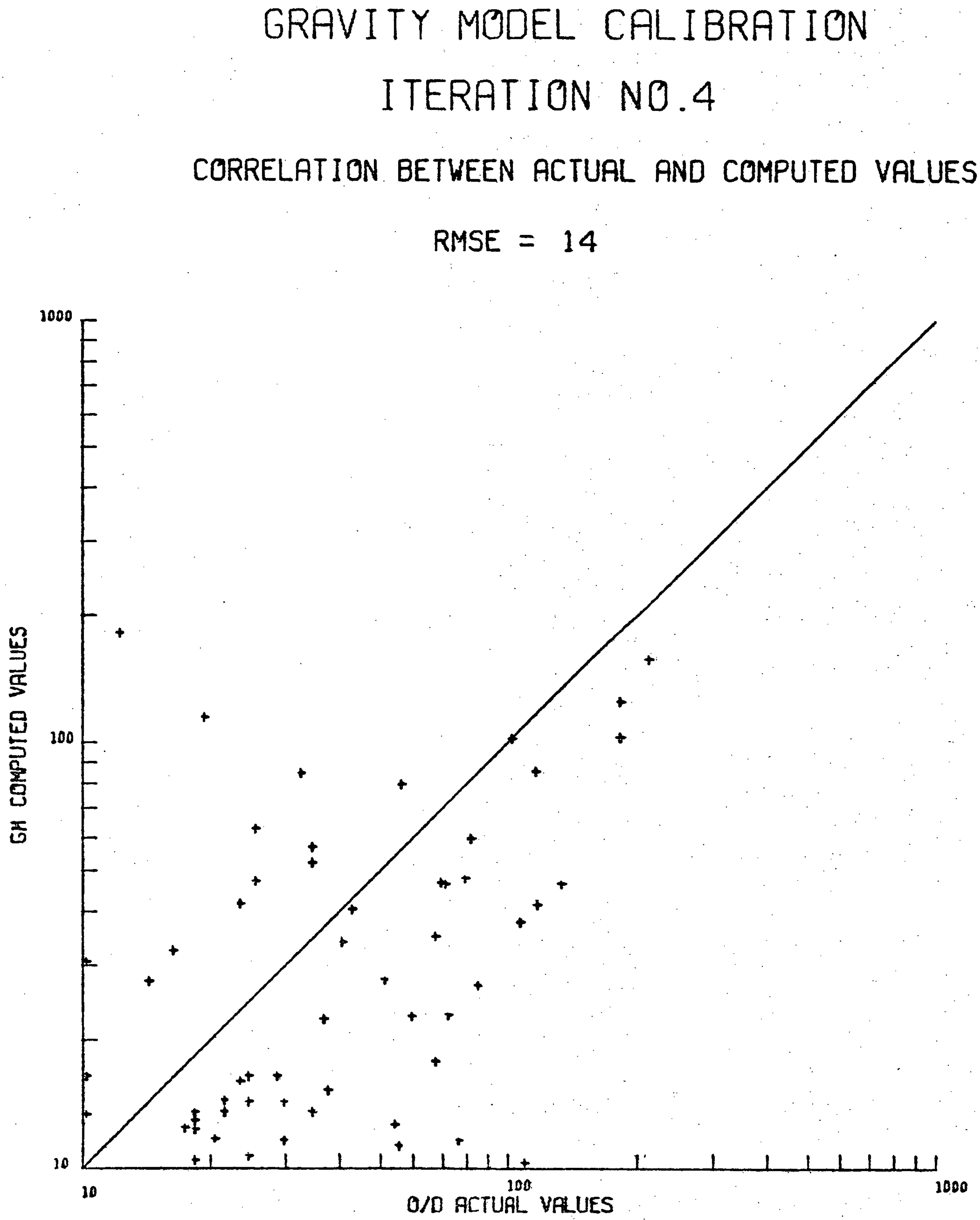


Figure 5.2.1(b) Scatter Plot--Iteration #4

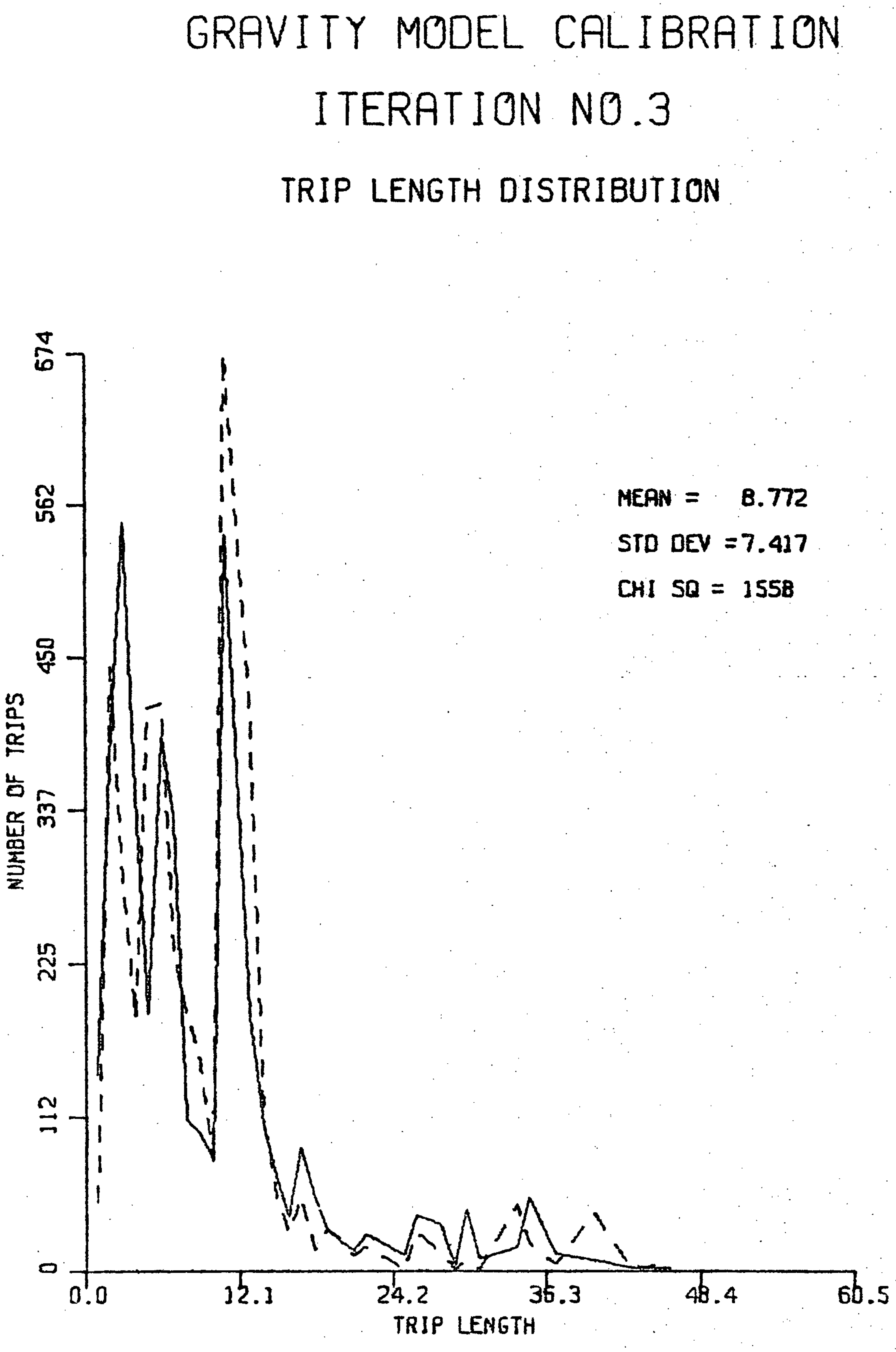


Figure 5.2.2(a) Trip Cost Distribution--Iteration #3

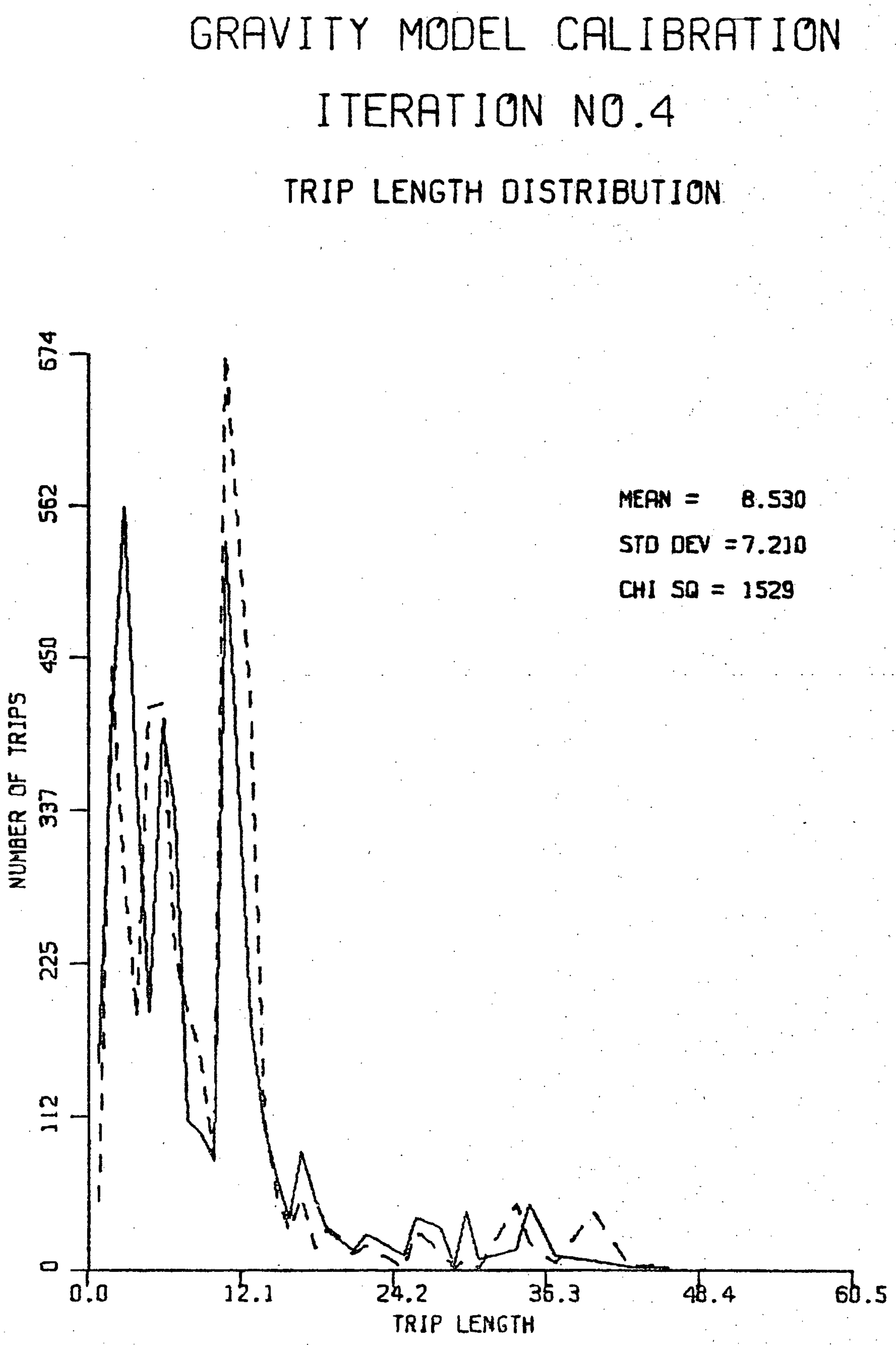


Figure 5.2.2(b) Trip Cost Distribution--Iteration #4

GRAVITY MODEL CALIBRATION

ITERATION NO.3

FRICTION FACTOR DISTRIBUTION

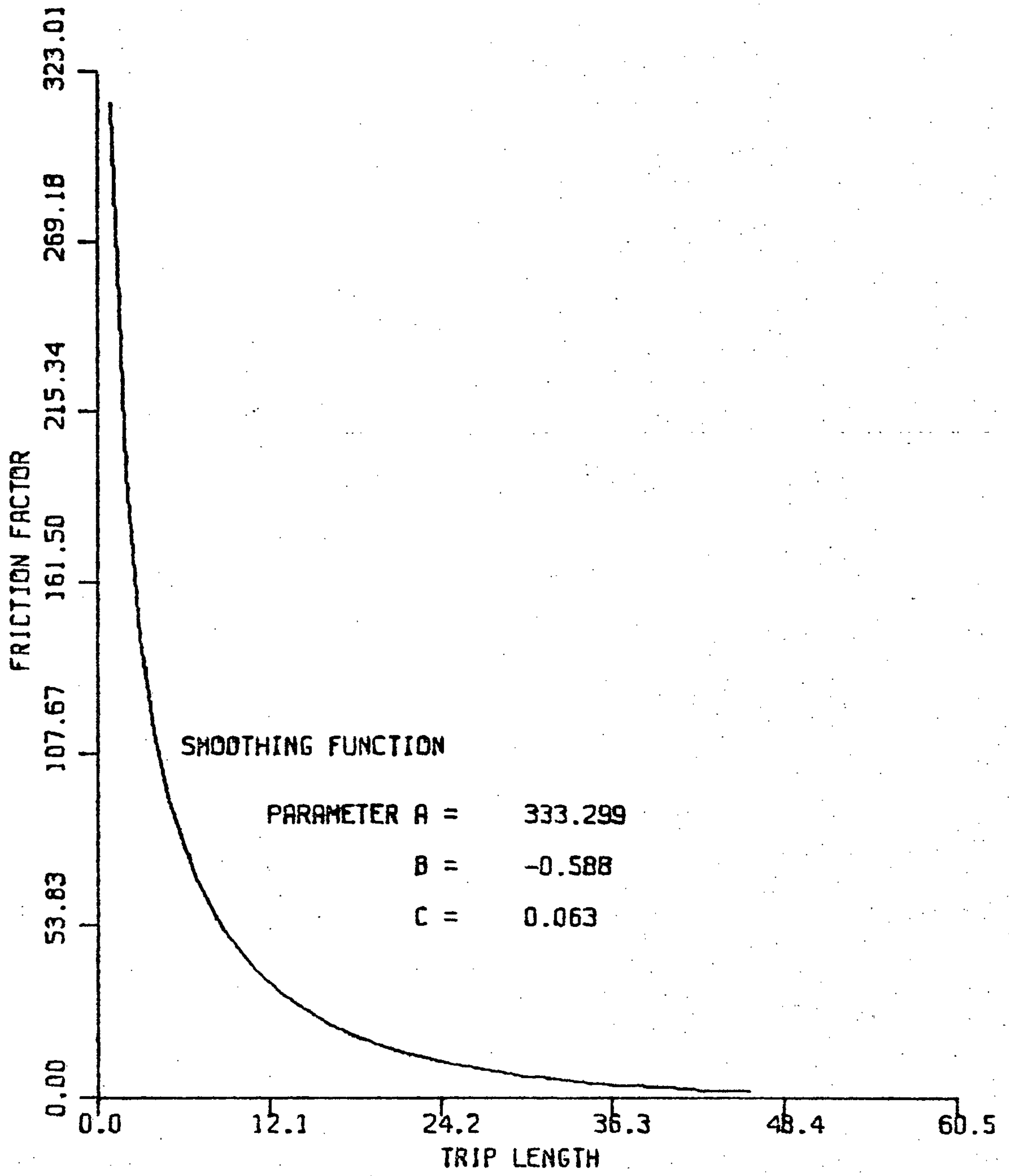


Figure 5.2.3(a) F-factor Distribution--Itreation #3

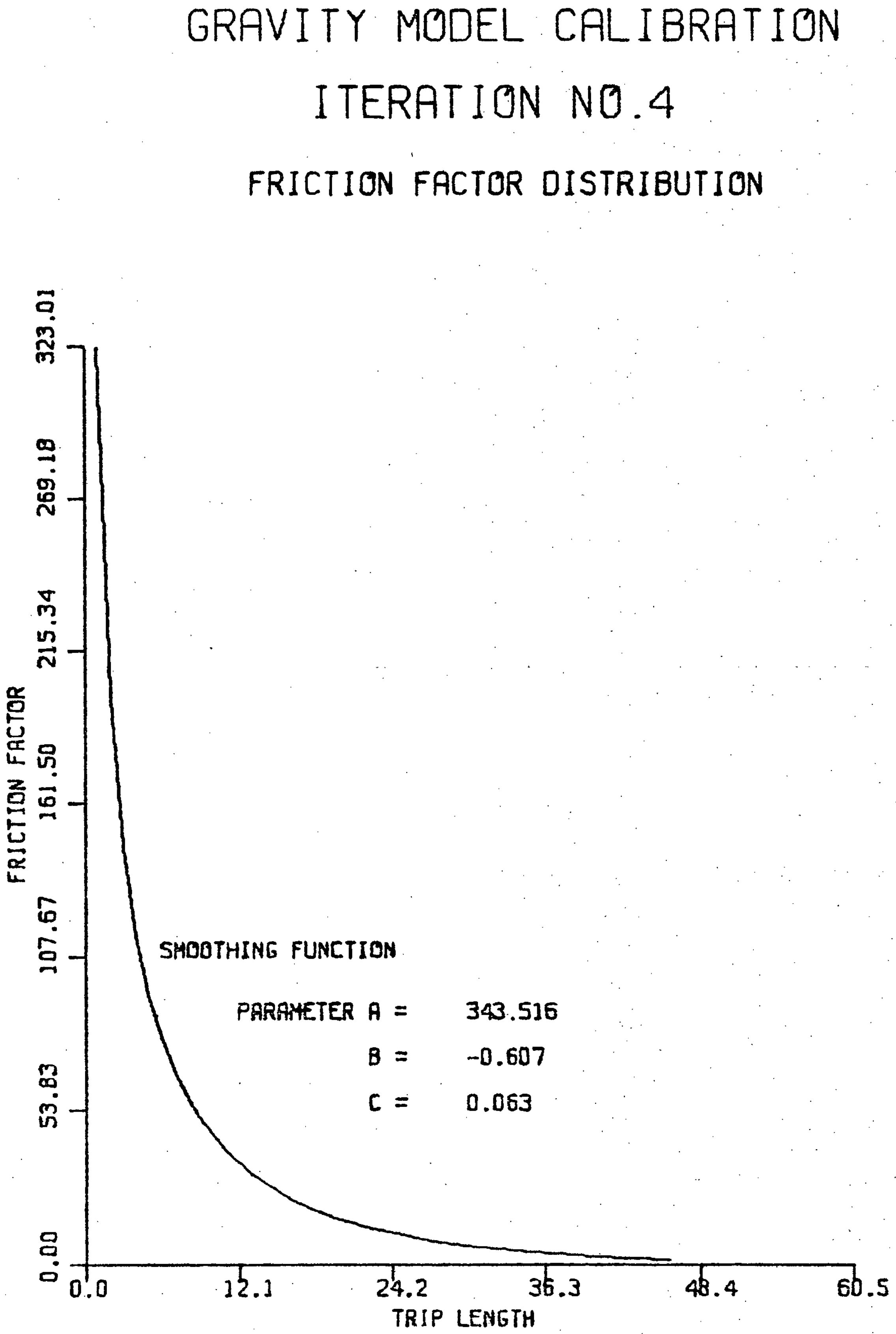


Figure 5.2.3(b) F-factor Distribution--Iteration #4

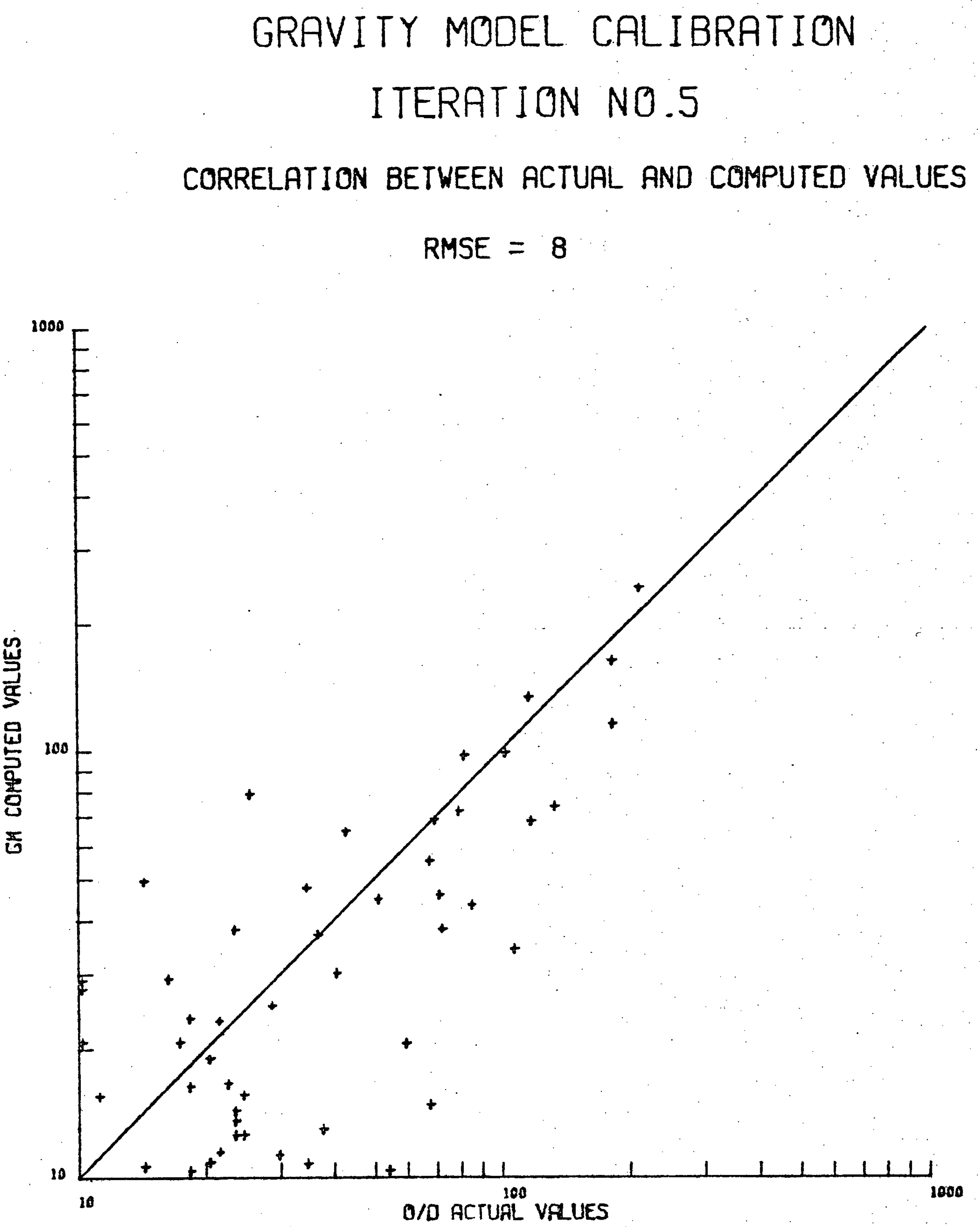


Figure 5.3.1(a) Scatter Plot--Iteration #5

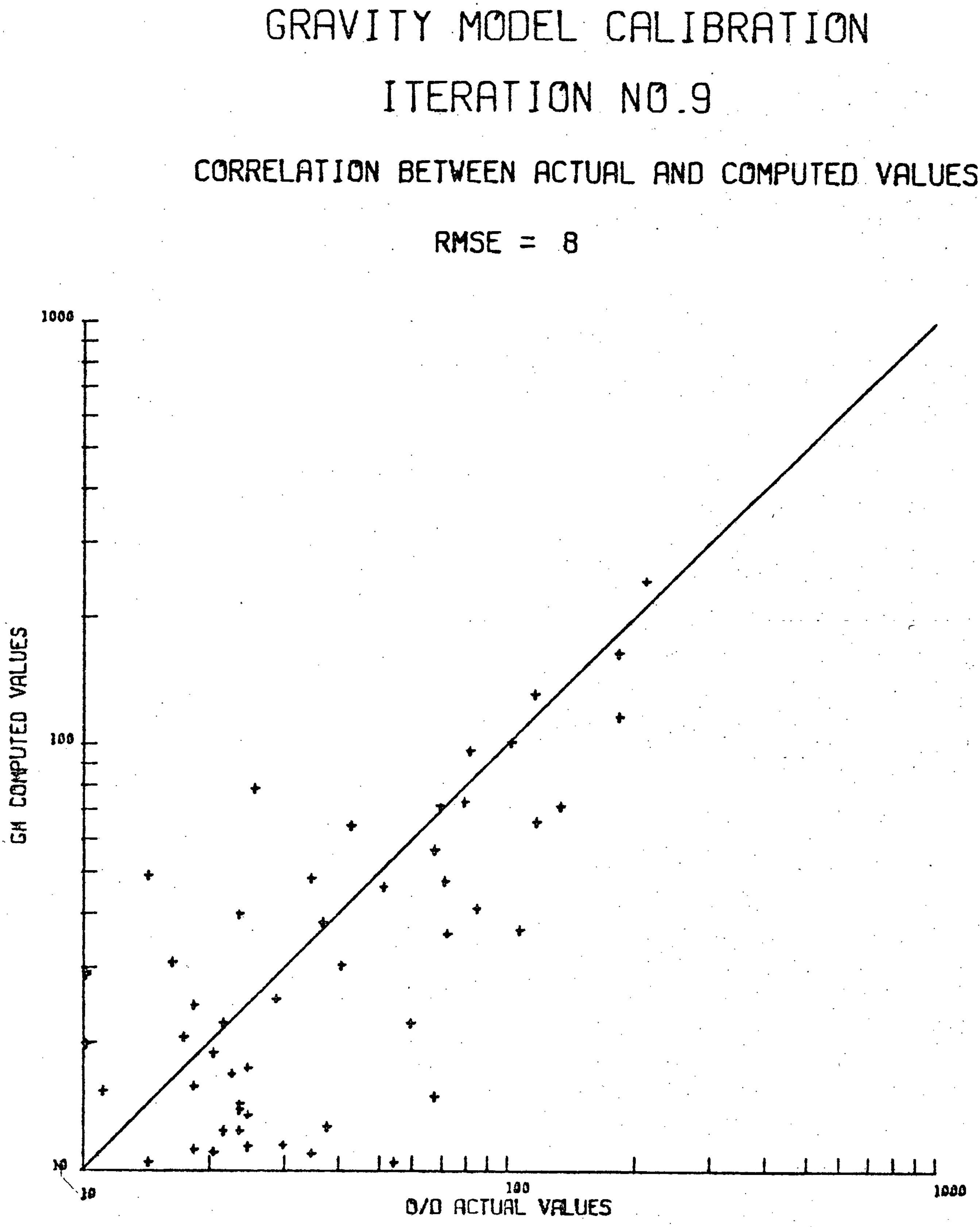


Figure 5.3.1(b) Scatter Plot--Iteration #9

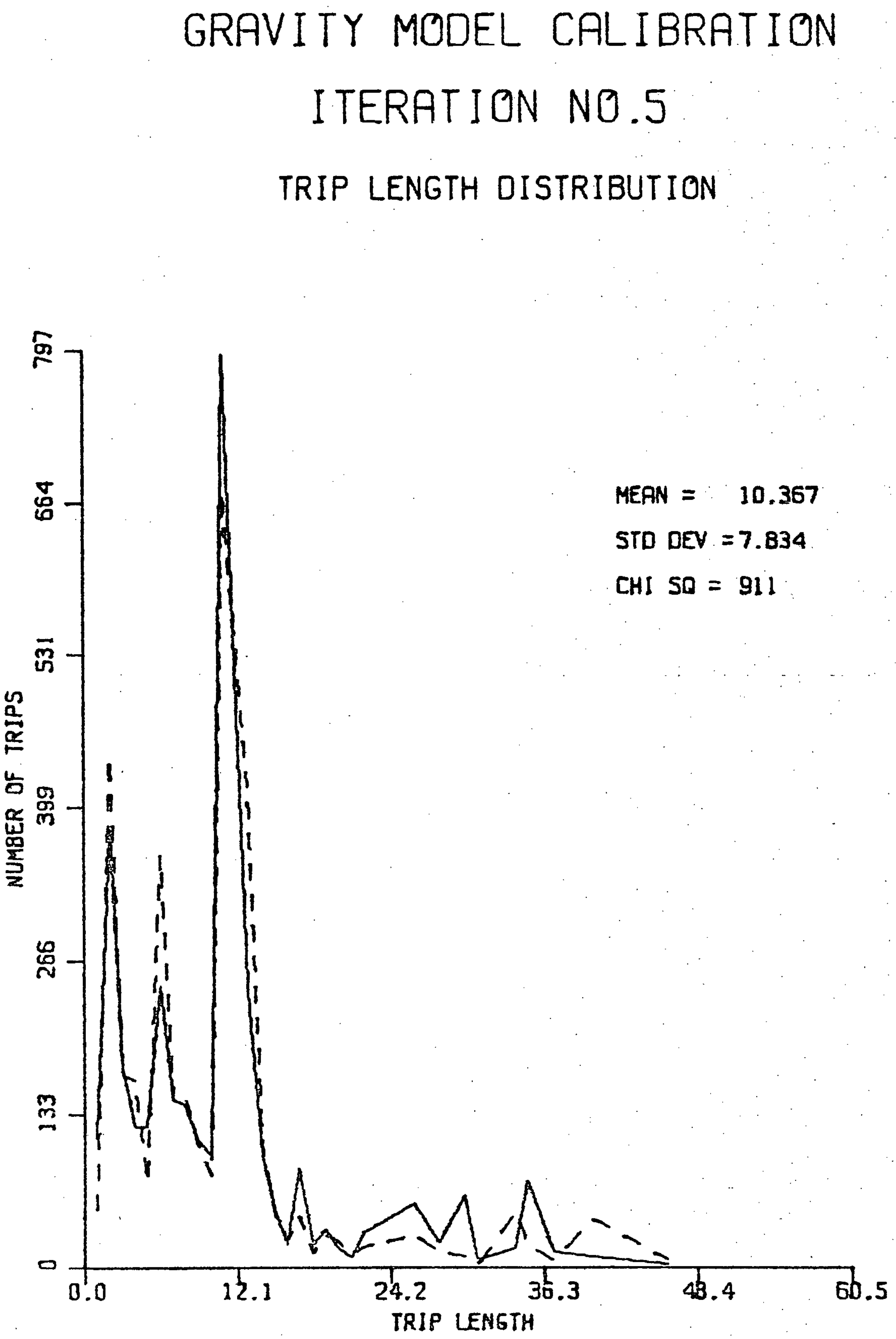


Figure 5.3.2(a) Trip Cost Distribution--Iteration #5

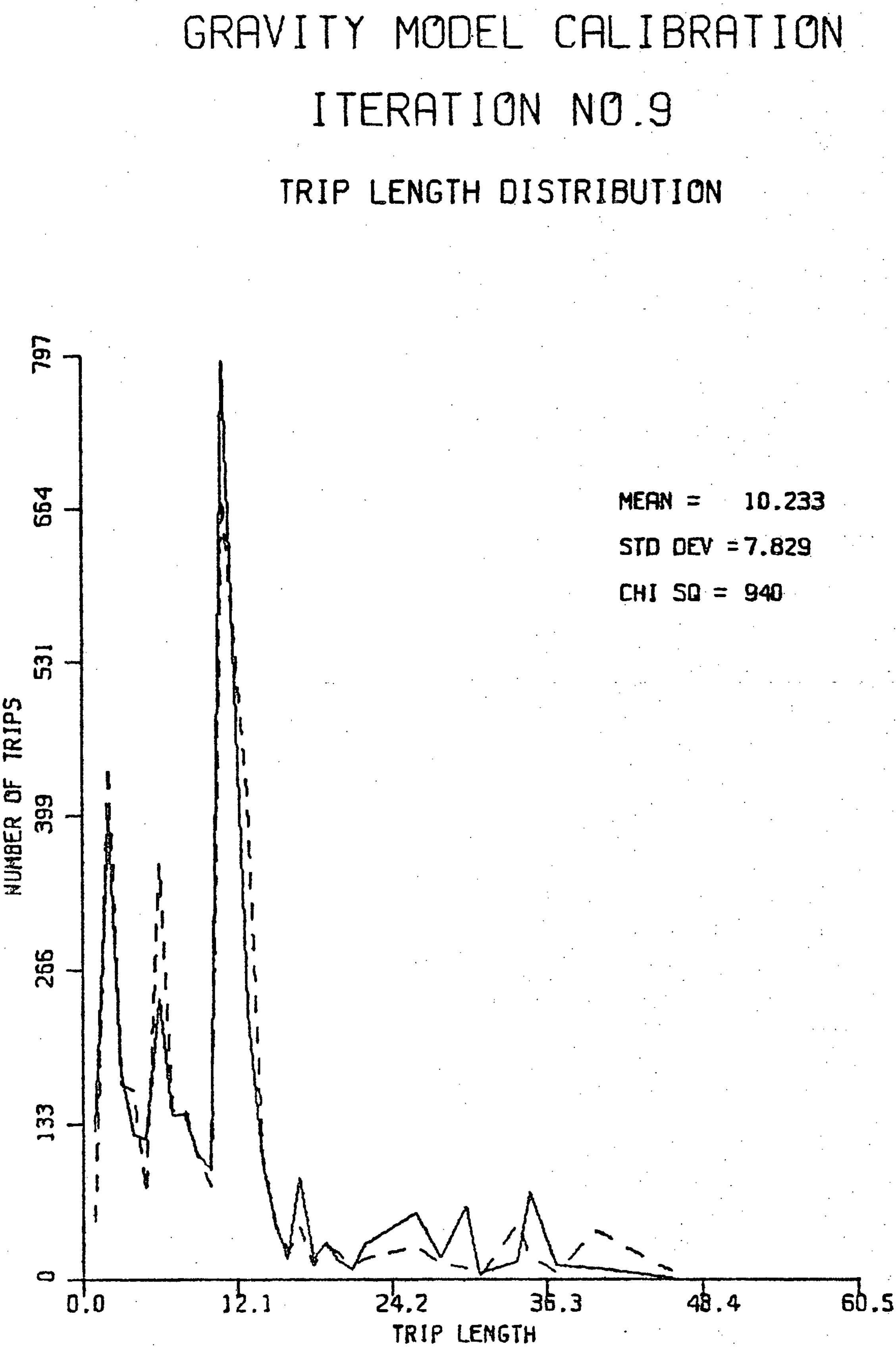


Figure 5.3.2(b) Trip Cost Distribution--Iteration #9

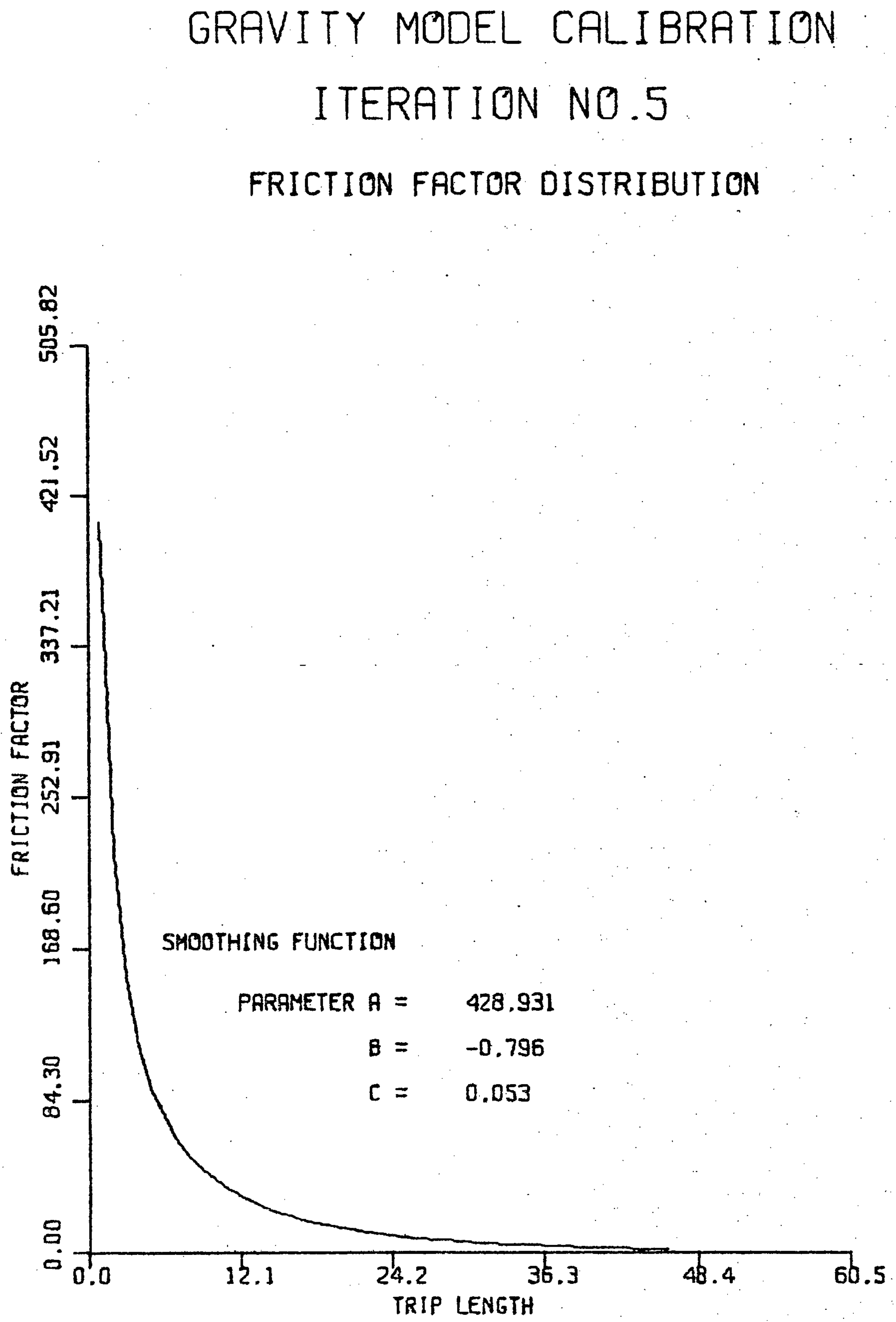


Figure 5.3.3(a) F-factor Distribution--Iteration #5

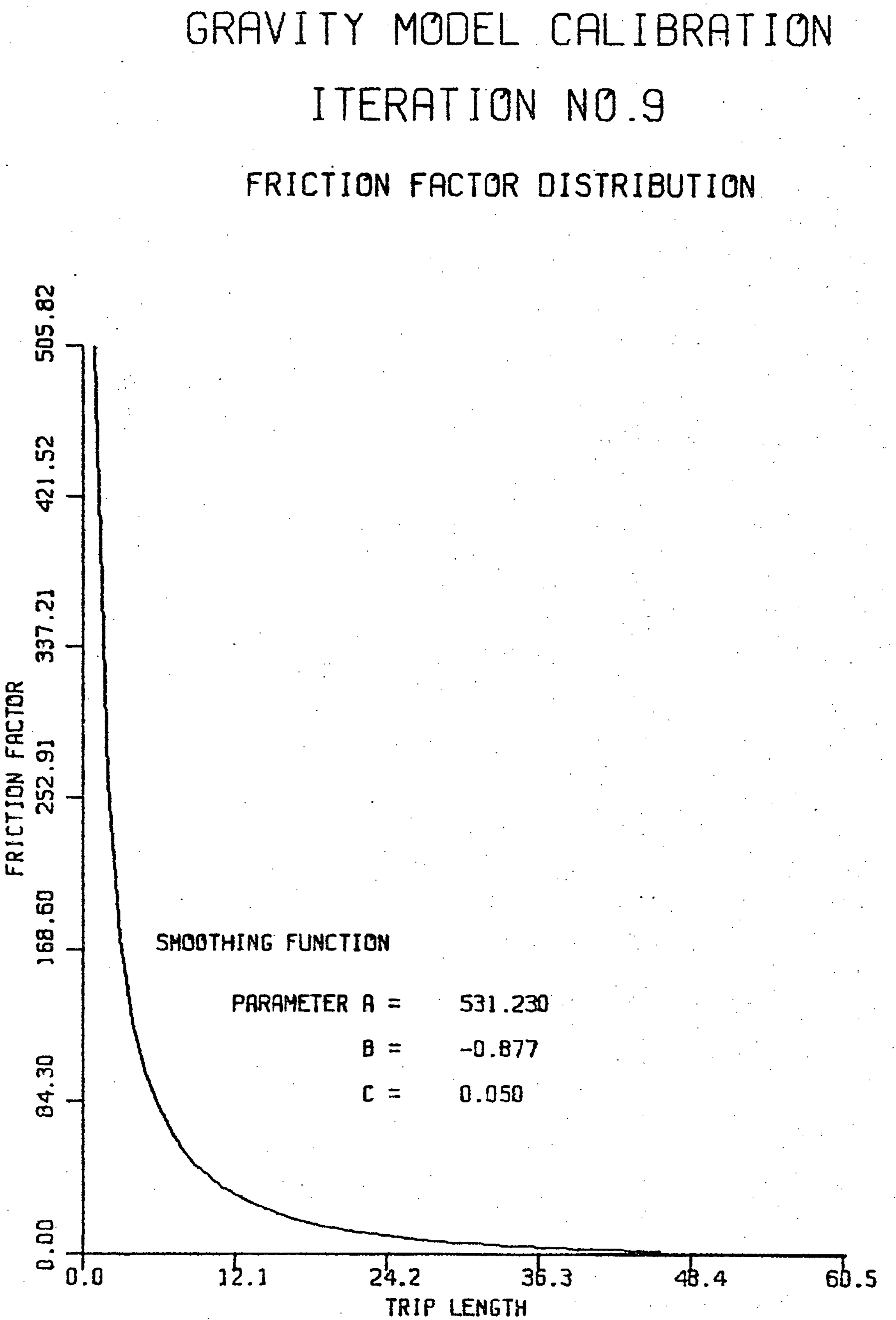


Figure 5.3.3(b) F-factor Distribution--Iteration #9

REFERENCES

I. Townsend, D. F., "Highway Investment in B. C. 1946-71", M.A. Thesis, University of B.C., 1973.

6. DISCUSSION OF RESULTS

This chapter presents a comparison of the results of this research with that of others. Also, comments and recommendations are made concerning the results of the calibration, the results of other research and the survey.

6.1 COMPARISON of 27 & 31 NODE MODELS

MODEL	ITERATION	CHI-SQUARE	RMSE	AVG. TRIP COST DIFFERENCE
27 Node	5	893	8	+5.5%
27 Node	9	917	8	+4.1%
31 Node	3	1558	14	-3.7%
31 Node	4	1529	14	-8.3%

TABLE 6.1.1 CALIBRATION STATISTICS

The criteria are inconsistent in indicating the best calibration or set of friction factors. Using average trip cost alone indicates that the third calibration iteration of the 31 node model gives the best results. Both the chi-squared and RMSE statistics indicate that the fifth iteration of the 27 node model gives the best results. It is the opinion of the author that the chi-squared and RMSE statistics are better measures of performance than the average trip cost difference. Therefore, it is regrettable that the performance of gravity model calibrations have been analysed in terms of average trip cost (or length) difference.

There are three distinct peaks (or valleys depending on your perspective) in the trip cost distributions. The first peak occurs at a trip cost of $20 and results from the relatively high number of trips between Terrace and Kitimat (170) which have a cost of $20. The valley at $40 in the 31 node model results from the lack of data on trips between Victoria and Vancouver. There was no survey station (scale) that directly measured this link. The peak at $50 and $60 in the 31 node distribution is caused by trips on Vancouver Island and trips between Terrace and Smithers ($60). The highest peak at $110 stems from the Vancouver-Kamloops and Vancouver-Penticton trip costs both being $110. These two links have a total of 580 trips per week.

6.2 COMPARISON WITH OTHER G-M CALIBRATIONS

The other gravity model calibrations (1, 2, 4, 6, 7) were developed on the basis of average trip length (cost) difference, therefore, they are compared to the "best" calibration in this exercise based on the same criteria.

In terms of trip purpose the closest category (conceptually) to that of the B. C. study is non-home-based trips. It can be seen from Table 6.2.1 that the results of the B. C. study compare favorably with those of previous calibrations. The differences of 3.6% and 4.1% are well within the previous range of 2.9% to 6.5%.

STUDY	TOTAL TRIPS	NODES (ZONES)	AVG. TRIP COST (LENGTH) DIFF.	TRIP PURPOSE
Sioux Falls (1)	29,882	28	-0.9%	Home-Work
Pittsburg (10)	2,336,312	?	-1.2%	All
Hutchinson (18)	71,242	83	?	All
"	?	83	-0.5%	Home-Work
"	?	83	+0.8%	Home-Other
"	?	83	+3.6%	Non-Home
Honolulu (14)	590,250	13	?	All
"	?	13	0.00%	Military Work
"	?	13	+0.5%	Civilian Work
"	?	13	+1.1%	Shopping
"	?	13	+2.6%	Social-Rec.
"	?	13	-1.3%	Misc.
"	?	13	-2.9%	Non-Home
Washington (2)	2,482,000	47	?	All
"	?	47	-2.6%	Home-Work
"	?	47	-7.6%	Shopping
"	?	47	0.0%	Social-Rec
"	?	47	+2.5%	School
"	?	47	-4.4%	Misc.
"	?	47	+6.5%	Non-Home
B.C.	4,067	31	-3.7%	Truck
B.C.	3,313	27	+4.1%	Truck

TABLE 6.2.1 AVERAGE TRIP COST (LENGTH) DIFFERENCE

Reference 3 (pg. IV-41) suggests that the difference between the average trip length (cost) should be less than 5 percent for acceptance of the calibration. This criterion is met by both the 27 and 31 node models in the B. C. study.

6.3 COMPARISON WITH VANCOUVER G-M CALIBRATION

	DOWNTOWN VANCOUVER (5)	B. C. STUDY	B. C. STUDY
Total Trips	67,128	4067	3313
Nodes (zones)	14	31	27
Avg. Trip Cost (Time) Difference	-0.3%	-8.3%	+5.5%
Chi-Squared	56	1529	893
RMSE	56	14	8
Trip Purpose	Home-Work	Commercial Truck	Commercial Truck

TABLE 6.3.1 CALIBRATION STATISTICS

These statistics (Table 6.3.1) indicate that the truck study model is simulating the inter-nodal movements much better than that of the downtown Vancouver study. However, the downtown Vancouver model's simulation of the trip length (cost) frequency distribution is much superior to that of the truck study.

6.4 COMMENTS AND RECOMMENDATIONS

6.4.1. These gravity model calibrations produce statistics in the same range as the other studies (of intra-urban car travel) in spite of the fact that the survey was not very well designed for calibration of a gravity model of internal truck traffic. Three of the 12 (25%) survey locations (scales) were located along provincial boundaries. Two of the remaining nine scales were used for training and experimentation purposes (Duncan and Parksville). Therefore, this study really uses only 7 out of 12 survey locations to their full capacity or a minimum of 58% of the total survey people-hours.

6.4.2 As mentioned earlier, the chi-squared and root mean square error statistics are felt to be much better indicators of model performance than average trip cost (length) differences. As a result, the findings must be based primarily on comparisons of average trip cost differences.

6.4.3 Since the formulas for calculating the chi-squared and RMSE statistics both include the number of nodes, for a comparison of these statistics to be of great value the number of nodes in the different studies must approximate each other.

6.5.4 Surveys of this type (inter-urban truck traffic) could be valuable for decision-making purposes involving investment in the highway system. The methodology can be used to develop flow charts of truck traffic between cities similar to desire line charts. This would seem to be a more comprehensive basis on which to decide where and when to make road network improvements than standard screenline counts alone. Economic and transportation linkages become clear. Having this picture of truck traffic would help in deciding where new routes or improvements to old routes should be located to maximize benefits and minimize costs. It is the heavy trucks (axle loads) that determine the critical values of pavement and roadbed design parameters.

6.4.5 The potential of this form of analysis in terms of the transportation planning process is greatly increased if the gravity model is linked to a suitable trip generation model of truck trips. Truck trip generation equations are more complicated than those for person trips. As yet, there does not seem to be a satisfactory model available (5).

6.4.6 This type of survey provides other data such as commodity type, axle weight, etc. The information on weights could be valuable for pavement design and maintenance scheduling. Compilation to give loading frequency distributions would be useful in analysing the performance of different types of road construction under different loading patterns (in terms of axle load repetitions).

6.4.7 In light of the above, it is felt that the potential of this form of survey is sufficient to justify its continuation by an agency responsible for road transport. The present investment in resources will be judged to have been well spent when the final produce--a decision-making tool--is required.

6.4.8 Constructing the O/D table from the survey data requires by far the most time and effort in this kind of project. Editing the data file for the selected origins and destinations is the first step. The second step is to factor-up the data to weekly truck trips at each scale. Experience here leads to the firm recommendation that the survey be done for at least one 24 hour period at each survey location. In both steps the problems are relatively easy to solve; under one condition in the case of step two. A tabulation program must be available that will allow the elements in a table to be multiplied by a REAL number (weighting-factor). Also it must be capable of summing the weighted tables. UBC MVTAB was used but it only allows integer weighting-factors. This problem can be partially overcome by multiplying the real number weighting-factor by 10 raised to an appropriate power. This results in a table for each scale that gives trips per 10 or 100 weeks.

6.4.9 The last step in building the O/D table is to combine the results at each scale to obtain total weekly truck trips between each O/D combination without "double-counting". Automation of this step would require a program that enables each trip record to be multiplied by a factor (real number) based on: (1) the shift during which the trip interview was completed; (2) the scale where the trip interview took place; (3) the origin of the trip; and (4) the destination of the trip. The weighted trip record is then added to the O/D table. This would necessitate the option of an individual weighting-factor (real number) for each element of the final O/D table. This compares with the requirement of comment 6.4.8 which would require only one weighting-factor (real number) for all elements of the O/D table at each scale.

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7. Smith, Bob L., "Gravity Model Theory Applied to a Small City Using a Small Sample of Origin-Destination Data", HRR 88.

7. CONCLUSIONS

This chapter contains more general conclusions related to the research done in this thesis and some thoughts about the implications of the findings for future related research in transportation planning.

It was concluded from the results of the calibration, from experience with this truck survey and from experience with other roadside surveys of passenger vehicles that this form of survey is very useful in the analysis of inter-regional or inter-urban traffic (truck or car). With passenger vehicles the survey locations can be almost any-where along a road (safety being a prime consideration) and a percentage of the traffic is interviewed.

This application of the gravity model to commodity flows was successful. A better choice of survey locations and more data would improve the results and allow separate models for different commodities or groups of commodities to be built.

The cost approach to impedance shows promise in inter-urban or inter-regional traffic simulation. It would seem reasonable that impedance would be seen mostly in terms of trip cost to a commercial transport operation.

In terms of future research this present effort indicates good possibilities in several areas:

a) Application of the gravity model to inter-urban car traffic using roadside surveys.

b) Application of the gravity model to commodity flows on a more selective basis i.e. building separate models for each commodity or group of commodities.

c) Further development of the cost concept of impedance and its comparison with the usual distance or time parameters especially when used as input to the gravity model.

In light of the above (analysis and conclusions) it is concluded that traditional planning techniques such as the gravity model of trip distribution can be developed so that the design of road networks between cities is more sensitive to truck traffic.

IMPORTANT

PLEASE NOTE THAT MOST OF THE MATERIAL IN THE APPENDICES IS RELEVANT ONLY TO THOSE TRYING TO REPEAT THIS ANALYSIS IN DETAIL.

APPENDIX I

THE INTERVIEW FORM

BRITISH COLUMBIA
TRUCK ORIGIN-DESTINATION SURVEY

INTERVIEWER ______________

DATE ______________

OFFICE USE ONLY

SEQUENCE NUMBER

1

SURVEY LOCATION	DIRECTION OF TRAVEL	TIME OF DAY (HR. ENDING)	NAME OF CARRIER / # OF TRIPS	TRUCK DESCRIPTION	TRUCK BODY	TOTAL AXLES	VEHICLE REGISTRATION	LICENCE CLASS
6	8	9	11	12	13	14	15	17

ORIGINAL ORIGIN	LAST ORIGIN	NEXT DESTINATION	FINAL DESTINATION	COMMODITY CODE 1	COMMODITY CODE 2	HAZARDOUS MATERIALS	VOLUME USEAGE	REGISTERED G.V.W.	TARE WEIGHT	ACTUAL G.V.W.
18	23	28	33	38	40	42	44	45	47	49

STEERING AXLES		SINGLE	TANDEM		SINGLE	TANDEM		SINGLE	TANDEM		SINGLE
51	53	55	57	59	61	63	65	67	69	71	73

APPENDIX II

THE INTERVIEWER/CODER MANUAL

INTERVIEWER/CODER

MANUAL

FOR

BRITISH COLUMBIA

TRUCK ORIGIN-DESTINATION SURVEY

General Notes

1. The interviewer is to initial and date each form.

2. PRINT (CLEARLY) all information on the questionnaire before coding.

3. Try to develop a detailed knowledge of the codes.

4. Fill in as much as possible on the questionnaire before the truck arrives and as much as you can without asking the driver.

5. All coding is to be right justified.

6. Direct all vehicles across the scale in order to facilitate interviewing. This can be done using traffic cones to block by-pass lanes.

7. If truck congestion builds up causing a safety hazard, excessive delays or operational problems for the weigh scale operators, waive through some of the trucks. Record those trucks waived through on the TRUCKS NOT SURVEYED/REPEAT form.

8. Any truck not interviewed because it didn't stop should be recorded on the TRUCKS NOT SURVEYED/REPEAT TRIPS form.

9. Watch for repetitive trips in the same direction by the same truck.

   Eg: A dump truck hauling gravel out of a nearby pit. Only fill out 1 questionnaire for the truck in each direction and record each successive trip in the same direction on the TRUCKS NOT SURVEYED/REPEAT TRIPS form.

10. Record the license number of the tractor or truck at the top of each interview form.

11. If the scale is located in an area where there are many trips of a local nature such as within the industrial area of a city, ignor all of the local trips of less than about 30 kilometers. (20 miles)

1. SEQUENCE NUMBER - TO BE COMPLETED LATER IN THE OFFICE

Column 1: The day of the week on which the survey was done.

EG: Monday - 1;
Tuesday - 2; etc.

Columns 2-5: For each station, each direction, the interviews done during each day are numbered in chronological order.

NOTE: Laidlaw - Hunter Creek is considered to be one station.

The sequence numbering is done separately for each station (Hunter Creek - Laidlaw is <u>one</u> station) for each day.

For each day of interviews at one station (Hunter Creek and Laidlaw combined is one station) the sequence numbers start with 1 in column 5 for the first interview of the day. Column 1 contains 1, 2, 3, 4, or 5 depending on whether the day was Monday, Tuesday, Wednesday, Thursday, or Friday respectively.

The day starts at 0001 hours (one minute past midnight) i.e. the sequence numbering starts with those interviews done between 0001 and 0100 hours or whenever the first shift started that day.

The interview sheets are then numbered in chronological order hour by hour for the rest of the day (till 2400 hours when a new day starts and the sequence numbers starting over again at 1 in column 5 and the appropriate number in column 1.)

For example, at Laidlaw - Hunter Creek the interviews done between 0800 and 0900 hours at Laidlaw and/or Hunter Creek are sequence numbered before those done between 0900 and 1000 hours at Laidlaw and/or Hunter Creek.

2. SURVEY LOCATION - COLUMN 6-7

Each survey location has a code which will be supplied by the supervisor.

Saanich	01
Duncan	02
Parksville	03
Pacific	04
Deas Tunnel N & S	05
Pattullo Bridge	06
Port Mann W & E	07
Abbotsford	08
Laidlaw-Hunter CK.	09
Ruskin	10
Haig	11
Cache Creek	12
Kamloops	13
Kamloops N.	14
Sicamous	15
Vernon	16
Rutland	17
Kaleden	18
Rossland	19
Midway	20
Kinnaird	21
Yahk	22
Fernie	23
Golden	24
Williams Lake	25
Tete Jaune Cache	26
Quesnel	27
Prince George S.	28
Prince George N.	29
Vanderhoof	31
Terrace	32
Chetwynd	33
Fort St. John	34
Dawson Creek	35
Tupper Creek	36
Fort Nelson	37
Radium Hot Springs	38 (On Hwy. 93)

3. DIRECTION OF TRAVEL

Column 8: The direction in which the truck being surveyed is headed.

North -1
East -2
South -3
West -4

4. TIME OF DAY (HR. ENDING)

Columns 9 - 10: The hour of the day based on the 24 hour clock

Eg: 3 p.m. = 15

All trucks interviewed between 1400 and 1500 hours would have 15 entered in columns 9 and 10.

5. NAME OF CARRIER = NO CODE

If it is not printed on the side of the truck ask the driver who the registered owner of the vehicle is. If the truck is rented (Hertz, U-Haul, Ryder, etc.) record the name of the person who rented it.

OF TRIPS - Column 11

This is the number of trips made by the same vehicle in the SAME DIRECTION on the same day as noted in general note number 9.

# of Trips in Same Dir'n	CODE
1	1 or blank
2	2
3	3
4	4
5	5
6	6
7	7
8	8
9 or more	9

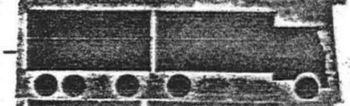
6. TRUCK DESCRIPTION Column 12

Truck Description	Code
Straight Truck (ST)	1
Tractor Semi-Trailer (TST)	2
Truck and Trailer (TT)	3
Truck and Trailers (TTS)	4
Tractor Semi-Trailer and Trailer (TSTT)	5
Tractor Semi-Trailer and Trailers (TSTTS)	6
Other (Tractor only, Tow Truck, etc.)	7

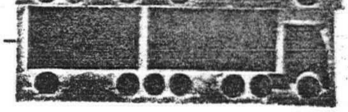
STRAIGHT TRUCK

TRACTOR SEMI-TRAILER

TRUCK AND TRAILER



TRACTOR SEMI-TRAILER AND TRAILER



Notes:

1. Loaded logging trucks are to be coded as Tractor Semi-Trailer (2).

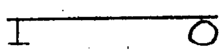
2. Empty logging trucks (2 up - 3 down) are to be coded as Other (7).

7. <u>TRUCK BODY</u> - Column 13

Body or Trailer Type	Code
Common Van	1
lowbed	2
Flat-Deck or Hibed	3
Liquid Bulk Tank	4
Dry Bulk Tank	5
Dry Bulk Dump	6
Refrigerated Unit	7
Livestock Unit	8
Other (Logging, Pole Carrier, Tractor only, Tow Truck)	9

Common Van - a "straight" truck, trailer, or sime-trailer

Lowbed - 

Flat-Deck - 

Liquid Bulk Tank - tank truck carrying liquids

Dry Bulk Tank - tank truck carrying dry bulk. It usually has an unloading mechanism underneath the truck called a "belly-dump".

Dry Bulk Dump - dump truck carrying dry bulk. Truck body usually tips to unload.

Refrigerated Unit - look for refrigeration unit at front <u>or underneath</u> of trailer, or semi-trailer.

Livestock Unit - truck carrying livestock.

8. TOTAL AXLES - Column 14

Description	Code
2 Axles	2
3 Axles	3
4 Axles	4
.	
.	
.	
9 Axles	9
10 Axles	1

NOTE: 1. The number of axles is equal to the number of tires showing on one side that are in contact with the road.

2. In the case of an empty logging truck (2 up - 3 down) the number of axles usually is 3.

9. VEHICLE REGISTRATION - Columns 15-16

The place where the vehicle is registered is given by the base licence which is usually located in the licence plate holder provided by the vehicle manufacturer.

If the vehicle is registered in B.C. and prorated for use in other places the licence number will have a P prefix.

If registered elsewhere and prorated for use in B.C. there will be a backing plate (located on the front of the truck) with a B.C. decal on the vehicle.

Location	Non-Prorated	Prorated
B.C.	01	51
Alberta	02	52
Saskatchewan	03	53
Manitoba	04	54
Ontario	05	55
Quebec	06	56
Atlantic Provinces	07	57
Yukon & N.W.T.	08	58
DND or Canada	09	59
Alaska	11	61
Washington	12	62
Oregon	13	63
California	14	64
Montana, Idaho, Wyoming	15	65
Nevada, Utah, Colorado, Arizona & New Mexico	16	66
N. Dakota S. Dakota, Nebraska, Iowa, Minnesota, Wisconsin, Illinois & Michigan	17	67
Kansas, Missouri, Arkansas, Oklahoma, Texas & Louisiana	18	68
Indiana, Ohio, Kentucky, W. Virginia Tennessee, N. Carolina, S. Carolina, Georgia, Alabama, Mississippi & Florida	19	69
Pennsylvania, New York, New Jersey, Maryland, Washington, D.C., Delaware, Conn., R.I., Mass., Vermont, New Hampshire & Maine	21	71
Mexico & Others	22	72

10. LICENCE CLASS - Column 17

Class	Code	Example
Common or For Hire Carrier	1	Smith, Trimac, CP Express
Private Carrier	2	Eaton's, Dairyland, Safeway
Government	3	DND, Etc. Check Licence or ask driver
Farm	4	Check Licence or ask driver

NOTES

1. A common or for hire carrier is the holder of a valid public commercial vehicle licence issued by any province or state which allows him to haul for any shipper. Any common or for hire carrier registered in B.C. (and sometimes those registered outside B.C.) must have a motor carrier licence. This is a blue licence plate with white lettering usually located on the front of the truck. This plate is about 50% to 75% the size of the standard provincial license plate.

   However, in some cases the motor carrier plate might have fallen off or not yet have been placed on the vehicle.

   All moving vans (United, North American, Mayflower, etc.) are common carriers.

2. A private carrier is a trucking operation which is owned or controlled by the shipper of the goods and which is hauling only the shippers' goods.

   Rented trucks such as Hertz, U-Haul, Ryder, etc., are private carriers.

3. Governmnnt vehicles are those combinations such as DND, mail and local (municipal) government trucks.

4. All farm vehicles registered in B.C. have licence plates with the prefix "A" on them.

11. ORIGIN-DESTINATION - Columns 18 - 37

Original Origin	Last Origin	Next Destination	Final Destination
18-22	23-27	28-32	33-37

ORIGINAL ORIGAN - where the vehicle combination started from

FINAL DESTINATION - where the vehicle combination will terminate its trip

LAST ORIGIN - the last stop made for the purpose of loading or unloading cargo which would control route selection

NEXT DESTINATION - the next stop made for the purpose of loading or unloading cargo which would control route selection

Two columns are for CENSUS DIVISION and two columns are for CENSUS SUBDIVISION in each O/D box. Column 5 is for province or state.

NOTES FOR CODING

If an origin or destination is in:	Column 5 is:
British Columbia	Blank
Alberta	9
Saskatchewan	8
Manitoba	7
Ontario	6
Quebec	5
Maritimes	4
Yukon, N.W.T.	3
Washington	2
Other U.S.A.	1

The coding system used for O/D's in this survey for B.C., Alberta, Saskatchewan, Manitoba, Ontario, Quebec, Yukon and N.W.T. is Statistics Canada's STANDARD GEOGRAPHICAL CLASSIFICATION system EXCEPT for the first two (2) digits denoting province, which have been dropped.

For the Areas of the Maritimes, and other U.S.A., the first column is coded according to the following tables.

FOR MARITIMES (i.e. "4" is Column 5)

Province	Columns 1-2
Nova Scotia	10
New Brunswick	20
Prince Edward Island	30
Newfoundland	40

FOR WASHINGTON (i.e. "2" in Column 5)

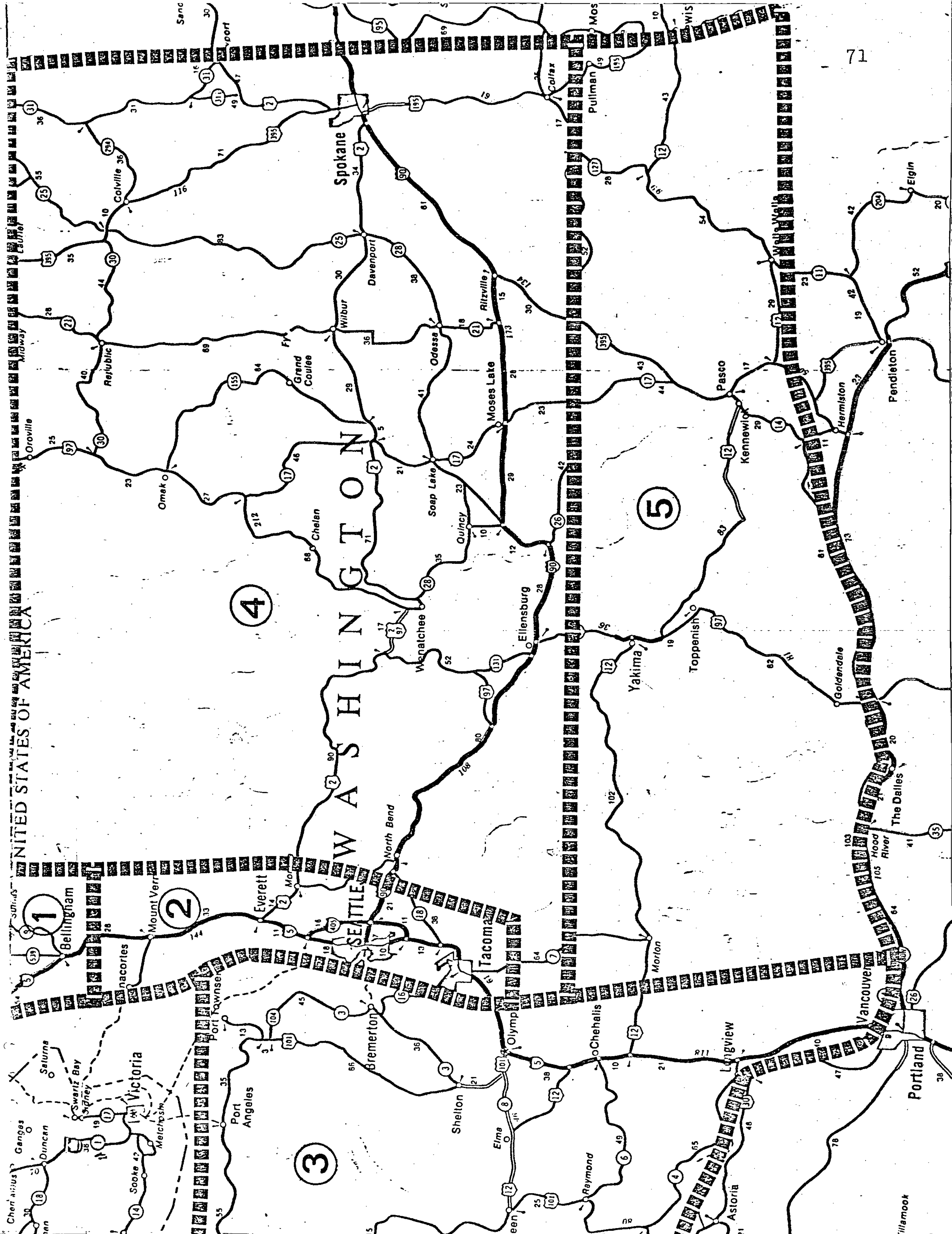
Area (See Attached Map)	Columns 1-2
North-west Washington (near border)	10
North-west Washington	20
Western Washington	30
Northern half of Washington	40
Southern half of Washington	50
Unknown	Blank

FOR OTHER U.S.A. (i.e. "1" is Column 5)

(See Attached Table)

Example:

ORIGINAL ORIGIN					LAST ORIGIN					NEXT DESTINATION					FINAL DESTINATION				
Fairbanks, Alaska					Beaver Cr., Yukon					Bellingham, Wash					Portland, Oregan				
0	2			1	0	1	1	6	3	1	0			2	3	6			1


NITED STATES OF AMERICA
WASHINGTON
1
2
3
4
5
Spokane
Colville
Republic
Oroville
Omak
Grand Coulee
Wilbur
Davenport
Odessa
Ritzville
Moses Lake
Soap Lake
Quincy
Chelan
Wenatchee
Ellensburg
Yakima
Toppenish
Goldendale
Pasco
Kennewick
Hermiston
Pendleton
Walla Walla
Pullman
Colfax
Elgin
The Dalles
Hood River
North Band
Everett
Mount Vern
Bellingham
SEATTLE
Tacoma
Olymp
Bremerton
Shelton
Port Townsend
Port Angeles
Elma
Chehalis
Morton
Raymond
Longview
Astoria
Vancouver
Portland
Tillamook
Victoria
Sidney
Swartz Bay
Saturna
Ganges
Duncan
Sooke
Metchosin

FOR OTHER U.S.A. (ie. "1" in Column 5)

STATE	Columns 1-2	STATE	Columns 1-2
Alabama	01	Nebraska	26
Alaska	02	Nevada	27
Arizona	03	New Hampshire	28
Arkansas	04	New Jersey	29
California	05	New Mexico	30
Colorado	06	New York	31
Connecticut	07	North Carolina	32
Delaware	08	North Dakota	33
Florida	09	Ohio	34
Georgia	10	Oklahoma	35
Idaho	11	Oregon	36
Illinois	12	Pennsylvania	37
Indiana	13	Rhode Island	38
Iowa	14	South Carolina	39
Kansas	15	South Dakota	40
Kentucky	16	Tennessee	41
Louisiana	17	Texas	42
Maine	18	Utah	43
Maryland	19	Vermont	44
Massachusetts	20	Washington, D.C.	45
Michigan	21	West Virginia	46
Minnesota	22	Wisconsin	47
Mississippi	23	Wyoming	48
Missouri	24		
Montana	25		

EXAMPLE:

A trip is being made from Vancouver to Calgary. Stops to load or unload cargo will be made in Cache Creek, Kamloops, and Banff.

Questionnaire at Laidlaw - Hunter Creek

Original Origin	Last Origin	Next Destination	Final Destination
Vancouver	Vancouver	Cache Creek	Calgary

Questionnaire at Cache Creek (weigh scale beyond cargo load location)

Original Origin	Last Origin	Next Destination	Final Destination
Vancouver	Cache Cr.	Kamloops	Calgary

Questionnaire at Sicamous

Original Origin	Last Origin	Next Destination	Final Destination
Vancouver	Kamloops	Banff	Calgary

Questionnaire at Golden

Original Origin	Last Origin	Next Destination	Final Destination
Vancouver	Kamloops	Banff	Calgary

12. COMMODITY CODE - Columns 38 - 41

The commodity codes used are given by the attached appendix.

The commodity being carried is given on the bill of lading which the driver must have with him. Only ask about the bill of lading if the driver does not know what is being carried.

13. HAZARDOUS MATERIALS - Columns 42-43

Ask the driver if he is carrying cargo that is considered hazardous. If yes, ask the driver how much of the total cargo is considered a hazardous material.

Column 42:

Description	Code
No H-M	1
Less then 50% of load H-M	2
More than 50% of load H-M	3
Total load is H-M	4

Attempt to identify the type of hazardous material by reading off the various categories listed below.

Column 43:

Type of H-M	Code
If no H-M	Blank
Explosive	1
Compressed Gas	2
Inflammables	3
Poison	4
Radioactive Material	5
Corrosive	6

14. VOLUME USEAGE - Column 44

Estimate quickly how much of the volumetric capacity of the truck is being used. Ask the driver if necessary.

Volume Useage	Code
Empty - 1/4 Full	1
1/4 full - 1/2 full	2
1/2 full - 3/4 full	3
3/4 full - full	4
Unknown	5

This is an estimate of volume use ONLY and NOT weight.

When the truck is a closed van and the driver does not know how full it is, use Code 5 for "Unknown".

When the truck is recorded on the "TRUCKS NOT SURVEYED/REPEAT TRIPS" form as a truck not surveyed, use code 5 IF the volume useage is not known.

15. REGISTERED (LICENCED) G.V.W.

The maximum allowable weight of the vehicle in kips. This should be written on the side of the vehicle.

R.G.V.W. (Lbs.)	Code
100,000	01
101,000	01
102,000	02
103,000	03
104,000	04
105,000	05
106,000	06
107,000	07
108,000	08
109,000	09
110,000	10
111,000	11
112,000	12

16. TARE WEIGHT

This is the weight of the vehicle combination ready to "roll" without its payload. The units are kips.

If the tare weight is not printed on the side of the truck the driver or the scale operator should know.

N.B. Tare weight should never be more than the actual G.V.W.

17. ACTUAL GROSS VEHICLE WEIGHT

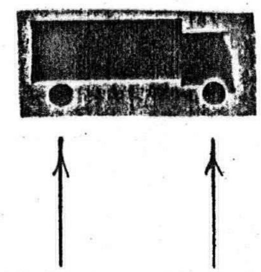
The actual total weight in kips as taken by the weight-scale.

If the Actual G.V.W. is greater than 99,000 lbs. code as follows:

A.G.V.W. (Lbs.)	CODE
100,000	01
101,000	01
102,000	02
103,000	03
104,000	04
105,000	05
106,000	06
107,000	07
108,000	08
109,000	09
110,000	10
111,000	11
112,000	12

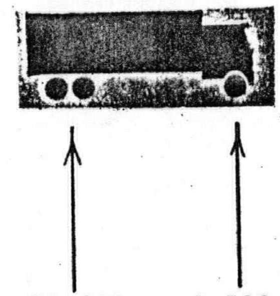
18. AXLE WEIGHTS

These are the weights on each axle which are taken as the truck drives off the scale one acle at a time, some scales are equipped to give the axle weights automatically.



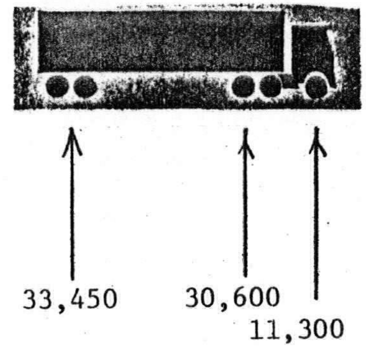
ACTUAL GVW = 29,700

Steering Axles		Single	Tandem		Single	Tandem		Single	Tandem		Single
10,800		18,900									
1 1		1 9									



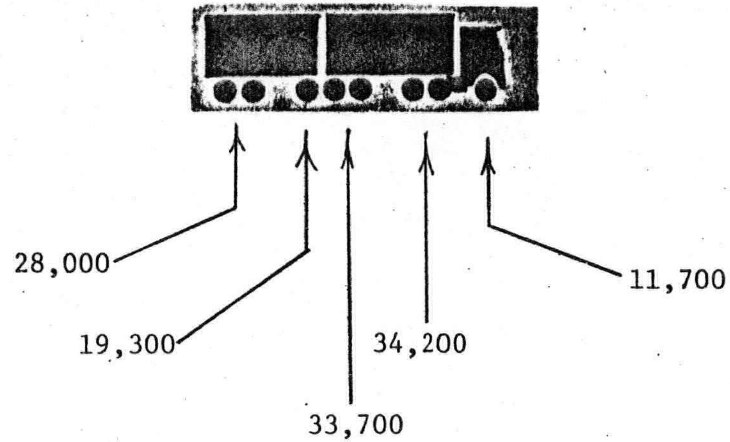
ACTUAL GVW = 41,100

Steering Axles		Single	Tandem		Single	Tandem		Single	Tandem		Single
9,500			31,600 / 2								
1 0			1 6	1 6							



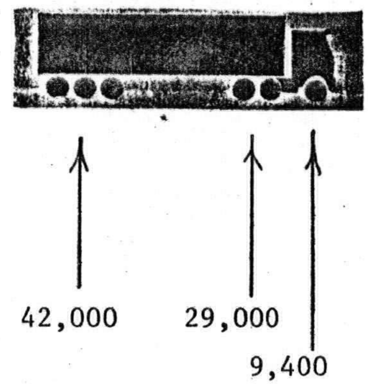
ACTUAL GVW = 75,350

Steering Axles		Single	Tandem		Single	Tandem		Single	Tandem		Single
11,300			30,600 / 2			33,450 / 2					
1 1			1 5	1 5		1 7	1 7				



ACTUAL GVW = 126,900

Steering Axles		Single	Tandem		Single	Tandem		Single	Tandem		Single
11,700			34,200 / 2			33,700 / 2		19,300	28,000 / 2		
1 2			1 7	1 7		1 7	1 7	1 9	1 4	1 4	



ACTUAL GVW = 80,400

Steering Axles		Single	Tandem		Single	Tandem		Single	Tandem		Single
9,400			29,000 / 2			42,000 / 3					
0 9			1 5	1 5	1 4	1 4	1 4				

COMMODITY CODE

CODE 1

01 GENERAL FREIGHT

	CODE 2
More than one bill of lading (LTL)	01
One bill of lading - mixed freight	02
Waste materials (ex. returned bottles)	03
Other - specifiy	04

CODE 1

02 FOODSTUFFS (NON-PERISHABLE)

	CODE 2
Food preparations (can, box, bottle, bag)	01
Non-alcoholic beverages (bottle or can)	02
Alcoholic beverages	03
Tobacco	04
Other - specify	05

CODE 1

03 FOODSTUFFS (PERISHABLE)

	CODE 2
Meat and meat preparations	01
Fish and seafood	02
Dairy produce (not bulk)	03
Bakery products	04
Fresh fruits and vegetables	05
Frozen fruits and vegetables	06
Other - specify	07

CODE 1

04 HEAVY MACHINERY

	CODE 2
Construction and maintenance machinery and equipment	01
Oil industry equipment and machinery (includes field equipment)	02
Automobiles and truck chasses	03
Automobile parts and accessories	04
Industrial machinery	05
Agricultural machinery and equipment	06
Other - specify	07

CODE 1

05 METAL PRODUCTS

	CODE 2
Scrap metal	01
Slag, drosses, etc.	02
Iron and steel products	03
Precious metals (gold, mercury, etc.)	04
Other - specify	05

CODE 1

06 PETROLEUM PRODUCTS

	CODE 2
Petroleum (crude)	01
Natural gas and propane	02
Gasoline	03
Diesel, lube, and fuel oils	04
Liquid gas	05
Other gas (ex. oxyacetylene)	06
Asphalt and road oils	07
Plastics and rubber products	08
Other - specify	09

CODE 1

07 BULK LIQUIDS AND CHEMICALS

	CODE 2
Acids	01
Alcholols (bulk industrial)	02
Hydrated limes	03
Anhydrous ammonia	04
Chlorine	05
Paint	06
Solvents	07
Water	08
Milk (bulk)	09
Liquified gases	10
Oils and fats (non-petroleum)	11
Other - specify	12

CODE 1

08 BULK DRY CHEMICALS AND MINERALS

	CODE 2
Fertilizer	01
Sulphur	02
Lime	03
Potash	04
Cement (dry)	05
Gypsum	06
Ores and ore concentrates	07
Coal	08
Sand and gravel	09
Alum	10
Other - specify	11

CODE 1

09 FOREST PRODUCTS

	CODE 2
Logs	01
Woodchips or sawdust	02
Firewood	03
Planks and boards	04

Posts and poles	05
Plywood products	06
Cardboard	07
Newsprint (rools)	08
Paper products	09
Waste paper	10
Other - specify	11

CODE 1

10 LIVESTOCK

	CODE 2
Animals (cattle, swine, horses, etc.)	01
Poultry (chickens, turkeys, ducks, etc.)	02
Other - specify	03

CODE 1

11 CONSTRUCTION MATERIALS

	CODE 2
Bricks of blocks	01
Cement (bags)	02
Landscaping materials (sod, trees, etc.)	03
Tar products (roofing)	04
Flooring	05
Gypsum products (drywall)	06
Insulation	07
Precast concrete	08
Prefab housing components	09
Ready Mix Concrete	10
Other - specify	11

CODE 1

12 SEED, FEED AND FEED PRODUCTS

	CODE 2
Feed grains	01
Seed grains	02
Milling grains	03
Industrial grains	04
Prepared feed	05
Meal	06
Other - specify	07

CODE 1

13 TRAILER-MOBILE HOMES

	CODE 2
Recreational trailers	01
House trailer (over 20 feet)	02
Construction buildings	03
Prefab modular homes	04
Other - specify	05

CODE 1	CODE 2
14 HOUSEHOLD GOODS	01
(eg. Moving vans)	

CODE 1	CODE 2
15 MAIL	01

CODE 1	CODE 2
16 OTHER	
Empty truck	01
Other - specify	02

APPENDIX III

THE SECTIONS OF D.F. TOWNSEND'S M.A. THESIS DEALING WITH THE TRAVEL COSTS THAT WERE USED FOR IMPEDANCE IN THE GRAVITY MODELS

<u>NOTE</u>: THIS IS A REPRODUCTION OF SECTIONS OF D. F. TOWNSEND'S THESIS

6.4 METHOD OF SIMULATION OF TRUCK OPERATING COSTS

The accuracy of a simulation depends on the quality of data available, on the strength and stability of logically - or empirically-supported relationships, and on the successful arrangement in steps of natural or induced processes that are generally fluid and continuous. Qualtities and relationships have to vary by measureable degrees, or be ignored by the simulation. The fineness of measurement depends mainly on the purposes of the simulation. If one is seeking the "truth" in travel costs between places, then the simulation includes such detail as oil consumption, gear changes, rise and fall in feet, drivers' response to congestion, drivers' fringe benefits, and so on. Less detail would be required to provide a fleet operator with an estimate of his running costs. For most studies of spatial relationships in Geography, even more generalized measurements have been made, using only time or total distance data. It was suggested in an earlier chapter that the deterrent component in the gravity model ought to be more thoroughly described and quantified--but not to the extent of having a fine measure in the denominator as against a gross measure in the numerator. Since the relationships between travel cost, frequency of travel, prices of goods and general economic activity are not clearly defined nor necessarily determinated, it would be inconsistent to apply a strict estimate of costs to a rather vague assessment of response. Indicative quantities only are required for this study, to pick out the varying degree of change for links in the network.

The most detailed simulations of truck costs have come from the civil engineers, some working on engine and vehicle design, others on the design of facilities.[23] Increasing refinement of the parameters usually entails a multiplication of the data requirements, hence the restriction of empirical tests to very small sections of highways.[24] Highway economy studies generalize from the basic research.[25] Guidelines for use on evaluation of projects generalize further, adjusting to the data available and to the purposes of the evaluation.[26]

Roberts (1966) used a substantial amount of detail in preparing a simulation for truck costs in developing countries. The 8 variables for the link and 12 for the truck require some data not generally available in that situation. The fineness of the simulation and the effort required, seem out of balance with the type and degree of response which one might expect in those circumstances. A similar criticism might be applied to the simulation used by Griffiths (1968), which included very fine margins of fuel, oil, and tyre costs in a model for assessing road development projects in Dahomey. Gauthier described the difficulty of obtaining information on transportation costs in Brazil, mainly because the industry "is characterized by a large number of very small firms" (1968, p. 108). Using locally generated estimates, Gauthier included overhead charges, initial equipment costs and administrative expenses to derive a set of values relating transport costs to length of haul over different types of surface. The relationship between travel cost and administrative and overhead costs was discussed by Stevens (1961) and Adkins et al. (1967) generally, the relationship is too weak or indeterminated to fix a measure of gain due to road improvement.[27] Kissling (1966) relied mainly on the guidelines of Stevens (1961) and AASHO (1960) in obtaining running speeds and operating costs for Nova Scotia, from a highway inventory taking in 10 variables. For lack of time and information, the present study takes in only 7 variables describing the link, to derive running speeds, link time and cost for a 70,000 lb. gross tandem semi-trailer.[28] Elaboration of the content and mechanics of the simulation is provided in Appendix III.

The description of links in the B.C. road system has been compiled from topographic maps, tourist maps, and by tracing the development history of each link through the accounts in the Annual Reports. The years 1952, 1962, and 1971 have been chosen to mark stages in highway development. Route data before 1952 are scarce; investment data are available only until March 1971, at the time of writing. Distances and ferry delays have been taken from published tourist maps. Zones of legal speed restrictions have been estimated from topographic maps and, in the latest year, from personal observations. The type and condition of surfaces has been taken from tourist maps, topographic maps, references in the accounts, and personal observation. Lane and roadway width-- for which the data are least reliable--have been estimated from topographic maps, references in the accounts and personal observation. Grades have been estimated rather crudely from topographic maps, calculating the total rise and fall over a link, and modifying the gradient factor where references in the accounts suggested cut-and-fill or redesign operations had taken place. Curves could not be estimated from the available information. Volume of traffic was measured from the Department of Highways summer traffic counts of 1953, 1954, 1962, and 1971.

Average running speeds on straight, level, unimpeded surfaces were set at 50mph. for paved and 38mph. for gravel.[29] Speeds within legal zones were set at 20mph.[30] - legal zones indicate a higher frequency of intersections, crosswalks, traffic lights, stop signs, on-street parking etc., which reduce speeds within urban areas. Personal observation on a Thursday in September, 1972, of trucks passing through Kamloops and Vernon, supported the 20mph. estimate.

Lane and roadway widths reduce desired or free speed. From the sources referred to,[31] a range of factors was derived for Table XI. Indications from comparison of calculated and observed speeds suggest that greater restrictive influence should apply on narrow and restricted roads in the earlier years.

TABLE XI

PERCENTAGE OF FREE SPEED, UNDER WIDTH RESTRICTIONS

Description		Range
Open:	12' lanes, good shoulders, good vision	96 - 100
Narrow:	10'-12' lanes, poor shoulders, adequate vision	88 - 95
Restricted:	less than 10' lanes, poor shoulders, poor vision	82 - 88

The danger is that the width factor is applied with the grade and volume factor in hilly winding sections, giving an unrealistic cumulative restraint; whereas the presence of a grade factor more or less cancels out the effect of a width factor, as the vehicle is slowed by gravity rather than by driver's caution.

A measurement of the total rise and fall was taken from maps, i.e. each time the road crossed a 100' contour line. The average rise and fall, a slightly better indicator of severity, was found by dividing the total by the link distance. This measure is not as precise as Kissling's 'critical gradient' (1969, p. 114) in measuring the effects on truck speed. A range of factors was derived from experiments elsewhere.[32] Grades also increase the rate of fuel consumption by a greater margin than that caused by a decrease in speed, due to gear reduction. So a factor for extra fuel consumption on grades was added, (see Table XII).

TABLE XII

INDICES OF FREE SPEED AND NORMAL CONSUMPTION, DUE TO INCREASING RISE AND FALL

Rise and Fall* (total R.and F. ÷ miles)	1	2	3	4	5	6
Modern paved	95	85	74	62	53	46
Old paved	93	82	71	57	47	40
Gravel	98	92	81	72	66	60
Consumption	110	120	145	170	200	230

* Total Rise and Fall is found by counting the number of times the road crosses 100' contour lines, then multiplying by $\frac{1000}{5280'}$ to supply the scale with an integer.

Note: reductions of speed on gravel are less severe because of the lower base speeds attributable to gravel roads. The reductions on modern pavements are relatively less severe because of the realigning of curves, grades and cuttings during reconstruction.

Incorporation of a factor to reflect volume of traffic was most difficult. The traffic counts are patchy and do not tell of the frequency of trucks in the total stream. The summer counts overstate the average annual daily flow. Without knowing the hourly distributions of traffic, it is impossible to deduce the length of periods when flow is approaching capacity. Also, one can only generalize very broadly in saying that truck drivers and owners will avoid congested periods by rescheduling. Such rescheduling carries an extra penalty to the operator in overtime or night shift rates, so the application of a factor for daytime congestion is not entirely indiscriminate (Table XIII).

Fuel consumption varies according to running speed, gross weight, engine power, gradients and so on.[34]

TABLE XIII

PERCENTAGE OF FREE SPEED, UNDER AVERAGE DAILY FLOWS

Volume	Paved	Gravel
<3500 per day, 2 lane	100	100
3500 - 5500	98	97
>5500	92	90

Note: the factors are somewhat inflated for this simulation, since they are applied after width and grade factors.

: the greater hazard of vision and increased spacing reduces the speed on gravel surfaces by a slightly wider margin.

: ref. Saal (1950), p. 21; AASHO (1960), p. 29, 66, 80; and de Weille (1966), p. 49.

For simplicity, this simulation ties consumption to speeds and gradients only. Consumption decreases for speeds from 20 to 35mph., then starts to increase (see Table XIV). Fuel is one cost whose total might rise because of improvements to road facilities. Cost per gallon is set at 40 cents.

TABLE XIV

INDICATIVE FUEL CONSUMPTION AT AVERAGE RUNNING SPEEDS
(vehicle 3-S-2, diesel, 70,000lb. gross)

Speed	20	25	30	35	40	45	50
Gallons per mile	.26	.23	.20	.20	.22	.26	.28

The calculation of hourly cost of vehicles and drivers has provided widely differing values. Kissling (1966) used $3.00 per hour; Fleischer (1962) used $3.90; Adkins et al. (1967) used $4 to $8; Winfrey and Zellner used $3.75; and Koppelman used $6.00. Based on the existing Teamsters' Union contract, drivers' wages in B.C. are set at $5.00 per hour, and an average of \$0.60 is allowed for subsistence (meals and overnight stops). Following the example of Adkins et al. (1967, p. 36), \$2 has been added for drivers' welfare (holidays, workers' compensation, etc.) and vehicle depreciation.[35] The justification for these inclusions is that on an improved link, less time is spent, and therefore less of the direct operating cost is attributable to that section. The total time cost applied in this simulation is \$7.50 per hour.

Vehicle maintenance and repair cost is a complex function of average speed, weight, loads, surfaces, stops, speed changes, curves and grades. Using evidence gathered in test sections elsewhere,[36] the cost of repairs, maintenance and tyres was set at 18 cents per mile for old gravel, 17 cents for normal gravel, 13 cents for old pavement, and 12 cents for pavement under 8 years old (where this information was available from maps and the financial accounts).

APPENDIX III

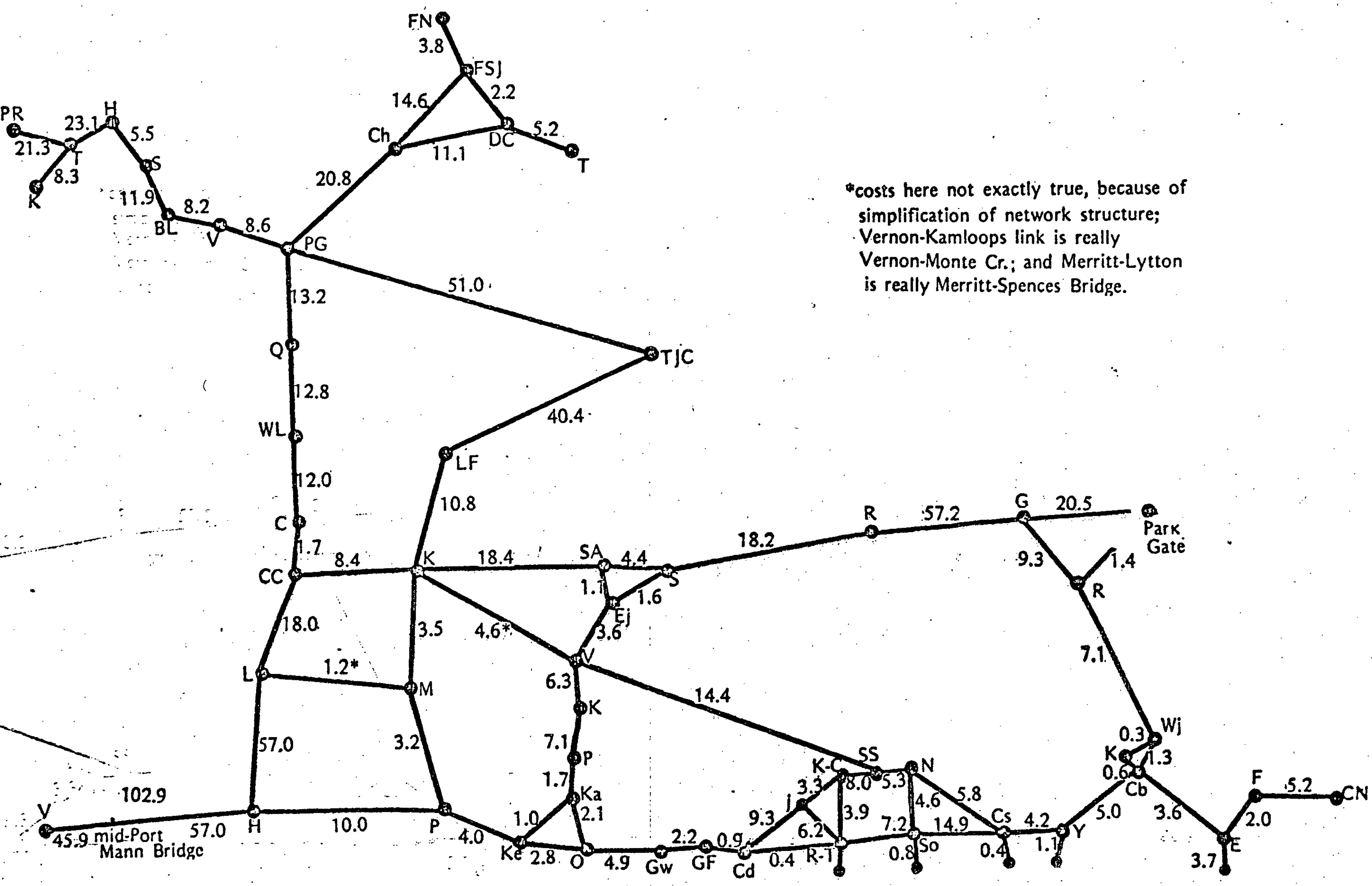
CONTENT AND METHODS OF THE SIMULATION OF TRUCK COSTS*

Identify link.
Identify miles (D) of surfaces, P paved and G gravel.
Identify miles of legally restricted speeds (L).
Identify widths for various sections, convert to factors (W) as in Table XI.
Count up total rise and fall in feet from 100' contour maps, divide by link distance, to get average rise and fall; convert to factors for speed (H) and for fuel consumption (N) according to Table XII.
Take traffic flow from published counts, convert to factors (V) according to Table XIII.
Add in any ferry delays (Y).
Set base speeds at 50mph. for P, and 38mph. for G.

STEPS:

1. Total D - legal D = (Dp + Dg)
2. Legal D ÷ 20mph. = time over legal D.
3. 50 x Wp = speed over paved sections, allowing for W.
4. 38 x Wg = speed over gravel sections, allowing for W.
5. step 3 x H = speed over paved, allowing for W and H.
6. step 4 x H = speed over gravel, allowing for W and H.
7. step 5 x V = speed over paved, allowing for W, H and V.
8. step 6 x V = speed over gravel, allowing for W, H and V.
9. step 7 x Dp = time over paved sections.
10. step 8 x Dg = time over gravel sections.
11. sum steps 2,9, and 10 = link time.
12. link time ÷ D = average running speed.
13. Find consumption at this speed, see Table XIV.
14. Add extra grade factor to consumption (Table XIV) to get average consumption.
15. total D x average consumption = fuel consumed.
16. fuel consumed x $0.40 = fuel cost on link.
17. step 11 + Y = total link time.
18. link time x $7.50 per hour = driver and truck cost on link.
19. (Dp + legal D) x paved repair costs = repair cost on paved.
20. Dg x gravel repair cost = repair cost on gravel sections.
21. sum steps 16, 18, 19, 20 = <u>total link cost</u>.

* Computer Programme put together by Larry Meyer, Dept. of Geography, U.B.C.



*costs here not exactly true, because of simplification of network structure; Vernon-Kamloops link is really Vernon-Monte Cr.; and Merritt-Lytton is really Merritt-Spences Bridge.

Fig 17. Total Cost of Links in the Trunk System 1946-71
$ million (surveys, right-of-way, construction, paving, improving).

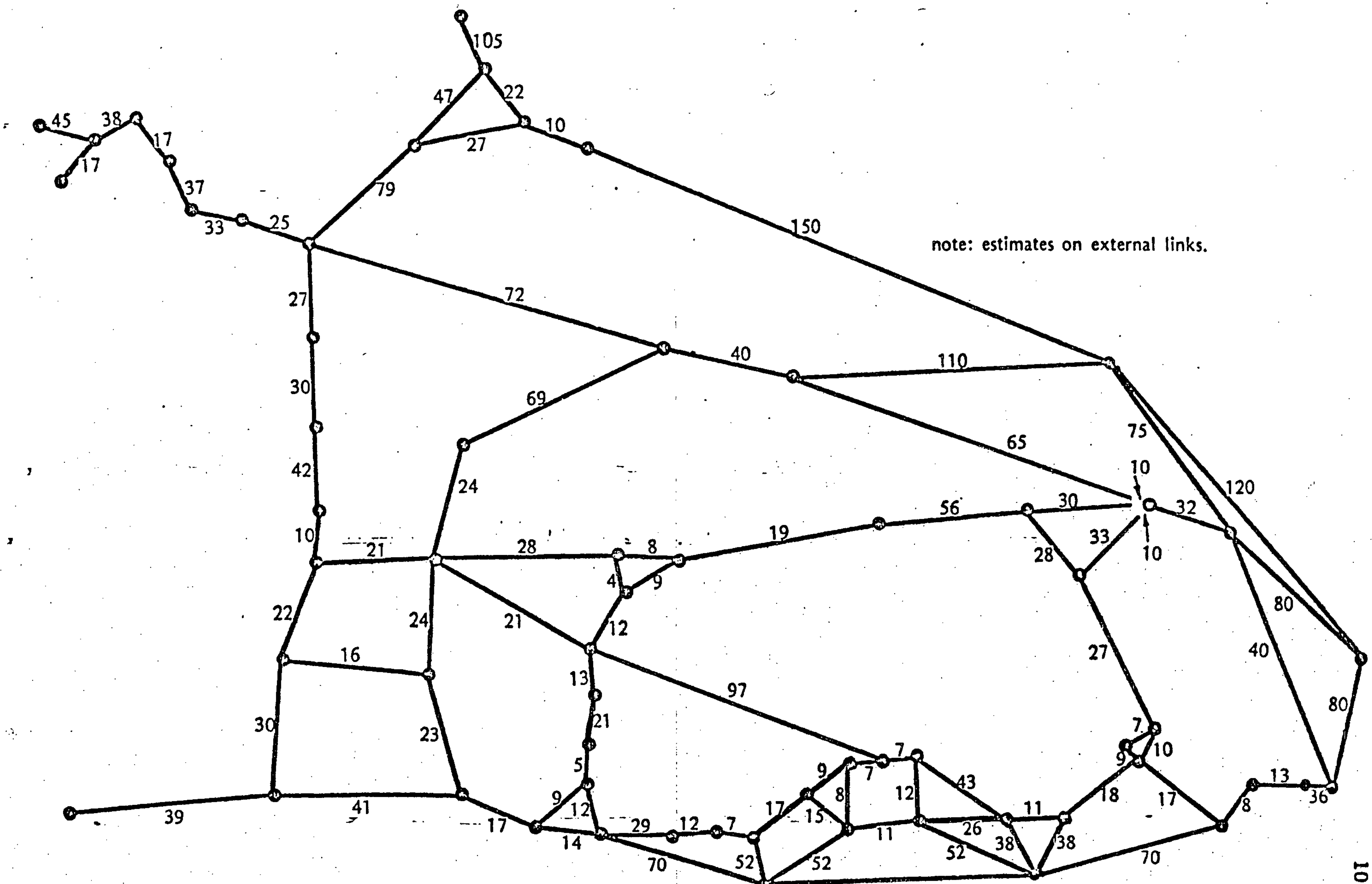


Fig 21. Simulated Heavy-Truck Costs, 1971 Links, ($ rounded)

APPENDIX IV

THE SURVEY SCHEDULE

DUNCAN

DAY	2400-0800	0800-1600	1600-2400
MONDAY 8 JUL 74	-----	-----	-----
TUESDAY 9 JUL 74	-----	-----	-----
WEDNESDAY 10 JUL 74	-----	1000 - 1600 A,B,C,	1600 - 2200 D,E,F
THURSDAY 11 JUL 74	-----	A,B,C,	D,E,F
FRIDAY 12 JUL 74	-----	-----	-----

NOTE: Each letter represents an interviewer on duty.

PARKSVILLE

DAY	2400-0800	0800-1600	1600-2400
MONDAY 8 JUL 74	-----	-----	-----
TUESDAY 9 JUL 74	-----	-----	-----
WEDNESDAY 19 JUL 74	-----	1100 - 1600 G,H,I	1600 - 2200 J,K,L
THURSDAY 11 JUL 74	-----	G,H,I	J,K,L
FRIDAY 12 JUL 74	-----	-----	-----

LAIDLAW (15 - 19 JULY)

DAY	2400-0800	0800-1600	1600-2400
MONDAY	-----	1200 - 1800 A,B	1800 - 2400 E,F
TUESDAY	-----	A,B,	-----
WEDNESDAY	-----	A,B	G,H
THURSDAY	E,F	A,B	-----
FRIDAY	-----	E,F	A,B

HUNTER CREEK (15 - 19 JULY)

DAY	2400-0800	0800-1600	1600-2400
MONDAY	-----	1200 - 1800 C,D	1800 - 2400 G,H
TUESDAY	-----	C,D	G,H
WEDNESDAY	E,F,	C,D	-----
THURSDAY	-----	C,D	G,H
FRIDAY	-----	C,D	G,H

HAIG (22 - 26 JULY)

DAY	2400-0800	0800-1600	1600-2400
MONDAY	-----	C,D	G,H
TUESDAY	-----	C,D	A,B
WEDNESDAY	G,H	C,D	A,B
THURSDAY	-----	C,D	G,H
FRIDAY	A,B	C,D	G,H

KALEDEN (22 - 26 JULY)

DAY	2400-0800	0800-1600	1600-2400
MONDAY	-----	-----	-----
TUESDAY	-----	E,F	-----
WEDNESDAY	-----	E,F	-----
THURSDAY	-----	E,F	-----
FRIDAY	-----	E,F	-----

KAMLOOPS (29 JULY - 2 AUGUST)

DAY	2400-0800	0800-1600	1600-2400
MONDAY	-----	A,B	E,F
TUESDAY	-----	G,H	-----
WEDNESDAY	-----	G,H	A,B
THURSDAY	-----	-----	-----
FRIDAY	-----	E,F	G,H

KAMLOOPS NORTH (29 JULY - 2 AUGUST)

DAY	2400-0800	0800-1600	1600-2400
MONDAY	-----	C,D	-----
TUESDAY	-----	C,D	A,B
WEDNESDAY	E,F	C,D	-----
THURSDAY	-----	C,D	-----
FRIDAY	-----	C,D	-----

CACHE CREEK (29 JULY - 2 AUGUST)

DAY	2400-0800	0800-1600	1600-2400
MONDAY	-----	-----	-----
TUESDAY	-----	-----	-----
WEDNESDAY	-----	-----	-----
THURSDAY	-----	E,F	G,H
FRIDAY	A,B	-----	-----

GOLDEN (5 - 9 AUGUST)

DAY	2400-0800	0800-1600	1600-2400
MONDAY	-----	-----	-----
TUESDAY	-----	C,D	-----
WEDNESDAY	-----	C,D	-----
THURSDAY	G,H	C,D	E,F
FRIDAY	G,H	C,D	E,F

TETE JAUNE CACHE (5 - 9 AUGUST)

DAY	2400-0800	0800-1600	1600-2400
MONDAY	-----	-----	-----
TUESDAY	-----	A,B	G,H
WEDNESDAY	-----	A,B	-----
THURSDAY	-----	A,B	-----
FRIDAY	-----	A,B	-----

FERNIE (12 - 16 AUGUST)

DAY	2400-0800	0800-1600	1600-2400
MONDAY	-----	C,D	E,F
TUESDAY	-----	C,D	E,F
WEDNESDAY	-----	C,D	E,F
THURSDAY	G,H	C,D	E,F
FRIDAY	-----	C,D	-----

YAHK (12 - 16 AUGUST)

DAY	2400-0800	0800-1600	1600-2400
MONDAY	-----	-----	-----
TUESDAY	-----	-----	-----
WEDNESDAY	-----	-----	A,B
THURSDAY	-----	-----	-----
FRIDAY	A,B	G,H	-----

TERRACE

DAY	2400-0800	0800-1600	1600-2400
MONDAY 19 AUG 74	-----	-----	-----
TUESDAY 20 AUG 74	-----	-----	-----
WEDNESDAY 21 AUG 74	-----	-----	-----
THURSDAY 22 AUG 74	-----	X,Y,Z	-----
FRIDAY 23 AUG 74	-----	-----	-----

NOTE: Each letter represents an interviewer on duty.

APPENDIX V

FACTORS FOR TRIPS/WEEK

SCALE	SHIFT	FACTOR
Duncan	08 - 16	(1.43 + 2.86)*
"	16 - 24	3.08
Fernie	-----	--------
Golden	24 - 08	2.5
"	08 - 16	1.25
"	16 - 24	2.5
Haig	24 - 08	2.5
"	08 - 16	1
"	16 - 24	1
Kaleden	08 - 16	(1.38 + 1.25)*
Kamloops	08 - 16	(1.25 + 1.25)*
"	16 - 24	1.67
Kamloops North	24 - 08	5
"	08 - 16	1
"	16 - 24	5
Laidlaw - Hunter Creek	24 - 08	5
	08 - 16	1.11
	16 - 24	1.43
Parksville	08 - 16	(1.54 + 3.08)*
"	16 - 24	3.08
Terrace	08 - 16	(5 + 5)*
Tete Jaune Cache	-----	------
Yahk	24 - 08	5
"	08 - 16	5
"	16 - 24	5

*NOTE: At scales where the survey was not done for at least one 24 hour period the 08 - 16 shift was factored-up as compensation. The first number in the brackets is this special adjustment.

APPENDIX VI

SCALE FORMULAS

An explanation of these formulas is in section 4.1 of the thesis. Note that the formula for T(i,j) is the same as the formula for T(j,i).

VARIABLES:

T(i,j) = total trips/week from i to j.
= value of T(i,j) in the final O/D table.

D = trips/week from i to j recorded at the Duncan scale.

F = trips/week from i to j recorded at the Fernie scale.

G = trips/week from i to j recorded at the Golden scale.

H = trips/week from i to j recorded at the Haig scale.

KL = trips/week from i to j recorded at the Kaleden scale.

K = trips/week from i to j recorded at the Kamloops scale.

KN = trips/week from i to j recorded at the Kamloops North scale.

L = trips/week from i to j recorded at the Laidlaw-Hunter Ck.

P = trips/week from i to j recorded at the Parksville scale.

T = trips/week from i to j recorded at the Terrace scale.

TJC = trips/week from i to j recorded at the Tete Jaune Cache scale.

Y = trips/week from i to j recorded at the Yahk scale.

LINK	FORMULA
Cranbrook – Nelson	$T(i,j) = Y$
" – Kinnaird, Castlegar	$= Y$
" – Rossland, Trail	$= Y$
" – Vancouver	$= \frac{H+L+Y}{2} + \frac{G+K}{4}$
" – Kamloops	$= G$
" – Kelowna	$= G + Y$
" – Vernon	$= G + Y$
" – Golden	$= G$
" – Salmon Arm	$= G$
" – Terrace	$= \frac{G+K+T}{3}$
Nelson – Grank Forks	$T(i,j) = KL$
" – Vancouver	$= H + L$
" – Kamloops	$= KL + K + KN$
Kinnaird, Castlegar – Penticton	$T(i,j) = KL$
" – Vancouver	$= H + L$
Rossland, Trail – Penticton	$T(i,j) = KL$
" – Vancouver	$= H + L$
Grand Forks – Penticton	$T(i,j) = KL$
" – Vancouver	$T(i,j) = H + L$
Osoyoos – Penticton	$T(i,j) = KL$
" –Vancouver	$= H + L$
" – Kelowna	$= KL$
" – Vernon	$= KL$
Keremeos – Penticton	$T(i,j) = KL$
" – Vancouver	$= H + L$
" – Kelowna	$= KL$
" – Vernon	$= KL$
" – Golden	$= KL$
Princeton – Penticton	$T(i,j) = KL$
" – Vancouver	$= H + L$
" – Kelowna	$= KL$
" – Vernon	$= KL$
Penticton – Hope	$T(i,j) = KL$
" – Vancouver	$= \frac{H + L + KL}{2}$
" – Victoria	$= \frac{H + L + KL}{2}$
" – Nanaimo	$= \frac{H + L + KL}{2}$

LINK	FORMULA
Penticton - Campbell River	$T(i,j) = \frac{KL + H + L + P}{3}$
" - Merrit	$= KL$
" - Kamloops	$= KL + K + KN$
" - Kelowna	$= KL$
" - Terrace	$= \frac{KL + K + T}{2}$
Vancouver - Hope	$T(i,j) = H + L$
" - Victoria	$= D$
" - Nanaimo	$= D$
" - Courtenay	$= P$
" - Campbell River	$= P$
" - Merrit	$= H + L$
" - Lytton	$= H + L$
" - Revelstoke	$= \frac{K + H + L}{2}$
" - Cache Creek	$= H + L$
" - Clinton	$= H + L$
" - Kamloops	$= \frac{KL + K + H + L}{2}$
" - Kelowna	$= \frac{H + L + K + KL}{2}$
" - Vernon	$= \frac{H + L + K + KL}{2}$
" - Golden	$= \frac{K + H + L}{2}$
" - Salmon Arm	$= \frac{K + H + L + KL}{2}$
" - Williams Lake	$= H + L$
" - Quesnel	$= H + L$
" - Prince Rueert	$= \frac{H + L + T}{2}$
" - Kitimat	$= \frac{H + L + T}{2}$
" - Terrace	$= \frac{T + H + L}{2}$
" - Smithers	$= H + L$
Victoria - Nanaimo	$T(i,j) = D$
" - Courtenay	$= \frac{D + P}{2}$
" - Campbell River	$= \frac{D + P}{2}$
" - Kamloops	$= \frac{K + H + L}{2}$
" - Kelowna	$= \frac{H + L + K + KL}{2}$
" - Vernon	$= \frac{H + L + K + KL}{2}$

LINK	FORMULA
Nanaimo - Courtenay " - Campbell River " - Kelowna " - Williams Lake	$T(i,j) = D$ $= P$ $= \frac{H + L + K + KL}{2}$ $= H + L$
Courtenay - Kamloops	$T(i,j) = \frac{K + H + L + P}{3}$
Campbell River - Kamloops " - Kelowna " - Salmon Arm	$T(i,j) = \frac{K + H + L + P}{3}$ $= \frac{H + L + K + KL + P}{3}$ $= \frac{K + H + L + P}{3}$
Merrit - Kamloops	$T(i,j) = K + KN$
Revelstoke - Lytton " - Kamloops " - Kelowna " - Williams Lake	$T(i,j) = K$ $= K + KN$ $= K$ $= K$
Cache Creek - Penticton " - Revelstoke " - Kamloops	$T(i,j) = K$ $= K$ $= K$
Clinton - Kamloops	$T(i,j) = K$
Kamloops - Rossland, Trail " - Osoyoos " - Princeton " - Hope " - Nanaimo " - Lytton " - Kelowna " - Vernon " - Golden " - Salmon Arm " - Williams Lake " - Terrace	$T(i,j) = K$ $= KL + K$ $= K + KN$ $= \frac{K + KN}{2}$ $= \frac{H + L + K}{2}$ $= K$ $= K + KN$ $= K + KN$ $= \frac{G + KN}{2}$ $= K + KN$ $= K$ $= \frac{T + K}{2}$
Kelowna - Hope " - Courtenay	$T(i,j) = KL$ $= \frac{K + KL + H + L + P}{3}$

LINK	FORMULA
Kelowna - Clinton " - Golden " - Williams Lake " - Quesnel " - Terrace	$T(i,j) = K$ $= G$ $= K$ $= K$ $= \frac{T + K}{2}$
Vernon - Kelowna " - Golden " - Williams Lake	$T(i,j) = K$ $= G$ $= K$
Golden - Penticton " - Hope " - Nanaimo " - Williams Lake	$T(i,j) = G$ $= K$ $= \frac{K + H + L + KL}{2}$ $= K$
Williams Lake - Penticton " - Victoria " - Terrace	$T(i,j) = K$ $= H + L$ $= T$
Quesnel - Prince Rupert	$T(i,j) = T$
Prince Rupert - Victoria " - Smithers	$T(i,j) = H + L$ $= T$
Kitimat - Terrace	$T(i,j) = T$
Terrace - Prince Rupert " - Smithers	$T(i,j) = T$ $= T$
Smithers - Cranbrook " - Kitimat	$T(i,j) = \frac{K + G}{2}$ $= T$

APPENDIX VII

MODEL WITH 31 NODES

```
***** G R A V I T Y   M O D E L *****

          ( CALIBRATION MODE )


INPUT/OUTPUT SPECIFICATIONS

    NUMBER OF CALIBRATION ITERATIONS                          =  4

    NUMBER OF ATTRACTION BALANCING ITERATIONS                 =  8

    SMOOTHING OPTIONS IN EFFECT           (1=YES,0=NO)        =  1

    PRINT OUT OF INPUT DATA               (1=YES,0=NO)        =  1

    PRINT OUT OF INTERMEDIATE OUTPUT      (1=YES,0=NO)        =  0

    PLOT OUTPUT                           (1=YES,0=NO)        =  1

    K-FACTOR DATA INPUT                   (1=YES,0=NO)        =  0

    K-FACTOR PUNCHED OUTPUT TO UNIT 7     (1=YES,0=NO)        =  0

    TRIP MATRIX PUNCHED                   (1=YES,0=NO)        =  0
```

TRIP PRODUCTIONS AND ATTRACTIONS

ZONE	PRODUCTION	ATTRACTION
1	66.00	58.00
2	18.00	23.00
3	19.00	39.00
4	44.00	38.00
5	25.00	31.00
6	142.00	185.00
7	53.00	63.00
8	126.00	99.00
9	316.00	231.00
10	0.0	85.00
11	968.00	994.00
12	153.00	185.00
13	221.00	243.00
14	114.00	96.00
15	141.00	136.00
16	29.00	46.00
17	2.00	13.00
18	71.00	73.00
19	51.00	41.00
20	16.00	35.00
21	491.00	337.00
22	216.00	224.00
23	141.00	138.00
24	41.00	33.00
25	0.0	35.00
26	85.00	76.00
27	32.00	16.00
28	33.00	41.00
29	71.00	124.00
30	314.00	137.00
31	68.00	192.00

BASE YEAR O/D PATTERN

ZONE	1	2	3	4	5	6	7	8	9	10
1	0	5	5	25	0	0	0	0	0	0
2	0	0	0	0	3	0	0	0	0	0
3	0	0	0	0	0	0	0	0	3	0
4	15	0	0	0	0	0	0	0	11	0
5	0	0	0	0	0	0	0	0	5	0
6	0	0	0	0	0	0	0	0	58	0
7	0	0	0	0	0	0	0	0	24	0
8	0	0	0	0	0	0	0	0	34	0
9	3	3	3	0	5	105	24	29	0	8
10	0	0	0	0	0	0	0	0	0	0
11	18	12	31	11	23	25	21	66	80	68
12	1	0	0	0	0	0	0	0	1	0
13	0	0	0	0	0	0	0	0	0	0
14	0	0	0	0	0	0	0	0	1	0
15	0	0	0	0	0	0	0	0	0	0
16	0	0	0	0	0	0	0	0	3	0
17	0	0	0	0	0	0	0	0	0	0
18	0	0	0	0	0	0	0	0	0	0
19	0	0	0	0	0	0	0	0	2	0
20	0	0	0	0	0	0	0	0	0	0
21	3	3	0	2	0	5	0	1	3	3
22	3	0	0	0	0	37	13	0	0	3
23	5	0	0	0	0	13	5	3	0	0
24	4	0	0	0	0	0	0	0	3	3
25	0	0	0	0	0	0	0	0	0	0
26	0	0	0	0	0	0	0	0	3	0
27	0	0	0	0	0	0	0	0	0	0
28	0	0	0	0	0	0	0	0	0	0
29	0	0	0	0	0	0	0	0	0	0
30	5	0	0	0	0	0	0	0	0	0
31	1	0	0	0	0	0	0	0	0	0
CSUM	58	23	39	38	31	185	63	99	231	85

ZONE	11	12	13	14	15	16	17	18	19	20
1	10	0	0	0	0	0	0	0	0	0
2	10	0	0	0	0	0	0	0	0	0
3	16	0	0	0	0	0	0	0	0	0
4	18	0	0	0	0	0	0	0	0	0
5	20	0	0	0	0	0	0	0	0	0
6	42	0	0	0	0	0	0	0	0	0
7	10	0	0	0	0	0	0	0	0	0
8	78	0	0	0	0	0	0	0	0	0
9	114	4	1	0	1	5	0	0	0	0
10	0	0	0	0	0	0	0	0	0	0
11	0	4	12	34	55	17	6	1	20	1
12	19	0	98	9	20	0	0	0	0	0
13	0	107	0	51	59	0	0	0	0	0
14	25	32	54	0	0	0	0	0	0	0
15	32	30	75	0	0	0	0	0	0	0
16	23	0	0	0	0	0	0	0	0	0
17	2	0	0	0	0	0	0	0	0	0
18	3	0	0	0	0	0	3	0	0	0

19	28	0	0	0	0	0	0	3	0	0
20	2	0	0	0	0	0	0	0	0	0
21	207	3	1	1	1	24	4	66	21	32
22	131	1	1	1	0	0	0	3	0	2
23	83	1	0	0	0	0	0	0	0	0
24	6	0	1	0	0	0	0	0	0	0
25	0	0	0	0	0	0	0	0	0	0
26	50	1	0	0	0	0	0	0	0	0
27	22	0	0	0	0	0	0	0	0	0
28	21	2	0	0	0	0	0	0	0	0
29	1	0	0	0	0	0	0	0	0	0
30	14	0	0	0	0	0	0	0	0	0
31	7	0	0	0	0	0	0	0	0	0
CSUM	994	185	243	96	136	46	13	73	41	35

ZONE	21	22	23	24	25	26	27	28	29	30
1	3	3	8	3	3	0	0	0	0	1
2	5	0	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0	0	0	0
5	0	0	0	0	0	0	0	0	0	0
6	0	29	13	0	0	0	0	0	0	0
7	0	11	3	5	0	0	0	0	0	0
8	0	11	3	0	0	0	0	0	0	0
9	5	5	0	0	0	0	0	0	0	1
10	0	0	0	0	0	0	0	0	0	0
11	179	115	71	2	14	36	13	21	4	6
12	3	1	1	0	0	0	0	0	0	0
13	0	3	0	0	0	1	0	0	0	0
14	2	0	0	0	0	0	0	0	0	0
15	1	2	0	0	1	0	0	0	0	0
16	3	0	0	0	0	0	0	0	0	0
17	0	0	0	0	0	0	0	0	0	0
18	53	4	0	0	0	8	0	0	0	0
19	18	0	0	0	0	0	0	0	0	0
20	14	0	0	0	0	0	0	0	0	0
21	0	34	23	6	17	23	0	0	0	8
22	7	0	0	8	0	2	3	0	0	1
23	16	3	0	9	0	3	0	0	0	0
24	5	3	13	0	0	3	0	0	0	0
25	0	0	0	0	0	0	0	0	0	0
26	18	0	3	0	0	0	0	0	0	10
27	0	0	0	0	0	0	0	10	0	0
28	0	0	0	0	0	0	0	0	0	0
29	0	0	0	0	0	0	0	0	0	70
30	5	0	0	0	0	0	0	10	100	0
31	0	0	0	0	0	0	0	0	20	40
CSUM	337	224	138	33	35	76	16	41	124	137

ZONE	31	RSUM

1	0	66
2	0	18
3	0	19
4	0	44
5	0	25
6	0	142
7	0	53
8	0	126
9	0	316
10	0	0
11	2	968
12	0	153
13	0	221
14	0	114
15	0	141
16	0	29
17	0	2
18	0	71
19	0	51
20	0	16
21	0	491
22	0	216
23	0	141
24	0	41
25	0	0
26	0	85
27	0	32
28	10	33
29	0	71
30	180	314
31	0	68

CSUM 192

IMPEDANCE MATRIX

ZONE	1	2	3	4	5	6	7	8	9	10
1	60	7	9	7	11	15	16	18	16	22
2	7	60	1	2	5	9	10	12	11	16
3	9	1	60	1	3	7	9	11	9	15
4	7	2	1	60	4	8	9	11	10	15
5	11	5	3	4	60	4	6	7	6	11
6	15	9	7	8	4	60	1	3	2	7
7	16	10	9	9	6	1	60	2	1	6
8	18	12	11	11	7	3	2	60	3	4
9	16	11	9	10	6	2	1	3	60	7
10	22	16	15	15	11	7	6	4	7	60
11	26	20	34	19	15	11	10	8	11	4
12	29	23	37	23	17	13	11	12	13	5
13	28	22	36	22	18	14	12	11	14	6
14	32	26	40	25	21	17	16	14	17	10
15	33	27	41	26	22	18	17	15	18	11
16	20	14	13	13	10	5	4	2	5	5
17	22	16	14	15	11	7	6	4	7	3
18	12	18	17	17	13	9	9	10	7	13
19	20	18	17	17	13	9	8	6	8	5
20	21	19	18	18	14	10	9	7	9	6
21	18	16	15	15	11	7	7	5	6	7
22	17	13	11	12	8	4	4	5	2	9
23	16	14	13	13	9	5	5	7	3	9
24	7	14	15	13	17	15	14	16	13	18
25	15	16	14	15	11	7	6	8	5	10
26	25	23	22	22	19	14	13	11	13	10
27	28	26	25	25	22	17	16	14	16	13
28	50	48	47	48	44	40	38	37	38	36
29	47	46	44	45	41	37	35	34	35	33
30	46	44	43	43	39	35	34	32	34	31
31	40	38	37	38	34	30	28	27	28	26

ZONE	11	12	13	14	15	16	17	18	19	20
1	26	29	28	32	33	20	22	12	20	21
2	20	23	22	26	27	14	16	18	18	19
3	34	37	36	40	41	13	14	17	17	18
4	19	23	22	25	26	13	15	17	17	18
5	15	17	18	21	22	10	11	13	13	14
6	11	13	14	17	18	5	7	9	9	10
7	10	11	12	16	17	4	6	9	8	9
8	8	12	11	14	15	2	4	10	6	7
9	11	13	14	17	18	5	7	7	8	9
10	4	5	6	10	11	5	3	13	5	6
11	60	4	3	6	7	9	7	17	9	10
12	4	60	5	8	9	12	10	20	13	14
13	3	5	60	3	5	11	9	19	12	13
14	6	8	3	60	1	14	13	23	15	16
15	7	9	5	1	60	16	14	24	16	17
16	9	12	11	14	16	60	2	8	4	5
17	7	10	9	13	14	2	60	10	2	3
18	17	20	19	23	24	8	10	60	8	9
19	9	13	12	15	16	4	2	8	60	1
20	10	14	13	16	17	5	3	9	1	60

21	11	15	14	17	18	2	4	6	2	3
22	13	17	16	19	20	6	8	5	6	7
23	13	17	16	19	21	5	6	4	4	5
24	22	26	25	28	30	14	15	6	13	14
25	14	18	17	20	21	5	7	3	5	6
26	14	18	17	20	22	8	7	13	5	4
27	17	21	20	23	25	11	10	16	8	7
28	40	43	42	45	47	33	33	38	30	29
29	37	40	39	43	44	30	30	35	28	27
30	35	39	38	41	42	29	28	34	26	25
31	30	33	32	35	37	23	23	28	20	19

ZONE	21	22	23	24	25	26	27	28	29	30
1	18	17	16	7	15	25	28	50	47	46
2	16	13	14	14	16	23	26	48	46	44
3	15	11	13	15	14	22	25	47	44	43
4	15	12	13	13	15	22	25	48	45	43
5	11	8	9	17	11	19	22	44	41	39
6	7	4	5	15	7	14	17	40	37	35
7	7	4	5	14	6	13	16	38	35	34
8	5	5	7	16	8	11	14	37	34	32
9	6	2	3	13	5	13	16	38	35	34
10	7	9	9	18	10	10	13	36	33	31
11	11	13	13	22	14	14	17	40	37	35
12	15	17	17	26	18	18	21	43	40	39
13	14	16	16	25	17	17	20	42	39	38
14	17	19	19	28	20	20	23	45	43	41
15	18	20	21	30	21	22	25	47	44	42
16	2	6	5	14	5	8	11	33	30	29
17	4	8	6	15	7	7	10	33	30	28
18	6	5	4	6	3	13	16	38	35	34
19	2	6	4	13	5	5	8	30	28	26
20	3	7	5	14	6	4	7	29	27	25
21	60	3	2	11	3	7	10	33	30	28
22	3	60	1	11	3	11	14	36	33	31
23	2	1	60	10	2	9	12	35	32	30
24	11	11	10	60	8	18	21	44	41	39
25	3	3	2	8	60	10	13	35	33	31
26	7	11	9	18	10	60	3	25	22	21
27	10	14	12	21	13	3	60	22	19	18
28	33	36	35	44	35	25	22	60	6	5
29	30	33	32	41	33	22	19	6	60	2
30	28	31	30	39	31	21	18	5	2	60
31	23	26	25	34	25	15	12	10	7	6

ZONE	31
1	40
2	38
3	37
4	38
5	34
6	30

7	28
8	27
9	28
10	26
11	30
12	33
13	32
14	35
15	37
16	23
17	23
18	28
19	20
20	19
21	23
22	26
23	25
24	34
25	25
26	15
27	12
28	10
29	7
30	6
31	60

EXISTING TRIP LENGTH DISTRIBUTION & INITIAL F-FACTOR

TL	TRIPS	F-FACTOR
1	51.00	1.00
2	443.00	1.00
3	284.00	1.00
4	185.00	1.00
5	413.00	1.00
6	416.00	1.00
7	232.00	1.00
8	190.00	1.00
9	158.00	1.00
10	80.00	1.00
11	674.00	1.00
12	0.0	0.0
13	419.00	1.00
14	110.00	1.00
15	54.00	1.00
16	28.00	1.00
17	54.00	1.00
18	16.00	1.00
19	30.00	1.00
20	24.00	1.00
21	11.00	1.00
22	18.00	1.00
23	0.0	0.0
24	0.0	0.0
25	1.00	1.00
26	28.00	1.00
27	0.0	0.0
28	13.00	1.00
29	1.00	1.00
30	9.00	1.00
31	1.00	1.00
32	0.0	0.0
33	0.0	0.0
34	48.00	1.00
35	20.00	1.00
36	0.0	0.0
37	5.00	1.00
38	0.0	0.0
39	0.0	0.0
40	43.00	1.00
41	0.0	0.0
42	0.0	0.0
43	2.00	1.00
44	0.0	0.0
45	0.0	0.0
46	6.00	1.00
47	0.0	0.0
48	0.0	0.0
49	0.0	0.0
50	0.0	0.0
51	0.0	0.0
52	0.0	0.0
53	0.0	0.0
54	0.0	0.0
55	0.0	0.0
56	0.0	0.0

57,	0.0	0.0
58	0.0	0.0
59	0.0	0.0
60	0.0	0.0

*** GRAVITY MODEL OUTPUT ***

CALIBRATION ITERATION = 1

O/D TABLE AFTER ITERATION 1

ZONE	1	2	3	4	5	6	7	8	9	10
1	0	0	0	0	0	3	1	1	4	1
2	0	0	0	0	0	1	0	0	1	0
3	0	0	0	0	0	1	0	0	1	0
4	0	0	0	0	0	2	0	1	3	1
5	0	0	0	0	0	1	0	0	1	0
6	2	0	1	1	1	0	2	3	8	3
7	0	0	0	0	0	2	0	1	3	1
8	2	0	1	1	1	6	2	0	8	3
9	4	1	3	3	2	15	5	8	0	7
10	0	0	0	0	0	0	0	0	0	0
11	18	7	12	11	9	58	19	31	72	26
12	2	0	1	0	1	8	2	0	10	3
13	4	1	0	2	2	12	0	6	16	5
14	0	0	1	1	0	5	1	3	7	2
15	0	0	0	1	1	7	2	4	9	3
16	0	0	0	0	0	1	0	0	1	0
17	0	0	0	0	0	0	0	0	0	0
18	0	0	0	0	0	3	1	1	4	1
19	0	0	0	0	0	2	0	1	3	1
20	0	0	0	0	0	0	0	0	0	0
21	8	3	5	5	4	25	8	13	32	11
22	3	1	2	0	1	10	3	5	13	5
23	2	0	1	1	1	6	2	3	8	3
24	0	0	0	0	0	2	0	1	2	0
25	0	0	0	0	0	0	0	0	0	0
26	1	0	0	0	0	3	1	2	4	1
27	0	0	0	0	0	1	0	0	2	0
28	0	0	0	0	0	2	0	1	0	0
29	0	0	0	0	0	4	1	2	5	0
30	5	0	3	3	0	18	6	0	23	8
31	1	0	0	0	0	4	1	0	5	2
CSUM	61	21	41	39	32	217	70	98	257	99

ZONE	11	12	13	14	15	16	17	18	19	20
1	18	3	4	0	0	0	0	0	0	0
2	5	0	1	0	0	0	0	0	0	0
3	5	1	0	0	0	0	0	0	0	0
4	13	0	3	1	1	0	0	0	0	0
5	6	1	1	0	0	0	0	0	0	0
6	36	6	8	3	4	1	0	2	1	1

7	14	2	0	1	1	0	0	1	0	0
8	36	0	8	3	4	1	0	2	1	1
9	82	15	20	7	11	3	1	6	3	2
10	0	0	0	0	0	0	0	0	0	0
11	0	58	76	30	42	14	4	22	12	11
12	45	0	11	4	6	0	0	3	1	1
13	68	12	0	6	9	3	0	5	0	2
14	31	5	7	0	4	1	0	0	1	1
15	40	7	9	3	0	1	0	0	1	1
16	8	0	1	0	1	0	0	0	0	0
17	0	0	0	0	0	0	0	0	0	0
18	19	3	4	0	0	0	0	0	0	0
19	13	2	0	1	1	0	0	0	0	0
20	4	0	0	0	0	0	0	0	0	0
21	139	25	34	13	19	6	1	10	5	4
22	58	10	14	5	8	2	0	4	2	2
23	36	6	9	3	5	1	0	2	1	1
24	10	2	2	1	1	0	0	0	0	0
25	0	0	0	0	0	0	0	0	0	0
26	21	3	5	2	2	0	0	1	0	0
27	8	1	2	0	1	0	0	0	0	0
28	14	2	0	0	0	0	0	0	0	0
29	24	4	0	2	0	1	0	1	1	0
30	101	0	0	0	0	4	1	7	4	3
31	23	0	0	2	3	0	0	1	0	0
CSUM	891	180	229	97	133	51	15	79	46	41

ZONE	21	22	23	24	25	26	27	28	29	30
1	6	4	2	0	0	1	0	0	0	2
2	1	1	0	0	0	0	0	0	0	0
3	1	1	0	0	0	0	0	0	0	0
4	4	0	1	0	0	1	0	0	0	1
5	2	1	0	0	0	0	0	0	0	0
6	12	8	5	1	1	2	0	1	4	5
7	4	3	1	0	0	1	0	0	1	1
8	12	8	5	1	1	2	0	1	4	0
9	28	18	11	2	2	6	1	0	10	11
10	0	0	0	0	0	0	0	0	0	0
11	106	70	43	10	11	23	5	12	39	43
12	15	10	6	1	1	3	0	1	5	0
13	23	15	9	2	2	5	1	0	0	0
14	10	7	4	1	1	2	0	0	3	0
15	13	9	5	1	1	3	0	0	0	0
16	2	1	1	0	0	0	0	0	0	1
17	0	0	0	0	0	0	0	0	0	0
18	6	4	2	0	0	1	0	0	2	2
19	4	3	1	0	0	1	0	0	1	1
20	1	0	0	0	0	0	0	0	0	0
21	0	31	19	4	4	10	2	0	17	19
22	19	0	8	1	2	4	0	0	0	8
23	12	8	0	1	1	2	0	1	0	5
24	3	2	1	0	0	0	0	0	0	0
25	0	0	0	0	0	0	0	0	0	0
26	7	4	2	0	0	0	0	0	2	2
27	2	1	0	0	0	0	0	0	1	1

28	0	0	2	0	0	1	0	0	1	2
29	8	0	0	0	0	1	0	1	0	3
30	34	22	14	0	3	7	1	4	12	0
31	0	5	3	0	0	1	0	0	2	3
CSUM	348	246	157	34	41	90	17	27	114	118

ZONE	31	RSUM
1	3	65
2	0	17
3	1	18
4	0	43
5	1	24
6	7	141
7	2	52
8	0	125
9	15	315
10	0	0
11	60	967
12	0	152
13	0	220
14	6	113
15	7	140
16	0	28
17	0	1
18	3	70
19	2	50
20	0	15
21	0	490
22	11	215
23	7	140
24	2	40
25	0	0
26	4	84
27	0	31
28	2	32
29	4	70
30	19	313
31	0	67
CSUM	165	

TRIP LENGTH DISTRIBUTION AND FRICTION FACTOR

TL	TRIPS	F-FACTOR
1	39.91	152.71
2	132.01	99.51
3	273.93	76.43

4	177.24	62.80
5	140.45	53.53
6	192.35	46.71
7	223.42	41.42
8	101.04	37.17
9	107.55	33.65
10	81.34	30.69
11	573.28	28.15
12	0.0	0.0
13	297.32	23.99
14	200.26	22.27
15	105.05	20.74
16	89.07	19.36
17	176.18	18.11
18	105.21	16.97
19	60.31	15.94
20	52.27	14.99
21	28.17	14.12
22	48.89	13.31
23	0.0	0.0
24	0.0	0.0
25	30.29	11.24
26	70.02	10.65
27	0.0	0.0
28	100.21	9.57
29	12.57	9.09
30	146.88	8.63
31	43.15	8.20
32	0.0	0.0
33	0.0	0.0
34	83.02	7.07
35	204.18	6.73
36	0.0	0.0
37	91.80	6.12
38	0.0	0.0
39	0.0	0.0
40	48.63	5.32
41	0.0	0.0
42	0.0	0.0
43	21.28	4.63
44	0.0	0.0
45	0.0	0.0
46	9.74	4.05
47	0.0	0.0
48	0.0	0.0
49	0.0	0.0
50	0.0	0.0
51	0.0	0.0
52	0.0	0.0
53	0.0	0.0
54	0.0	0.0
55	0.0	0.0
56	0.0	0.0
57	0.0	0.0
58	0.0	0.0
59	0.0	0.0
60	0.0	0.0

CALIBRATION ITERATION = 2

O/D TABLE AFTER ITERATION 2

ZONE	1	2	3	4	5	6	7	8	9	10
1	0	1	2	2	1	3	1	1	4	0
2	1	0	2	1	0	1	0	0	1	0
3	1	1	0	2	0	1	0	0	1	0
4	2	1	5	0	1	2	0	1	3	0
5	0	0	1	0	0	2	0	0	2	0
6	2	1	2	2	2	0	6	5	18	2
7	0	0	0	0	0	7	0	2	8	0
8	1	0	1	1	1	9	3	0	12	2
9	5	2	4	3	3	31	13	12	0	4
10	0	0	0	0	0	0	0	0	0	0
11	15	6	4	10	8	46	14	32	59	39
12	1	0	0	0	0	3	1	0	4	3
13	1	0	0	1	0	4	0	2	5	3
14	0	0	0	0	0	2	0	1	2	1
15	0	0	0	0	0	3	0	2	3	1
16	0	0	0	0	0	1	0	1	1	0
17	0	0	0	0	0	0	0	0	0	0
18	0	0	0	0	0	3	1	1	5	0
19	0	0	0	0	0	1	0	1	2	0
20	0	0	0	0	0	0	0	0	0	0
21	8	2	4	4	3	23	6	16	33	8
22	3	1	2	0	1	13	3	6	27	2
23	2	0	1	1	1	6	1	2	12	1
24	2	0	0	0	0	1	0	0	2	0
25	0	0	0	0	0	0	0	0	0	0
26	1	0	0	0	0	2	0	1	3	1
27	0	0	0	0	0	1	0	0	1	0
28	0	0	0	0	0	0	0	0	0	0
29	0	0	0	0	0	0	0	0	1	0
30	2	0	1	1	0	5	1	0	6	2
31	0	0	0	0	0	1	0	0	2	0
CSUM	58	23	39	38	31	185	63	99	231	85

ZONE	11	12	13	14	15	16	17	18	19	20
1	18	1	2	0	0	0	0	0	0	0
2	4	0	0	0	0	0	0	0	0	0
3	2	0	0	0	0	0	0	0	0	0
4	12	0	1	0	0	0	0	0	0	0
5	6	0	0	0	0	0	0	0	0	0
6	39	3	4	1	2	1	0	2	0	0
7	13	1	0	0	0	0	0	0	0	0
8	44	0	4	1	2	2	0	2	1	0

9	83	8	8	3	5	3	0	7	2	1
10	0	0	0	0	0	0	0	0	0	0
11	0	115	155	45	68	12	4	17	11	9
12	97	0	10	3	5	0	0	1	0	0
13	144	11	0	8	10	1	0	1	0	0
14	54	5	11	0	18	0	0	0	0	0
15	72	6	12	16	0	0	0	0	0	0
16	8	0	0	0	0	0	0	0	0	0
17	0	0	0	0	0	0	0	0	0	0
18	18	1	2	0	0	0	0	0	0	0
19	15	1	0	0	0	0	0	1	0	1
20	4	0	0	0	0	0	0	0	0	0
21	151	13	15	6	9	12	2	15	11	8
22	49	4	5	2	3	2	0	6	2	1
23	28	2	3	1	1	1	0	4	1	1
24	10	0	1	0	0	0	0	2	0	0
25	0	0	0	0	0	0	0	0	0	0
26	25	2	2	1	1	0	0	1	1	1
27	9	0	1	0	0	0	0	0	0	0
28	4	0	0	0	0	0	0	0	0	0
29	8	0	0	0	0	0	0	0	0	0
30	49	0	0	0	0	1	0	3	1	1
31	15	0	0	0	1	0	0	1	0	0
CSUM	994	185	243	96	136	46	13	73	41	35

ZONE	21	22	23	24	25	26	27	28	29	30
1	6	3	2	2	0	1	0	0	0	1
2	1	0	0	0	0	0	0	0	0	0
3	1	1	0	0	0	0	0	0	0	0
4	3	0	1	0	0	0	0	0	0	0
5	2	1	0	0	0	0	0	0	0	0
6	13	10	5	1	1	1	0	0	0	2
7	4	3	1	0	0	0	0	0	0	0
8	14	7	3	0	0	2	0	0	0	0
9	31	35	15	2	3	4	0	0	2	5
10	0	0	0	0	0	0	0	0	0	0
11	100	45	25	7	6	21	4	5	11	26
12	7	3	1	0	0	1	0	0	0	0
13	9	4	2	0	0	2	0	0	0	0
14	4	2	1	0	0	1	0	0	0	0
15	6	3	1	0	0	1	0	0	0	0
16	5	1	0	0	0	0	0	0	0	0
17	0	0	0	0	0	0	0	0	0	0
18	10	6	4	1	1	1	0	0	0	1
19	10	2	1	0	0	1	0	0	0	1
20	2	0	0	0	0	0	0	0	0	0
21	0	49	35	5	8	13	2	0	5	12
22	35	0	21	2	3	3	0	0	0	4
23	27	22	0	1	2	2	0	0	0	2
24	5	2	1	0	0	0	0	0	0	0
25	0	0	0	0	0	0	0	0	0	0
26	10	3	2	0	0	0	1	0	1	4
27	3	1	0	0	0	2	0	0	1	2
28	0	0	0	0	0	0	0	0	4	12
29	2	0	0	0	0	1	0	4	0	34

30	15	7	4	0	1	6	1	24	83	0
31	0	2	1	0	0	2	0	3	8	21
CSUM	337	224	138	33	35	75	15	40	123	136

ZONE	31	RSUM
1	2	65
2	0	18
3	0	18
4	0	43
5	0	25
6	3	142
7	1	53
8	0	126
9	7	316
10	0	0
11	36	968
12	0	153
13	0	221
14	2	114
15	2	141
16	0	28
17	0	1
18	2	71
19	1	50
20	0	16
21	0	491
22	5	216
23	3	141
24	1	40
25	0	0
26	6	85
27	0	31
28	7	32
29	14	71
30	90	313
31	0	67
CSUM	191	

TRIP LENGTH DISTRIBUTION AND FRICTION FACTOR

TL	TRIPS	F-FACTOR
1	127.27	267.22
2	349.49	171.25
3	502.29	128.73
4	312.71	103.30
5	180.99	85.91

6	338.70	73.09
7	304.37	63.16
8	107.40	55.21
9	100.70	48.68
10	80.11	43.22
11	542.23	38.59
12	0.0	0.0
13	204.87	31.16
14	119.20	28.15
15	76.80	25.50
16	45.65	23.16
17	105.00	21.08
18	63.56	19.22
19	36.47	17.56
20	29.07	16.06
21	17.35	14.72
22	33.06	13.50
23	0.0	0.0
24	0.0	0.0
25	15.92	10.49
26	49.39	9.66
27	0.0	0.0
28	50.63	8.21
29	5.47	7.58
30	74.01	7.00
31	15.02	6.47
32	0.0	0.0
33	0.0	0.0
34	31.22	5.13
35	92.71	4.75
36	0.0	0.0
37	27.77	4.08
38	0.0	0.0
39	0.0	0.0
40	16.69	3.26
41	0.0	0.0
42	0.0	0.0
43	6.12	2.61
44	0.0	0.0
45	0.0	0.0
46	4.75	2.10
47	0.0	0.0
48	0.0	0.0
49	0.0	0.0
50	0.0	0.0
51	0.0	0.0
52	0.0	0.0
53	0.0	0.0
54	0.0	0.0
55	0.0	0.0
56	0.0	0.0
57	0.0	0.0
58	0.0	0.0
59	0.0	0.0
60	0.0	0.0

CALIBRATION ITERATION = 3

O/D TABLE AFTER ITERATION 3

ZONE	1	2	3	4	5	6	7	8	9	10
1	0	2	3	4	1	4	1	1	4	0
2	1	0	2	1	0	1	0	0	1	0
3	1	1	0	3	0	1	0	0	1	0
4	4	2	6	0	1	3	0	1	3	0
5	1	0	1	1	0	2	0	0	2	0
6	2	1	2	2	2	0	7	6	21	2
7	0	0	0	0	0	7	0	2	9	0
8	1	0	1	1	1	10	3	0	12	2
9	5	2	4	3	3	35	15	13	0	4
10	0	0	0	0	0	0	0	0	0	0
11	13	5	2	9	7	46	14	33	58	44
12	0	0	0	0	0	3	1	0	3	3
13	1	0	0	0	0	3	0	2	4	3
14	0	0	0	0	0	1	0	1	2	1
15	0	0	0	0	0	2	0	1	2	1
16	0	0	0	0	0	1	0	1	1	0
17	0	0	0	0	0	0	0	0	0	0
18	0	0	0	0	0	3	1	1	6	0
19	0	0	0	0	0	1	0	1	2	0
20	0	0	0	0	0	0	0	0	0	0
21	8	2	4	4	3	23	6	16	34	8
22	3	1	2	0	1	14	4	6	30	2
23	2	0	1	1	1	7	1	2	13	1
24	4	0	0	0	0	1	0	0	2	0
25	0	0	0	0	0	0	0	0	0	0
26	1	0	0	0	0	2	0	1	3	1
27	0	0	0	0	0	0	0	0	1	0
28	0	0	0	0	0	0	0	0	0	0
29	0	0	0	0	0	0	0	0	0	0
30	1	0	0	0	0	2	0	0	3	1
31	0	0	0	0	0	1	0	0	1	0
CSUM	58	23	39	38	31	185	63	99	231	85

ZONE	11	12	13	14	15	16	17	18	19	20
1	16	1	1	0	0	0	0	0	0	0
2	4	0	0	0	0	0	0	0	0	0
3	1	0	0	0	0	0	0	0	0	0
4	10	0	0	0	0	0	0	0	0	0
5	6	0	0	0	0	0	0	0	0	0
6	39	3	3	1	1	1	0	2	0	0
7	13	1	0	0	0	0	0	0	0	0
8	46	0	3	1	2	2	0	2	1	0

9	83	6	6	2	3	3	0	7	2	1
10	0	0	0	0	0	0	0	0	0	0
11	0	129	171	50	76	12	4	15	11	9
12	108	0	9	3	4	0	0	0	0	0
13	158	10	0	8	10	0	0	1	0	0
14	60	4	11	0	20	0	0	0	0	0
15	80	6	11	18	0	0	0	0	0	0
16	8	0	0	0	0	0	0	0	0	0
17	0	0	0	0	0	0	0	0	0	0
18	16	1	1	0	0	0	0	0	0	0
19	15	1	0	0	0	0	0	1	0	1
20	4	0	0	0	0	0	0	0	0	0
21	152	10	11	4	7	13	2	16	12	8
22	46	3	3	1	2	2	0	7	2	1
23	26	1	2	0	1	1	0	5	1	1
24	9	0	0	0	0	0	0	2	0	0
25	0	0	0	0	0	0	0	0	0	0
26	26	1	2	0	1	1	0	1	1	1
27	9	0	0	0	0	0	0	0	0	0
28	2	0	0	0	0	0	0	0	0	0
29	3	0	0	0	0	0	0	0	0	0
30	29	0	0	0	0	0	0	1	1	1
31	10	0	0	0	0	0	0	0	0	0
CSUM	994	185	243	96	136	46	13	73	41	35

ZONE	21	22	23	24	25	26	27	28	29	30
1	6	3	2	4	0	1	0	0	0	0
2	1	0	0	0	0	0	0	0	0	0
3	1	1	0	0	0	0	0	0	0	0
4	3	0	1	0	0	0	0	0	0	0
5	2	1	0	0	0	0	0	0	0	0
6	13	11	5	1	1	1	0	0	0	1
7	3	3	1	0	0	0	0	0	0	0
8	14	7	3	0	0	1	0	0	0	0
9	32	39	16	2	3	4	0	0	0	3
10	0	0	0	0	0	0	0	0	0	0
11	100	41	23	6	6	21	4	2	4	16
12	5	2	1	0	0	1	0	0	0	0
13	7	3	1	0	0	1	0	0	0	0
14	3	1	0	0	0	0	0	0	0	0
15	5	2	1	0	0	1	0	0	0	0
16	6	1	0	0	0	0	0	0	0	0
17	0	0	0	0	0	0	0	0	0	0
18	11	7	4	2	1	1	0	0	0	1
19	11	2	1	0	0	1	0	0	0	0
20	3	0	0	0	0	0	0	0	0	0
21	0	53	39	6	8	15	2	0	2	8
22	39	0	23	2	3	3	0	0	0	2
23	30	24	0	1	2	2	0	0	0	1
24	5	2	1	0	0	0	0	0	0	0
25	0	0	0	0	0	0	0	0	0	0
26	12	3	2	0	0	0	1	0	1	3
27	4	1	0	0	0	3	0	0	0	2
28	0	0	0	0	0	0	0	0	4	16
29	1	0	0	0	0	0	0	3	0	43

30	10	4	2	0	0	5	1	29	96	0
31	0	1	0	0	0	2	0	3	9	31
CSUM	337	224	138	33	35	75	15	40	123	136

ZONE	31	RSUM
1	1	65
2	0	18
3	0	19
4	0	44
5	0	24
6	1	142
7	0	52
8	0	126
9	4	315
10	0	0
11	22	968
12	0	153
13	0	221
14	1	114
15	1	141
16	0	28
17	0	1
18	1	71
19	1	51
20	0	16
21	0	490
22	3	216
23	2	141
24	0	40
25	0	0
26	6	85
27	0	31
28	7	32
29	15	71
30	116	314
31	0	67
CSUM	191	

TRIP LENGTH DISTRIBUTION AND FRICTION FACTOR

TL	TRIPS	F-FACTOR
1	144.18	312.81
2	398.93	195.32
3	549.71	144.43
4	347.93	114.46
5	189.11	94.22

6	390.91	79.44
7	332.68	68.09
8	109.69	59.08
9	101.69	51.74
10	80.88	45.64
11	541.08	40.50
12	0.0	0.0
13	187.65	32.34
14	106.05	29.06
15	68.73	26.19
16	39.32	23.66
17	90.29	21.43
18	53.92	19.45
19	29.85	17.68
20	22.73	16.10
21	14.40	14.69
22	26.65	13.41
23	0.0	0.0
24	0.0	0.0
25	11.40	10.28
26	40.02	9.43
27	0.0	0.0
28	33.37	7.95
29	3.57	7.31
30	46.27	6.73
31	8.91	6.19
32	0.0	0.0
33	0.0	0.0
34	17.70	4.85
35	54.05	4.47
36	0.0	0.0
37	12.48	3.81
38	0.0	0.0
39	0.0	0.0
40	7.73	3.01
41	0.0	0.0
42	0.0	0.0
43	2.65	2.39
44	0.0	0.0
45	0.0	0.0
46	2.48	1.90
47	0.0	0.0
48	0.0	0.0
49	0.0	0.0
50	0.0	0.0
51	0.0	0.0
52	0.0	0.0
53	0.0	0.0
54	0.0	0.0
55	0.0	0.0
56	0.0	0.0
57	0.0	0.0
58	0.0	0.0
59	0.0	0.0
60	0.0	0.0

CALIBRATION ITERATION = 4

O/D TABLE AFTER ITERATION 4

ZONE	1	2	3	4	5	6	7	8	9	10
1	0	2	3	4	1	4	0	1	4	0
2	1	0	3	1	0	1	0	0	1	0
3	1	2	0	3	0	1	0	0	1	0
4	4	2	7	0	1	3	0	1	3	0
5	1	0	1	1	0	2	0	0	2	0
6	2	1	2	2	2	0	7	6	22	2
7	0	0	0	0	0	8	0	2	10	0
8	1	0	1	1	1	10	3	0	13	2
9	5	2	4	3	3	36	15	13	0	4
10	0	0	0	0	0	0	0	0	0	0
11	13	4	2	8	7	45	13	34	57	45
12	0	0	0	0	0	2	0	0	3	2
13	1	0	0	0	0	3	0	2	3	2
14	0	0	0	0	0	1	0	1	1	1
15	0	0	0	0	0	2	0	1	2	1
16	0	0	0	0	0	1	0	1	1	0
17	0	0	0	0	0	0	0	0	0	0
18	0	0	0	0	0	3	0	1	6	0
19	0	0	0	0	0	1	0	1	2	0
20	0	0	0	0	0	0	0	0	0	0
21	8	2	4	4	3	23	6	16	34	8
22	3	1	2	0	1	14	3	6	31	2
23	2	0	1	1	0	6	1	2	13	1
24	5	0	0	0	0	1	0	0	2	0
25	0	0	0	0	0	0	0	0	0	0
26	1	0	0	0	0	2	0	1	3	1
27	0	0	0	0	0	0	0	0	1	0
28	0	0	0	0	0	0	0	0	0	0
29	0	0	0	0	0	0	0	0	0	0
30	1	0	0	0	0	2	0	0	3	1
31	0	0	0	0	0	0	0	0	1	0
CSUM	58	23	39	38	31	185	63	99	231	85

ZONE	11	12	13	14	15	16	17	18	19	20
1	15	1	1	0	0	0	0	0	0	0
2	3	0	0	0	0	0	0	0	0	0
3	1	0	0	0	0	0	0	0	0	0
4	10	0	0	0	0	0	0	0	0	0
5	6	0	0	0	0	0	0	0	0	0
6	39	2	2	1	1	1	0	2	0	0
7	12	1	0	0	0	0	0	0	0	0
8	46	0	3	1	1	2	0	2	1	0

9	82	6	5	2	3	3	0	8	2	1
10	0	0	0	0	0	0	0	0	0	0
11	0	133	175	50	77	12	4	15	11	9
12	111	0	9	2	4	0	0	0	0	0
13	162	10	0	8	9	0	0	1	0	0
14	60	4	10	0	22	0	0	0	0	0
15	82	5	11	19	0	0	0	0	0	0
16	8	0	0	0	0	0	0	0	0	0
17	0	0	0	0	0	0	0	0	0	0
18	16	1	1	0	0	0	0	0	0	0
19	15	0	0	0	0	0	0	1	0	1
20	4	0	0	0	0	0	0	0	0	0
21	152	9	10	4	6	13	2	17	13	9
22	45	2	3	1	2	2	0	7	1	1
23	26	1	1	0	1	1	0	5	1	1
24	9	0	0	0	0	0	0	3	0	0
25	0	0	0	0	0	0	0	0	0	0
26	26	1	1	0	1	1	0	1	1	1
27	9	0	0	0	0	0	0	0	0	0
28	2	0	0	0	0	0	0	0	0	0
29	3	0	0	0	0	0	0	0	0	0
30	26	0	0	0	0	0	0	1	1	1
31	10	0	0	0	0	0	0	0	0	0
CSUM	994	185	243	96	136	46	13	73	41	35

ZONE	21	22	23	24	25	26	27	28	29	30
1	6	3	2	4	0	1	0	0	0	0
2	1	0	0	0	0	0	0	0	0	0
3	1	1	0	0	0	0	0	0	0	0
4	3	0	1	0	0	0	0	0	0	0
5	2	1	0	0	0	0	0	0	0	0
6	13	11	5	1	1	1	0	0	0	1
7	3	3	1	0	0	0	0	0	0	0
8	14	7	2	0	0	1	0	0	0	0
9	32	40	16	2	3	4	0	0	0	2
10	0	0	0	0	0	0	0	0	0	0
11	99	40	22	6	6	21	4	1	4	14
12	5	2	1	0	0	1	0	0	0	0
13	6	2	1	0	0	1	0	0	0	0
14	3	1	0	0	0	0	0	0	0	0
15	4	1	0	0	0	0	0	0	0	0
16	6	1	0	0	0	0	0	0	0	0
17	0	0	0	0	0	0	0	0	0	0
18	12	7	4	2	1	1	0	0	0	1
19	12	2	1	0	0	1	0	0	0	0
20	3	0	0	0	0	0	0	0	0	0
21	0	55	40	6	9	15	2	0	2	8
22	40	0	24	2	3	3	0	0	0	2
23	31	25	0	1	2	2	0	0	0	1
24	5	2	1	0	0	0	0	0	0	0
25	0	0	0	0	0	0	0	0	0	0
26	12	3	2	0	0	0	2	0	1	3
27	4	1	0	0	0	4	0	0	0	2
28	0	0	0	0	0	0	0	0	4	17
29	1	0	0	0	0	0	0	3	0	45

30	9	3	2	0	0	5	1	29	98	0
31	0	1	0	0	0	2	0	3	8	33
CSUM	337	224	138	33	35	76	15	40	122	136

ZONE	31	RSUM
1	1	65
2	0	18
3	0	19
4	0	43
5	0	24
6	1	142
7	0	52
8	0	126
9	4	316
10	0	0
11	21	968
12	0	153
13	0	221
14	0	114
15	1	141
16	0	28
17	0	1
18	1	71
19	1	50
20	0	16
21	0	490
22	3	216
23	2	141
24	0	40
25	0	0
26	6	85
27	0	31
28	7	32
29	14	70
30	120	314
31	0	67
CSUM	190	

TRIP LENGTH DISTRIBUTION AND FRICTION FACTOR

TL	TRIPS	F-FACTOR
1	152.12	322.52
2	412.06	198.79
3	562.39	145.91
4	356.40	115.04
5	188.73	94.32

6	398.23	79.28
7	336.29	67.78
8	109.50	58.68
9	100.41	51.29
10	79.91	45.17
11	536.65	40.03
12	0.0	0.0
13	181.20	31.88
14	102.67	28.61
15	66.45	25.76
16	37.43	23.26
17	86.82	21.05
18	51.58	19.09
19	28.32	17.34
20	21.37	15.78
21	13.67	14.39
22	25.48	13.13
23	0.0	0.0
24	0.0	0.0
25	10.59	10.05
26	38.50	9.22
27	0.0	0.0
28	30.40	7.77
29	3.25	7.14
30	42.32	6.57
31	7.89	6.04
32	0.0	0.0
33	0.0	0.0
34	15.75	4.73
35	48.68	4.36
36	0.0	0.0
37	10.66	3.72
38	0.0	0.0
39	0.0	0.0
40	6.80	2.93
41	0.0	0.0
42	0.0	0.0
43	2.26	2.32
44	0.0	0.0
45	0.0	0.0
46	2.22	1.85
47	0.0	0.0
48	0.0	0.0
49	0.0	0.0
50	0.0	0.0
51	0.0	0.0
52	0.0	0.0
53	0.0	0.0
54	0.0	0.0
55	0.0	0.0
56	0.0	0.0
57	0.0	0.0
58	0.0	0.0
59	0.0	0.0
60	0.0	0.0

K-FACTOR TABLE

ZONE	1	2	3	4	5	6	7	8	9	10
1	1.0	1.8	1.4	8.0	1.0	1.0	1.0	1.0	1.0	1.0
2	1.0	1.0	1.0	1.0	6.4	1.0	1.0	1.0	1.0	1.0
3	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	2.0	1.0
4	4.6	1.0	1.0	1.0	1.0	1.0	1.0	1.0	4.5	1.0
5	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	2.5	1.0
6	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	3.8	1.0
7	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	3.4	1.0
8	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	3.2	1.0
9	0.5	1.4	0.7	1.0	1.3	3.8	1.6	2.2	1.0	1.8
10	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
11	1.4	2.4	12.7	1.2	3.0	0.5	1.5	2.0	1.4	1.5
12	1.2	1.0	1.0	1.0	1.0	1.0	1.0	1.0	0.3	1.0
13	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
14	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	0.5	1.0
15	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
16	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.7	1.0
17	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
18	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
19	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	0.9	1.0
20	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
21	0.4	1.3	1.0	0.5	1.0	0.2	1.0	0.1	0.1	0.4
22	0.9	1.0	1.0	1.0	1.0	2.8	3.4	1.0	1.0	1.3
23	2.4	1.0	1.0	1.0	1.0	1.9	2.7	1.2	1.0	1.0
24	0.8	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.2	7.6
25	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
26	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	0.9	1.0
27	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
28	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
29	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
30	4.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
31	1.9	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0

ZONE	11	12	13	14	15	16	17	18	19	20
1	0.6	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
2	4.5	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
3	71.2	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
4	2.3	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
5	11.4	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
6	1.1	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
7	0.7	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
8	2.8	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
9	1.6	0.6	0.2	1.0	0.3	1.4	1.0	1.0	1.0	1.0
10	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
11	1.0	0.0	0.1	0.7	0.7	1.4	1.2	0.1	1.8	0.1
12	0.1	1.0	28.3	3.1	4.8	1.0	1.0	1.0	1.0	1.0
13	1.0	19.8	1.0	7.6	7.9	1.0	1.0	1.0	1.0	1.0
14	0.2	10.0	8.5	1.0	1.0	1.0	1.0	1.0	1.0	1.0
15	0.2	6.2	13.1	1.0	1.0	1.0	1.0	1.0	1.0	1.0
16	8.8	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
17	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
18	0.1	1.0	1.0	1.0	1.0	1.0	15.3	1.0	1.0	1.0
19	2.7	1.0	1.0	1.0	1.0	1.0	1.0	3.0	1.0	1.0

20	0.3	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
21	1.6	0.3	0.1	0.2	0.1	1.8	1.6	4.3	1.6	3.6
22	5.8	0.4	0.3	0.8	1.0	1.0	1.0	0.4	1.0	1.2
23	6.3	0.6	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
24	0.6	1.0	1.5	1.0	1.0	1.0	1.0	1.0	1.0	1.0
25	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
26	3.1	0.6	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
27	4.9	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
28	26.7	13.9	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
29	0.3	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
30	0.5	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
31	0.6	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0

ZONE	21	22	23	24	25	26	27	28	29	30
1	0.4	0.8	4.0	0.6	4.1	1.0	1.0	1.0	1.0	1.2
2	5.6	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
3	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
4	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
5	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
6	1.0	3.0	2.7	1.0	1.0	1.0	1.0	1.0	1.0	1.0
7	1.0	3.9	2.1	16.6	1.0	1.0	1.0	1.0	1.0	1.0
8	1.0	1.5	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
9	0.1	0.1	1.0	1.0	1.0	1.0	1.0	1.0	1.0	0.4
10	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
11	2.0	3.1	3.4	0.3	2.3	1.7	3.1	10.9	1.0	0.4
12	0.6	0.5	0.9	1.0	1.0	1.0	1.0	1.0	1.0	1.0
13	1.0	1.1	1.0	1.0	1.0	0.7	1.0	1.0	1.0	1.0
14	0.6	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
15	0.2	1.0	1.0	1.0	3.3	1.0	1.0	1.0	1.0	1.0
16	0.4	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
17	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
18	14.0	0.5	1.0	1.0	1.0	5.8	1.0	1.0	1.0	1.0
19	1.8	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
20	28.6	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
21	1.0	0.6	0.5	1.0	1.9	1.5	1.0	1.0	1.0	1.0
22	0.1	1.0	1.0	3.7	1.0	0.6	4.6	1.0	1.0	0.4
23	0.4	0.1	1.0	6.5	1.0	1.2	1.0	1.0	1.0	1.0
24	0.9	1.1	10.7	1.0	1.0	4.0	1.0	1.0	1.0	1.0
25	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
26	1.5	1.0	1.1	1.0	1.0	1.0	1.0	1.0	1.0	3.0
27	1.0	1.0	1.0	1.0	1.0	1.0	1.0	43.9	1.0	1.0
28	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
29	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	40.0
30	0.5	1.0	1.0	1.0	1.0	1.0	1.0	0.3	1.0	1.0
31	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	2.8	1.5

ZONE	31
1	1.0
2	1.0
3	1.0
4	1.0
5	1.0

6	1.0
7	1.0
8	1.0
9	1.0
10	1.0
11	0.1
12	1.0
13	1.0
14	1.0
15	1.0
16	1.0
17	1.0
18	1.0
19	1.0
20	1.0
21	1.0
22	1.0
23	1.0
24	1.0
25	1.0
26	1.0
27	1.0
28	1.4
29	1.0
30	2.2
31	1.0

APPENDIX VIII

MODEL WITH 27 NODES

***** G R A V I T Y   M O D E L *****

(CALIBRATION MODE)

INPUT/OUTPUT SPECIFICATIONS

NUMBER OF CALIBRATION ITERATIONS		=	9
NUMBER OF ATTRACTION BALANCING ITERATIONS		=	4
SMOOTHING OPTIONS IN EFFECT	(1=YES,0=NO)	=	1
PRINT OUT OF INPUT DATA	(1=YES,0=NO)	=	1
PRINT OUT OF INTERMEDIATE OUTPUT	(1=YES,0=NO)	=	0
PLOT OUTPUT	(1=YES,0=NO)	=	1
K-FACTOR DATA INPUT	(1=YES,0=NO)	=	0
K-FACTOR PUNCHED OUTPUT TO UNIT 7	(1=YES,0=NO)	=	0
TRIP MATRIX PUNCHED	(1=YES,0=NO)	=	0

*** INPUT DATA LISTINGS ***

TRIP PRODUCTIONS AND ATTRACTIONS

ZONE	PRODUCTION	ATTRACTION
1	66.00	57.00
2	18.00	23.00
3	19.00	39.00
4	44.00	38.00
5	25.00	31.00
6	142.00	185.00
7	53.00	63.00
8	126.00	99.00
9	310.00	229.00
10	0.0	85.00
11	863.00	918.00
12	29.00	46.00
13	2.00	13.00
14	71.00	73.00
15	51.00	41.00
16	16.00	35.00
17	485.00	331.00
18	213.00	218.00
19	140.00	137.00
20	40.00	33.00
21	0.0	34.00
22	84.00	75.00
23	32.00	16.00
24	31.00	41.00
25	71.00	124.00
26	314.00	137.00
27	68.00	192.00

BASE YEAR O/D PATTERN

ZONE	1	2	3	4	5	6	7	8	9	10
1	0	5	5	25	0	0	0	0	0	0
2	0	0	0	0	3	0	0	0	0	0
3	0	0	0	0	0	0	0	0	3	0
4	15	0	0	0	0	0	0	0	11	0
5	0	0	0	0	0	0	0	0	5	0
6	0	0	0	0	0	0	0	0	58	0
7	0	0	0	0	0	0	0	0	24	0
8	0	0	0	0	0	0	0	0	34	0
9	3	3	3	0	5	105	24	29	0	8
10	0	0	0	0	0	0	0	0	0	0
11	18	12	31	11	23	25	21	66	80	68
12	0	0	0	0	0	0	0	0	3	0
13	0	0	0	0	0	0	0	0	0	0
14	0	0	0	0	0	0	0	0	0	0
15	0	0	0	0	0	0	0	0	2	0
16	0	0	0	0	0	0	0	0	0	0
17	3	3	0	2	0	5	0	1	3	3
18	3	0	0	0	0	37	13	0	0	3
19	5	0	0	0	0	13	5	3	0	0
20	4	0	0	0	0	0	0	0	3	3
21	0	0	0	0	0	0	0	0	0	0
22	0	0	0	0	0	0	0	0	3	0
23	0	0	0	0	0	0	0	0	0	0
24	0	0	0	0	0	0	0	0	0	0
25	0	0	0	0	0	0	0	0	0	0
26	5	0	0	0	0	0	0	0	0	0
27	1	0	0	0	0	0	0	0	0	0
CSUM	57	23	39	38	31	185	63	99	229	85

ZONE	11	12	13	14	15	16	17	18	19	20
1	10	0	0	0	0	0	3	3	8	3
2	10	0	0	0	0	0	5	0	0	0
3	16	0	0	0	0	0	0	0	0	0
4	18	0	0	0	0	0	0	0	0	0
5	20	0	0	0	0	0	0	0	0	0
6	42	0	0	0	0	0	0	29	13	0
7	10	0	0	0	0	0	0	11	3	5
8	78	0	0	0	0	0	0	11	3	0
9	114	5	0	0	0	0	5	5	0	0
10	0	0	0	0	0	0	0	0	0	0
11	0	17	6	1	20	1	179	115	71	2
12	23	0	0	0	0	0	3	0	0	0
13	2	0	0	0	0	0	0	0	0	0
14	3	0	3	0	0	0	53	4	0	0
15	28	0	0	3	0	0	18	0	0	0
16	2	0	0	0	0	0	14	0	0	0
17	207	24	4	66	21	32	0	34	23	6
18	131	0	0	3	0	2	7	0	0	8
19	83	0	0	0	0	0	16	3	0	9
20	6	0	0	0	0	0	5	3	13	0
21	0	0	0	0	0	0	0	0	0	0
22	50	0	0	0	0	0	18	0	3	0

23	22	0	0	0	0	0	0	0	0	0
24	21	0	0	0	0	0	0	0	0	0
25	1	0	0	0	0	0	0	0	0	0
26	14	0	0	0	0	0	5	0	0	0
27	7	0	0	0	0	0	0	0	0	0
CSUM	918	46	13	73	41	35	331	218	137	33

ZONE	21	22	23	24	25	26	27	RSUM
1	3	0	0	0	0	1	0	66
2	0	0	0	0	0	0	0	18
3	0	0	0	0	0	0	0	19
4	0	0	0	0	0	0	0	44
5	0	0	0	0	0	0	0	25
6	0	0	0	0	0	0	0	142
7	0	0	0	0	0	0	0	53
8	0	0	0	0	0	0	0	126
9	0	0	0	0	0	1	0	310
10	0	0	0	0	0	0	0	0
11	14	36	13	21	4	6	2	863
12	0	0	0	0	0	0	0	29
13	0	0	0	0	0	0	0	2
14	0	8	0	0	0	0	0	71
15	0	0	0	0	0	0	0	51
16	0	0	0	0	0	0	0	16
17	17	23	0	0	0	8	0	485
18	0	2	3	0	0	1	0	213
19	0	3	0	0	0	0	0	140
20	0	3	0	0	0	0	0	40
21	0	0	0	0	0	0	0	0
22	0	0	0	0	0	10	0	84
23	0	0	0	10	0	0	0	32
24	0	0	0	0	0	0	10	31
25	0	0	0	0	0	70	0	71
26	0	0	0	10	100	0	180	314
27	0	0	0	0	20	40	0	68
CSUM	34	75	16	41	124	137	192	

IMPEDANCE MATRIX

ZONE	1	2	3	4	5	6	7	8	9	10
1	60	7	9	7	11	15	16	18	16	22
2	7	60	1	2	5	9	10	12	11	16
3	9	1	60	1	3	7	9	11	9	15
4	7	2	1	60	4	8	9	11	10	15
5	11	5	3	4	60	4	6	7	6	11
6	15	9	7	8	4	60	1	3	2	7
7	16	10	9	9	6	1	60	2	1	6
8	18	12	11	11	7	3	2	60	3	4
9	16	11	9	10	6	2	1	3	60	7
10	22	16	15	15	11	7	6	4	7	60
11	26	20	34	19	15	11	10	8	11	4
12	20	14	13	13	10	5	4	2	5	5
13	22	16	14	15	11	7	6	4	7	3
14	12	18	17	17	13	9	9	10	7	13
15	20	18	17	17	13	9	8	6	8	5
16	21	19	18	18	14	10	9	7	9	6
17	18	16	15	15	11	7	7	5	6	7
18	17	13	11	12	8	4	4	5	2	9
19	16	14	13	13	9	5	5	7	3	9
20	7	14	15	13	17	15	14	16	13	18
21	15	16	14	15	11	7	6	8	5	10
22	25	23	22	22	19	14	13	11	13	10
23	28	26	25	25	22	17	16	14	16	13
24	50	48	47	48	44	40	38	37	38	36
25	47	46	44	45	41	37	35	34	35	33
26	46	44	43	43	39	35	34	32	34	31
27	40	38	37	38	34	30	28	27	28	26

ZONE	11	12	13	14	15	16	17	18	19	20
1	26	20	22	12	20	21	18	17	16	7
2	20	14	16	18	18	19	16	13	14	14
3	34	13	14	17	17	18	15	11	13	15
4	19	13	15	17	17	18	15	12	13	13
5	15	10	11	13	13	14	11	8	9	17
6	11	5	7	9	9	10	7	4	5	15
7	10	4	6	9	8	9	7	4	5	14
8	8	2	4	10	6	7	5	5	7	16
9	11	5	7	7	8	9	6	2	3	13
10	4	5	3	13	5	6	7	9	9	18
11	60	9	7	17	9	10	11	13	13	22
12	9	60	2	8	4	5	2	6	5	14
13	7	2	60	10	2	3	4	8	6	15
14	17	8	10	60	8	9	6	5	4	6
15	9	4	2	8	60	1	2	6	4	13
16	10	5	3	9	1	60	3	7	5	14
17	11	2	4	6	2	3	60	3	2	11
18	13	6	8	5	6	7	3	60	1	11
19	13	5	6	4	4	5	2	1	60	10
20	22	14	15	6	13	14	11	11	10	60
21	14	5	7	3	5	6	3	3	2	8
22	14	8	7	13	5	4	7	11	9	18
23	17	11	10	16	8	7	10	14	12	21
24	40	33	33	38	30	29	33	36	35	44

25	37	30	30	35	28	27	30	33	32	41
26	35	29	28	34	26	25	28	31	30	39
27	30	23	23	28	20	19	23	26	25	34

ZONE	21	22	23	24	25	26	27
1	15	25	28	50	47	46	40
2	16	23	26	48	46	44	38
3	14	22	25	47	44	43	37
4	15	22	25	48	45	43	38
5	11	19	22	44	41	39	34
6	7	14	17	40	37	35	30
7	6	13	16	38	35	34	28
8	8	11	14	37	34	32	27
9	5	13	16	38	35	34	28
10	10	10	13	36	33	31	26
11	14	14	17	40	37	35	30
12	5	8	11	33	30	29	23
13	7	7	10	33	30	28	23
14	3	13	16	38	35	34	28
15	5	5	8	30	28	26	20
16	6	4	7	29	27	25	19
17	3	7	10	33	30	28	23
18	3	11	14	36	33	31	26
19	2	9	12	35	32	30	25
20	8	18	21	44	41	39	34
21	60	10	13	35	33	31	25
22	10	60	3	25	22	21	15
23	13	3	60	22	19	18	12
24	35	25	22	60	6	5	10
25	33	22	19	6	60	2	7
26	31	21	18	5	2	60	6
27	25	15	12	10	7	6	60

EXISTING TRIP LENGTH DISTRIBUTION & INITIAL F-FACTOR

TL	TRIPS	F-FACTOR
1	51.00	1.00
2	443.00	1.00
3	167.00	1.00
4	162.00	1.00
5	74.00	1.00
6	357.00	1.00
7	145.00	1.00
8	149.00	1.00
9	108.00	1.00
10	80.00	1.00
11	674.00	1.00
12	0.0	0.0
13	414.00	1.00
14	108.00	1.00
15	48.00	1.00
16	24.00	1.00
17	45.00	1.00
18	12.00	1.00
19	29.00	1.00
20	22.00	1.00
21	10.00	1.00
22	18.00	1.00
23	0.0	0.0
24	0.0	0.0
25	0.0	0.0
26	28.00	1.00
27	0.0	0.0
28	13.00	1.00
29	0.0	0.0
30	9.00	1.00
31	1.00	1.00
32	0.0	0.0
33	0.0	0.0
34	48.00	1.00
35	20.00	1.00
36	0.0	0.0
37	5.00	1.00
38	0.0	0.0
39	0.0	0.0
40	43.00	1.00
41	0.0	0.0
42	0.0	0.0
43	0.0	0.0
44	0.0	0.0
45	0.0	0.0
46	6.00	1.00
47	0.0	0.0
48	0.0	0.0
49	0.0	0.0
50	0.0	0.0
51	0.0	0.0
52	0.0	0.0
53	0.0	0.0
54	0.0	0.0
55	0.0	0.0
56	0.0	0.0

57	0.0	0.0
58	0.0	0.0
59	0.0	0.0
60	0.0	0.0

*** GRAVITY MODEL OUTPUT ***

CALIBRATION ITERATION = 1

O/D TABLE AFTER ITERATION 1

ZONE	1	2	3	4	5	6	7	8	9	10
1	0	0	0	0	0	4	1	2	5	1
2	0	0	0	0	0	1	0	0	1	0
3	0	0	0	0	0	1	0	0	1	0
4	0	0	0	0	0	3	1	1	3	1
5	0	0	0	0	0	1	0	0	1	0
6	2	1	1	1	1	0	2	4	10	3
7	0	0	0	0	0	3	0	1	3	1
8	2	0	1	1	1	8	2	0	10	3
9	5	2	3	3	3	18	6	10	0	8
10	0	0	0	0	0	0	0	0	0	0
11	20	8	14	13	11	66	22	35	82	30
12	0	0	0	0	0	1	0	0	2	0
13	0	0	0	0	0	0	0	0	0	0
14	0	0	0	0	0	4	1	2	5	1
15	0	0	0	0	0	2	0	1	3	1
16	0	0	0	0	0	0	0	0	1	0
17	10	4	6	6	5	32	11	17	40	14
18	4	1	2	0	2	13	4	7	16	6
19	2	1	1	1	1	9	3	4	11	4
20	0	0	0	0	0	2	0	1	3	1
21	0	0	0	0	0	0	0	0	0	0
22	0	0	1	1	0	4	1	2	6	2
23	0	0	0	0	0	2	0	1	2	0
24	0	0	0	0	0	3	0	1	0	0
25	0	0	0	0	0	5	1	2	6	0
26	6	0	0	0	0	20	6	0	25	9
27	1	0	1	0	0	5	1	0	6	2
CSUM	62	22	40	35	32	217	74	101	251	99

ZONE	11	12	13	14	15	16	17	18	19	20
1	20	1	0	0	0	0	7	4	3	0
2	6	0	0	0	0	0	2	1	0	0
3	5	0	0	0	0	0	2	1	0	0
4	15	0	0	1	0	0	5	0	2	0
5	7	0	0	0	0	0	2	1	1	0
6	41	2	0	3	1	1	15	9	6	1
7	15	0	0	1	0	0	5	3	2	0
8	40	2	0	3	1	1	14	9	6	1
9	93	4	1	7	4	3	33	22	13	3
10	0	0	0	0	0	0	0	0	0	0

11	0	16	4	26	14	12	119	78	49	11
12	9	0	0	0	0	0	3	2	1	0
13	0	0	0	0	0	0	0	0	0	0
14	20	1	0	0	0	0	7	4	3	0
15	14	0	0	1	0	0	5	3	2	0
16	4	0	0	0	0	0	1	1	0	0
17	161	8	2	12	7	6	0	38	24	5
18	67	3	0	5	3	2	24	0	10	2
19	45	2	0	3	2	1	16	10	0	1
20	12	0	0	0	0	0	4	2	1	0
21	0	0	0	0	0	0	0	0	0	0
22	24	1	0	1	1	0	8	5	3	0
23	10	0	0	0	0	0	3	2	0	0
24	15	0	0	0	0	0	0	0	2	0
25	26	1	0	2	1	0	9	0	0	0
26	101	0	1	8	4	0	36	24	15	0
27	26	0	0	2	1	0	0	6	0	0
CSUM	787	48	15	84	49	37	330	236	150	34

ZONE	21	22	23	24	25	26	27	RSUM
1	0	0	0	0	0	3	4	65
2	0	0	0	0	0	0	0	17
3	0	0	0	0	0	0	1	18
4	0	1	0	0	0	0	0	43
5	0	0	0	0	0	0	1	24
6	1	3	0	1	5	6	8	141
7	0	1	0	0	2	2	3	52
8	1	3	0	1	5	0	0	125
9	3	7	1	0	12	13	19	309
10	0	0	0	0	0	0	0	0
11	12	27	5	14	44	49	69	862
12	0	0	0	0	1	0	0	28
13	0	0	0	0	0	0	0	1
14	0	1	0	0	2	3	4	70
15	0	1	0	0	1	2	2	50
16	0	0	0	0	0	0	1	15
17	5	13	2	0	21	24	0	484
18	2	5	1	0	0	10	14	212
19	1	3	0	2	0	6	0	139
20	0	1	0	0	0	0	2	39
21	0	0	0	0	0	0	0	0
22	0	0	0	0	3	3	5	83
23	0	0	0	0	1	1	0	31
24	0	0	0	0	2	2	3	30
25	0	2	0	1	0	3	5	70
26	3	8	1	4	13	0	21	313
27	0	2	0	1	3	3	0	67
CSUM	39	85	17	28	123	136	167	

TRIP LENGTH DISTRIBUTION AND FRICTION FACTOR

TL	TRIPS	F-FACTOR
1	39.02	100.49
2	160.41	85.17
3	140.04	75.72
4	87.80	68.65
5	113.51	62.91
6	149.66	58.05
7	171.57	53.81
8	104.11	50.05
9	108.82	46.68
10	90.74	43.62
11	623.67	40.83
12	0.0	0.0
13	287.11	35.92
14	84.66	33.75
15	62.88	31.73
16	35.36	29.85
17	81.17	28.11
18	31.41	26.48
19	35.23	24.96
20	21.88	23.53
21	13.68	22.20
22	36.99	20.95
23	0.0	0.0
24	0.0	0.0
25	0.0	0.0
26	70.95	16.67
27	0.0	0.0
28	103.98	14.89
29	0.0	0.0
30	166.97	13.32
31	47.46	12.60
32	0.0	0.0
33	0.0	0.0
34	94.04	10.67
35	210.64	10.10
36	0.0	0.0
37	87.64	9.05
38	0.0	0.0
39	0.0	0.0
40	40.73	7.69
41	0.0	0.0
42	0.0	0.0
43	0.0	0.0
44	0.0	0.0
45	0.0	0.0
46	10.86	5.56
47	0.0	0.0
48	0.0	0.0
49	0.0	0.0
50	0.0	0.0
51	0.0	0.0
52	0.0	0.0
53	0.0	0.0
54	0.0	0.0

55	0.0	0.0
56	0.0	0.0
57	0.0	0.0
58	0.0	0.0
59	0.0	0.0
60	0.0	0.0

CALIBRATION ITERATION = 2

O/D TABLE AFTER ITERATION 2

ZONE	1	2	3	4	5	6	7	8	9	10
1	0	1	2	2	1	3	1	1	4	1
2	0	0	1	0	0	1	0	0	1	0
3	1	0	0	1	0	1	0	0	1	0
4	2	1	2	0	0	3	0	1	3	0
5	0	0	0	0	0	1	0	0	1	0
6	2	1	2	2	1	0	3	4	13	2
7	0	0	0	0	0	4	0	1	5	0
8	1	0	1	1	1	7	2	0	9	2
9	5	2	4	4	3	22	8	10	0	5
10	0	0	0	0	0	0	0	0	0	0
11	20	8	7	15	11	71	23	45	91	46
12	0	0	0	0	0	1	0	1	1	0
13	0	0	0	0	0	0	0	0	0	0
14	0	0	0	0	0	3	1	1	5	1
15	0	0	0	0	0	1	0	1	2	0
16	0	0	0	0	0	0	0	0	0	0
17	8	2	5	5	3	24	7	14	33	9
18	3	1	3	0	2	12	4	6	20	3
19	2	0	1	1	1	7	2	3	11	2
20	2	0	0	0	0	1	0	0	2	0
21	0	0	0	0	0	0	0	0	0	0
22	0	0	0	0	0	2	0	1	3	1
23	0	0	0	0	0	1	0	0	1	0
24	0	0	0	0	0	0	0	0	0	0
25	0	0	0	0	0	1	0	0	1	0
26	2	0	0	0	0	6	2	0	8	3
27	0	0	0	0	0	1	0	0	2	0
CSUM	57	23	39	38	31	185	63	99	229	85

ZONE	11	12	13	14	15	16	17	18	19	20
1	24	0	0	0	0	0	6	4	2	2
2	7	0	0	0	0	0	1	1	0	0
3	3	0	0	0	0	0	1	1	0	0
4	18	0	0	0	0	0	3	0	1	0
5	9	0	0	0	0	0	2	1	0	0
6	58	1	0	2	1	1	13	9	5	1
7	20	0	0	0	0	0	4	3	1	0
8	59	1	0	2	1	1	12	7	3	0
9	125	3	0	7	2	2	30	26	14	2
10	0	0	0	0	0	0	0	0	0	0
11	0	18	5	24	16	14	143	75	45	11
12	12	0	0	0	0	0	3	1	1	0

13	0	0	0	0	0	0	0	0	0	0
14	25	0	0	0	0	0	8	5	3	1
15	21	0	0	0	0	0	6	2	1	0
16	7	0	0	0	0	0	2	0	0	0
17	215	8	1	12	7	6	0	40	27	5
18	79	2	0	5	2	1	28	0	13	2
19	50	1	0	4	1	1	20	14	0	1
20	14	0	0	1	0	0	4	2	1	0
21	0	0	0	0	0	0	0	0	0	0
22	34	1	0	1	1	1	9	4	2	0
23	13	0	0	0	0	0	3	1	0	0
24	6	0	0	0	0	0	0	0	0	0
25	14	0	0	0	0	0	3	0	0	0
26	73	0	0	3	2	0	18	9	5	0
27	21	0	0	1	0	0	0	2	0	0
CSUM	917	46	13	73	41	35	331	218	137	33

ZONE	21	22	23	24	25	26	27	RSUM
1	0	0	0	0	0	1	2	65
2	0	0	0	0	0	0	0	18
3	0	0	0	0	0	0	0	19
4	0	0	0	0	0	0	0	44
5	0	0	0	0	0	0	0	24
6	1	2	0	0	1	2	3	142
7	0	0	0	0	0	0	1	53
8	0	2	0	0	1	0	0	126
9	3	4	0	0	3	6	8	310
10	0	0	0	0	0	0	0	0
11	10	29	6	7	20	38	51	862
12	0	0	0	0	0	0	0	28
13	0	0	0	0	0	0	0	1
14	1	1	0	0	0	1	2	71
15	0	1	0	0	0	1	2	51
16	0	0	0	0	0	0	0	16
17	6	12	2	0	7	14	0	484
18	2	3	0	0	0	5	6	213
19	1	2	0	0	0	3	0	140
20	0	0	0	0	0	0	1	39
21	0	0	0	0	0	0	0	0
22	0	0	0	0	2	4	6	84
23	0	1	0	0	1	2	0	31
24	0	0	0	0	5	10	7	30
25	0	1	0	4	0	25	15	70
26	1	6	2	22	67	0	79	314
27	0	2	0	3	9	17	0	67
CSUM	34	75	15	40	123	136	190	

TRIP LENGTH DISTRIBUTION AND FRICTION FACTOR

TL	TRIPS	F-FACTOR
1	55.74	240.23
2	261.93	171.74
3	150.06	137.30
4	102.30	114.91
5	124.95	98.61
6	215.84	85.98
7	165.22	75.79
8	127.28	67.34
9	114.08	60.21
10	103.11	54.09
11	755.65	48.78
12	0.0	0.0
13	284.29	40.04
14	88.52	36.41
15	59.93	33.17
16	27.89	30.28
17	83.51	27.68
18	26.67	25.33
19	37.73	23.22
20	20.79	21.30
21	12.21	19.56
22	33.41	17.98
23	0.0	0.0
24	0.0	0.0
25	0.0	0.0
26	58.70	12.93
27	0.0	0.0
28	52.47	11.00
29	0.0	0.0
30	101.07	9.38
31	18.94	8.67
32	0.0	0.0
33	0.0	0.0
34	39.01	6.86
35	130.05	6.34
36	0.0	0.0
37	39.17	5.44
38	0.0	0.0
39	0.0	0.0
40	18.26	4.32
41	0.0	0.0
42	0.0	0.0
43	0.0	0.0
44	0.0	0.0
45	0.0	0.0
46	4.22	2.75
47	0.0	0.0
48	0.0	0.0
49	0.0	0.0
50	0.0	0.0
51	0.0	0.0
52	0.0	0.0
53	0.0	0.0
54	0.0	0.0
55	0.0	0.0
56	0.0	0.0

57	0.0	0.0
58	0.0	0.0
59	0.0	0.0
60	0.0	0.0

CALIBRATION ITERATION = 3

O/D TABLE AFTER ITERATION 3

ZONE	1	2	3	4	5	6	7	8	9	10
1	0	2	3	3	1	3	0	1	4	0
2	1	0	2	1	0	1	0	0	1	0
3	1	1	0	2	0	1	0	0	1	0
4	3	1	5	0	1	2	0	1	2	0
5	0	0	1	0	0	2	0	0	1	0
6	2	1	2	2	2	0	5	4	16	1
7	0	0	0	0	0	5	0	1	7	0
8	1	0	1	1	1	8	2	0	10	2
9	4	1	4	3	3	27	11	10	0	3
10	0	0	0	0	0	0	0	0	0	0
11	20	8	5	15	12	76	24	50	95	58
12	0	0	0	0	0	1	0	1	1	0
13	0	0	0	0	0	0	0	0	0	0
14	0	0	0	0	0	3	0	1	5	0
15	0	0	0	0	0	1	0	0	1	0
16	0	0	0	0	0	0	0	0	0	0
17	7	2	4	3	3	21	6	13	30	6
18	3	1	2	0	1	13	3	5	24	2
19	2	0	1	1	1	6	1	2	12	1
20	3	0	0	0	0	1	0	0	2	0
21	0	0	0	0	0	0	0	0	0	0
22	0	0	0	0	0	2	0	1	3	1
23	0	0	0	0	0	0	0	0	1	0
24	0	0	0	0	0	0	0	0	0	0
25	0	0	0	0	0	0	0	0	0	0
26	1	0	0	0	0	3	0	0	4	1
27	0	0	0	0	0	1	0	0	1	0
CSUM	57	23	39	38	31	186	63	99	230	85

ZONE	11	12	13	14	15	16	17	18	19	20
1	24	0	0	0	0	0	5	3	2	3
2	6	0	0	0	0	0	1	0	0	0
3	2	0	0	0	0	0	1	1	0	0
4	17	0	0	0	0	0	2	0	1	0
5	10	0	0	0	0	0	1	1	0	0
6	62	1	0	2	0	0	11	10	5	0
7	21	0	0	0	0	0	3	3	1	0
8	66	2	0	1	0	0	11	6	2	0
9	131	3	0	7	2	1	27	31	14	2
10	0	0	0	0	0	0	0	0	0	0
11	0	20	7	25	18	15	154	72	42	11
12	13	0	0	0	0	0	4	1	0	0

13	1	0	0	0	0	0	0	0	0	0
14	26	0	0	0	0	0	9	6	4	1
15	23	0	0	0	0	1	8	2	1	0
16	7	0	0	0	0	0	2	0	0	0
17	229	10	1	13	9	7	0	44	32	5
18	76	2	0	6	1	1	31	0	18	2
19	47	1	0	4	1	1	24	19	0	1
20	14	0	0	2	0	0	4	2	1	0
21	0	0	0	0	0	0	0	0	0	0
22	39	0	0	1	1	1	9	3	2	0
23	14	0	0	0	0	0	3	1	0	0
24	3	0	0	0	0	0	0	0	0	0
25	7	0	0	0	0	0	1	0	0	0
26	51	0	0	1	1	0	10	4	3	0
27	18	0	0	0	0	0	0	1	0	0
CSUM	918	46	13	73	41	35	333	219	137	33

ZONE	21	22	23	24	25	26	27	RSUM
1	0	0	0	0	0	0	1	66
2	0	0	0	0	0	0	0	18
3	0	0	0	0	0	0	0	19
4	0	0	0	0	0	0	0	44
5	0	0	0	0	0	0	0	24
6	1	1	0	0	0	1	1	142
7	0	0	0	0	0	0	0	52
8	0	1	0	0	0	0	0	125
9	2	3	0	0	1	2	4	309
10	0	0	0	0	0	0	0	0
11	10	33	6	3	9	27	36	862
12	0	0	0	0	0	0	0	28
13	0	0	0	0	0	0	0	1
14	1	1	0	0	0	1	1	71
15	0	1	0	0	0	0	1	50
16	0	0	0	0	0	0	0	16
17	7	12	2	0	2	8	0	484
18	2	3	0	0	0	2	3	213
19	2	2	0	0	0	1	0	140
20	0	0	0	0	0	0	0	40
21	0	0	0	0	0	0	0	0
22	0	0	1	0	1	3	5	84
23	0	2	0	0	0	2	0	31
24	0	0	0	0	4	14	7	30
25	0	0	0	4	0	38	15	70
26	0	5	1	27	88	0	104	314
27	0	2	0	3	9	26	0	67
CSUM	34	75	16	39	119	133	186	

TRIP LENGTH DISTRIBUTION AND FRICTION FACTOR

TL	TRIPS	F-FACTOR
1	79.67	336.40
2	329.95	209.09
3	163.26	154.31
4	116.06	122.17
5	127.43	100.53
6	243.89	84.76
7	158.84	72.68
8	137.01	63.09
9	116.29	55.28
10	103.59	48.80
11	793.92	43.34
12	0.0	0.0
13	267.24	34.67
14	94.54	31.18
15	55.08	28.13
16	23.63	25.45
17	85.02	23.07
18	23.20	20.96
19	35.05	19.08
20	18.55	17.40
21	9.94	15.89
22	30.51	14.52
23	0.0	0.0
24	0.0	0.0
25	0.0	0.0
26	53.66	10.27
27	0.0	0.0
28	29.81	8.68
29	0.0	0.0
30	67.64	7.36
31	9.72	6.79
32	0.0	0.0
33	0.0	0.0
34	21.97	5.34
35	86.86	4.93
36	0.0	0.0
37	18.46	4.22
38	0.0	0.0
39	0.0	0.0
40	9.84	3.34
41	0.0	0.0
42	0.0	0.0
43	0.0	0.0
44	0.0	0.0
45	0.0	0.0
46	2.34	2.12
47	0.0	0.0
48	0.0	0.0
49	0.0	0.0
50	0.0	0.0
51	0.0	0.0
52	0.0	0.0
53	0.0	0.0
54	0.0	0.0
55	0.0	0.0
56	0.0	0.0

57	0.0	0.0
58	0.0	0.0
59	0.0	0.0
60	0.0	0.0

CALIBRATION ITERATION = 4

O/D TABLE AFTER ITERATION 4

ZONE	1	2	3	4	5	6	7	8	9	10
1	0	2	3	4	1	3	0	1	3	0
2	1	0	3	1	0	0	0	0	0	0
3	1	2	0	3	0	1	0	0	1	0
4	3	2	7	0	1	2	0	0	2	0
5	0	0	1	0	0	2	0	0	1	0
6	2	1	2	2	2	0	6	5	18	1
7	0	0	0	0	0	7	0	2	8	0
8	1	0	1	1	1	8	3	0	10	1
9	4	1	4	3	3	31	13	10	0	3
10	0	0	0	0	0	0	0	0	0	0
11	21	8	4	15	12	76	23	52	95	64
12	0	0	0	0	0	1	0	1	1	0
13	0	0	0	0	0	0	0	0	0	0
14	0	0	0	0	0	3	0	1	5	0
15	0	0	0	0	0	1	0	0	1	0
16	0	0	0	0	0	0	0	0	0	0
17	6	1	3	3	2	19	5	12	27	5
18	2	0	2	0	1	12	3	4	27	1
19	1	0	1	0	0	6	1	2	12	1
20	4	0	0	0	0	1	0	0	2	0
21	0	0	0	0	0	0	0	0	0	0
22	0	0	0	0	0	2	0	1	2	0
23	0	0	0	0	0	0	0	0	1	0
24	0	0	0	0	0	0	0	0	0	0
25	0	0	0	0	0	0	0	0	0	0
26	1	0	0	0	0	2	0	0	3	0
27	0	0	0	0	0	0	0	0	1	0
CSUM	57	23	39	38	31	186	63	100	231	86

ZONE	11	12	13	14	15	16	17	18	19	20
1	25	0	0	0	0	0	5	3	2	4
2	6	0	0	0	0	0	0	0	0	0
3	2	0	0	0	0	0	1	1	0	0
4	16	0	0	0	0	0	2	0	0	0
5	10	0	0	0	0	0	1	1	0	0
6	62	1	0	2	0	0	10	9	4	0
7	20	0	0	0	0	0	3	2	1	0
8	68	2	0	1	0	0	11	6	2	0
9	130	3	0	6	1	1	25	34	14	2
10	0	0	0	0	0	0	0	0	0	0
11	0	20	7	25	18	16	157	68	39	11
12	13	0	0	0	0	0	5	1	0	0

13	1	0	0	0	0	0	0	0	0	0
14	26	0	0	0	0	0	9	6	4	2
15	24	0	0	0	0	1	9	2	1	0
16	7	0	0	0	0	0	2	0	0	0
17	233	11	1	14	10	7	0	45	35	5
18	73	1	0	6	1	1	33	0	22	2
19	44	1	0	4	1	1	26	23	0	1
20	14	0	0	2	0	0	4	2	1	0
21	0	0	0	0	0	0	0	0	0	0
22	42	0	0	1	1	1	9	3	2	0
23	15	0	0	0	0	0	3	1	0	0
24	3	0	0	0	0	0	0	0	0	0
25	6	0	0	0	0	0	1	0	0	0
26	48	0	0	1	0	0	8	3	2	0
27	18	0	0	0	0	0	0	1	0	0
CSUM	918	46	13	73	41	35	334	219	138	33

ZONE	21	22	23	24	25	26	27	RSUM
1	0	0	0	0	0	0	1	65
2	0	0	0	0	0	0	0	18
3	0	0	0	0	0	0	0	19
4	0	0	0	0	0	0	0	43
5	0	0	0	0	0	0	0	24
6	0	1	0	0	0	0	1	142
7	0	0	0	0	0	0	0	52
8	0	1	0	0	0	0	0	126
9	2	3	0	0	0	2	3	309
10	0	0	0	0	0	0	0	0
11	10	35	6	3	6	24	35	862
12	0	0	0	0	0	0	0	28
13	0	0	0	0	0	0	0	1
14	1	1	0	0	0	0	1	71
15	0	1	0	0	0	0	1	50
16	0	0	0	0	0	0	0	16
17	7	12	2	0	1	6	0	484
18	3	2	0	0	0	1	2	213
19	2	2	0	0	0	1	0	140
20	0	0	0	0	0	0	0	40
21	0	0	0	0	0	0	0	0
22	0	0	1	0	0	2	5	84
23	0	3	0	0	0	1	0	32
24	0	0	0	0	4	15	7	31
25	0	0	0	3	0	42	14	71
26	0	4	1	27	93	0	110	314
27	0	2	0	3	8	28	0	67
CSUM	34	75	16	39	118	131	185	

TRIP LENGTH DISTRIBUTION AND FRICTION FACTOR

TL	TRIPS	F-FACTOR
1	99.73	380.04
2	362.71	217.23
3	170.33	152.97
4	120.76	117.33
5	124.42	94.30
6	245.88	78.06
7	150.98	65.96
8	139.78	56.57
9	113.26	49.08
10	99.96	42.96
11	796.66	37.88
12	0.0	0.0
13	250.68	29.96
14	97.37	26.83
15	52.25	24.11
16	20.94	21.74
17	86.03	19.66
18	21.08	17.82
19	33.67	16.19
20	17.51	14.74
21	8.71	13.44
22	30.36	12.28
23	0.0	0.0
24	0.0	0.0
25	0.0	0.0
26	54.25	8.67
27	0.0	0.0
28	23.67	7.34
29	0.0	0.0
30	62.58	6.23
31	7.25	5.75
32	0.0	0.0
33	0.0	0.0
34	18.16	4.54
35	78.31	4.20
36	0.0	0.0
37	14.63	3.60
38	0.0	0.0
39	0.0	0.0
40	9.02	2.87
41	0.0	0.0
42	0.0	0.0
43	0.0	0.0
44	0.0	0.0
45	0.0	0.0
46	2.05	1.84
47	0.0	0.0
48	0.0	0.0
49	0.0	0.0
50	0.0	0.0
51	0.0	0.0
52	0.0	0.0
53	0.0	0.0
54	0.0	0.0
55	0.0	0.0
56	0.0	0.0

57	0.0	0.0
58	0.0	0.0
59	0.0	0.0
60	0.0	0.0

CALIBRATION ITERATION = 5

O/D TABLE AFTER ITERATION 5

ZONE	1	2	3	4	5	6	7	8	9	10
1	0	2	3	4	1	3	0	1	3	0
2	1	0	3	1	0	0	0	0	0	0
3	1	2	0	4	0	1	0	0	1	0
4	3	2	8	0	1	2	0	0	2	0
5	0	0	1	1	0	2	0	0	1	0
6	2	1	2	1	2	0	7	5	19	1
7	0	0	0	0	0	7	0	2	9	0
8	1	0	1	0	0	8	3	0	10	1
9	4	1	3	3	3	33	15	10	0	2
10	0	0	0	0	0	0	0	0	0	0
11	22	8	4	14	13	76	22	53	94	66
12	0	0	0	0	0	1	0	1	1	0
13	0	0	0	0	0	0	0	0	0	0
14	0	0	0	0	0	3	0	1	5	0
15	0	0	0	0	0	1	0	0	1	0
16	0	0	0	0	0	0	0	0	0	0
17	6	1	3	3	2	18	4	12	26	5
18	2	0	2	0	1	12	3	4	28	1
19	1	0	0	0	0	5	1	1	11	0
20	4	0	0	0	0	1	0	0	2	0
21	0	0	0	0	0	0	0	0	0	0
22	0	0	0	0	0	1	0	1	2	0
23	0	0	0	0	0	0	0	0	0	0
24	0	0	0	0	0	0	0	0	0	0
25	0	0	0	0	0	0	0	0	0	0
26	1	0	0	0	0	2	0	0	2	0
27	0	0	0	0	0	0	0	0	1	0
CSUM	57	23	39	38	31	187	63	100	231	86

ZONE	11	12	13	14	15	16	17	18	19	20
1	26	0	0	0	0	0	5	2	1	4
2	5	0	0	0	0	0	0	0	0	0
3	2	0	0	0	0	0	1	0	0	0
4	15	0	0	0	0	0	2	0	0	0
5	10	0	0	0	0	0	1	1	0	0
6	62	1	0	2	0	0	10	9	4	0
7	20	0	0	0	0	0	2	2	1	0
8	70	2	0	1	0	0	10	5	2	0
9	129	2	0	6	1	1	24	36	14	2
10	0	0	0	0	0	0	0	0	0	0
11	0	20	7	26	18	16	158	66	37	11
12	13	0	0	0	0	0	5	1	0	0

13	1	0	0	0	0	0	0	0	0	0
14	27	0	0	0	0	0	10	6	4	2
15	24	0	0	0	0	1	10	1	1	0
16	8	0	0	0	0	0	2	0	0	0
17	234	12	1	14	11	7	0	46	36	4
18	71	1	0	6	1	1	33	0	24	1
19	42	1	0	4	1	1	28	26	0	1
20	14	0	0	2	0	0	4	2	1	0
21	0	0	0	0	0	0	0	0	0	0
22	43	0	0	1	1	1	9	3	2	0
23	16	0	0	0	0	0	3	1	0	0
24	3	0	0	0	0	0	0	0	0	0
25	6	0	0	0	0	0	0	0	0	0
26	47	0	0	1	0	0	7	3	1	0
27	18	0	0	0	0	0	0	1	0	0
CSUM	918	46	13	73	41	35	334	220	138	33

ZONE	21	22	23	24	25	26	27	RSUM
1	0	0	0	0	0	0	1	65
2	0	0	0	0	0	0	0	18
3	0	0	0	0	0	0	0	19
4	0	0	0	0	0	0	0	44
5	0	0	0	0	0	0	0	24
6	0	1	0	0	0	0	1	142
7	0	0	0	0	0	0	0	52
8	0	1	0	0	0	0	0	126
9	2	3	0	0	0	1	3	309
10	0	0	0	0	0	0	0	0
11	10	36	7	3	6	23	35	862
12	0	0	0	0	0	0	0	28
13	0	0	0	0	0	0	0	1
14	1	1	0	0	0	0	1	71
15	0	1	0	0	0	0	0	50
16	0	0	0	0	0	0	0	16
17	8	12	2	0	1	5	0	484
18	3	2	0	0	0	1	2	213
19	2	2	0	0	0	1	0	140
20	0	0	0	0	0	0	0	39
21	0	0	0	0	0	0	0	0
22	0	0	1	0	0	2	4	84
23	0	3	0	0	0	1	0	31
24	0	0	0	0	4	15	7	30
25	0	0	0	3	0	44	13	71
26	0	4	1	28	96	0	111	314
27	0	2	0	3	7	29	0	67
CSUM	34	75	16	39	118	130	185	

TRIP LENGTH DISTRIBUTION AND FRICTION FACTOR

TL	TRIPS	F-FACTOR
1	112.28	406.55
2	379.90	221.84
3	173.76	152.23
4	122.50	114.73
5	122.05	91.04
6	244.58	74.62
7	146.12	62.55
8	140.84	53.31
9	110.75	46.00
10	97.20	40.09
11	795.10	35.22
12	0.0	0.0
13	240.65	27.70
14	98.79	24.75
15	50.82	22.20
16	19.49	19.99
17	86.71	18.05
18	19.98	16.35
19	32.94	14.84
20	16.99	13.50
21	8.11	12.31
22	30.60	11.25
23	0.0	0.0
24	0.0	0.0
25	0.0	0.0
26	55.30	7.94
27	0.0	0.0
28	21.37	6.73
29	0.0	0.0
30	62.17	5.72
31	6.30	5.28
32	0.0	0.0
33	0.0	0.0
34	16.84	4.18
35	76.25	3.87
36	0.0	0.0
37	13.50	3.33
38	0.0	0.0
39	0.0	0.0
40	9.10	2.66
41	0.0	0.0
42	0.0	0.0
43	0.0	0.0
44	0.0	0.0
45	0.0	0.0
46	2.00	1.73
47	0.0	0.0
48	0.0	0.0
49	0.0	0.0
50	0.0	0.0
51	0.0	0.0
52	0.0	0.0
53	0.0	0.0
54	0.0	0.0
55	0.0	0.0
56	0.0	0.0

57	0.0	0.0
58	0.0	0.0
59	0.0	0.0
60	0.0	0.0

CALIBRATION ITERATION = 6

O/D TABLE AFTER ITERATION 6

ZONE	1	2	3	4	5	6	7	8	9	10
1	0	2	3	4	1	3	0	1	3	0
2	1	0	3	1	0	0	0	0	0	0
3	1	2	0	4	0	1	0	0	1	0
4	3	2	9	0	1	2	0	0	2	0
5	0	0	1	1	0	2	0	0	1	0
6	2	0	2	1	2	0	7	5	20	1
7	0	0	0	0	0	8	0	2	10	0
8	1	0	1	0	0	8	3	0	10	1
9	4	1	3	2	3	34	15	11	0	2
10	0	0	0	0	0	0	0	0	0	0
11	23	8	4	14	13	76	22	54	94	68
12	0	0	0	0	0	1	0	1	1	0
13	0	0	0	0	0	0	0	0	0	0
14	0	0	0	0	0	2	0	1	5	0
15	0	0	0	0	0	1	0	0	1	0
16	0	0	0	0	0	0	0	0	0	0
17	6	1	3	2	2	17	4	12	26	4
18	2	0	1	0	1	12	3	4	29	1
19	1	0	0	0	0	5	1	1	11	0
20	4	0	0	0	0	1	0	0	1	0
21	0	0	0	0	0	0	0	0	0	0
22	0	0	0	0	0	1	0	1	2	0
23	0	0	0	0	0	0	0	0	0	0
24	0	0	0	0	0	0	0	0	0	0
25	0	0	0	0	0	0	0	0	0	0
26	1	0	0	0	0	2	0	0	2	0
27	0	0	0	0	0	0	0	0	1	0
CSUM	57	23	39	38	31	187	63	100	231	86

ZONE	11	12	13	14	15	16	17	18	19	20
1	27	0	0	0	0	0	4	2	1	4
2	5	0	0	0	0	0	0	0	0	0
3	2	0	0	0	0	0	1	0	0	0
4	15	0	0	0	0	0	2	0	0	0
5	10	0	0	0	0	0	1	1	0	0
6	62	1	0	2	0	0	9	9	4	0
7	19	0	0	0	0	0	2	2	1	0
8	70	2	0	1	0	0	10	5	2	0
9	128	2	0	6	1	1	24	37	14	2
10	0	0	0	0	0	0	0	0	0	0
11	0	20	7	26	18	16	159	65	36	11
12	13	0	0	0	0	0	5	1	0	0

13	1	0	0	0	0	0	0	0	0	0
14	27	0	0	0	0	0	10	6	4	2
15	24	0	0	0	0	1	10	1	1	0
16	8	0	0	0	0	0	2	0	0	0
17	235	12	1	14	11	8	0	46	37	4
18	70	1	0	6	1	1	34	0	26	1
19	41	1	0	4	1	1	29	27	0	1
20	15	0	0	2	0	0	4	2	1	0
21	0	0	0	0	0	0	0	0	0	0
22	44	0	0	1	1	1	9	2	2	0
23	16	0	0	0	0	0	3	1	0	0
24	3	0	0	0	0	0	0	0	0	0
25	5	0	0	0	0	0	0	0	0	0
26	47	0	0	1	0	0	7	3	1	0
27	19	0	0	0	0	0	0	1	0	0
CSUM	918	46	13	73	41	35	334	220	138	33

ZONE	21	22	23	24	25	26	27	RSUM
1	0	0	0	0	0	0	1	65
2	0	0	0	0	0	0	0	18
3	0	0	0	0	0	0	0	19
4	0	0	0	0	0	0	0	43
5	0	0	0	0	0	0	0	24
6	0	1	0	0	0	0	1	142
7	0	0	0	0	0	0	0	52
8	0	1	0	0	0	0	0	126
9	2	2	0	0	0	1	2	309
10	0	0	0	0	0	0	0	0
11	10	36	7	3	6	23	35	862
12	0	0	0	0	0	0	0	28
13	0	0	0	0	0	0	0	1
14	1	1	0	0	0	0	1	71
15	0	1	0	0	0	0	0	50
16	0	0	0	0	0	0	0	16
17	8	12	2	0	1	5	0	484
18	3	2	0	0	0	1	2	213
19	2	1	0	0	0	0	0	140
20	0	0	0	0	0	0	0	40
21	0	0	0	0	0	0	0	0
22	0	0	2	0	0	2	4	84
23	0	3	0	0	0	1	0	31
24	0	0	0	0	3	15	7	30
25	0	0	0	3	0	45	13	71
26	0	4	1	28	97	0	112	314
27	0	2	0	3	7	29	0	67
CSUM	34	75	16	39	118	130	185	

TRIP LENGTH DISTRIBUTION AND FRICTION FACTOR

TL	TRIPS	F-FACTOR
1	119.44	452.09
2	389.07	240.45
3	175.47	162.66
4	123.26	121.42
5	120.63	95.67
6	243.52	77.99
7	143.41	65.10
8	141.37	55.28
9	109.24	47.56
10	95.55	41.35
11	793.88	36.26
12	0.0	0.0
13	235.10	28.43
14	99.55	25.37
15	50.08	22.74
16	18.71	20.45
17	87.11	18.46
18	19.39	16.71
19	32.54	15.16
20	16.70	13.79
21	7.80	12.57
22	30.78	11.48
23	0.0	0.0
24	0.0	0.0
25	0.0	0.0
26	56.01	8.12
27	0.0	0.0
28	20.29	6.88
29	0.0	0.0
30	62.32	5.85
31	5.85	5.41
32	0.0	0.0
33	0.0	0.0
34	16.22	4.28
35	75.49	3.97
36	0.0	0.0
37	13.02	3.42
38	0.0	0.0
39	0.0	0.0
40	9.22	2.74
41	0.0	0.0
42	0.0	0.0
43	0.0	0.0
44	0.0	0.0
45	0.0	0.0
46	1.98	1.79
47	0.0	0.0
48	0.0	0.0
49	0.0	0.0
50	0.0	0.0
51	0.0	0.0
52	0.0	0.0
53	0.0	0.0
54	0.0	0.0
55	0.0	0.0
56	0.0	0.0

57	0.0	0.0
58	0.0	0.0
59	0.0	0.0
60	0.0	0.0

CALIBRATION ITERATION = 7

O/D TABLE AFTER ITERATION 7

ZONE	1	2	3	4	5	6	7	8	9	10
1	0	2	3	4	1	3	0	1	3	0
2	1	0	4	1	0	0	0	0	0	0
3	1	2	0	4	0	1	0	0	1	0
4	3	2	9	0	1	2	0	0	2	0
5	0	0	1	1	0	2	0	0	1	0
6	2	0	2	1	2	0	8	5	21	1
7	0	0	0	0	0	8	0	2	10	0
8	1	0	0	0	0	8	3	0	10	1
9	4	1	3	2	3	35	16	11	0	2
10	0	0	0	0	0	0	0	0	0	0
11	23	8	4	14	13	76	21	54	94	68
12	0	0	0	0	0	1	0	1	1	0
13	0	0	0	0	0	0	0	0	0	0
14	0	0	0	0	0	2	0	1	4	0
15	0	0	0	0	0	1	0	0	1	0
16	0	0	0	0	0	0	0	0	0	0
17	6	1	3	2	2	17	4	12	25	4
18	2	0	1	0	1	12	3	4	30	1
19	1	0	0	0	0	5	1	1	11	0
20	4	0	0	0	0	1	0	0	1	0
21	0	0	0	0	0	0	0	0	0	0
22	0	0	0	0	0	1	0	1	2	0
23	0	0	0	0	0	0	0	0	0	0
24	0	0	0	0	0	0	0	0	0	0
25	0	0	0	0	0	0	0	0	0	0
26	1	0	0	0	0	1	0	0	2	0
27	0	0	0	0	0	0	0	0	1	0
CSUM	57	23	39	38	31	187	63	100	231	86

ZONE	11	12	13	14	15	16	17	18	19	20
1	27	0	0	0	0	0	4	2	1	4
2	5	0	0	0	0	0	0	0	0	0
3	2	0	0	0	0	0	1	0	0	0
4	15	0	0	0	0	0	1	0	0	0
5	10	0	0	0	0	0	1	1	0	0
6	62	1	0	2	0	0	9	9	4	0
7	19	0	0	0	0	0	2	2	1	0
8	70	2	0	1	0	0	10	5	2	0
9	128	2	0	6	1	1	23	37	14	2
10	0	0	0	0	0	0	0	0	0	0
11	0	19	7	26	18	16	159	64	35	11
12	13	0	0	0	0	0	6	1	0	0

13	1	0	0	0	0	0	0	0	0	0
14	27	0	0	0	0	0	10	6	4	2
15	24	0	0	0	0	1	10	1	1	0
16	8	0	0	0	0	0	2	0	0	0
17	236	12	1	14	11	8	0	46	38	4
18	69	1	0	6	1	1	34	0	27	1
19	40	1	0	4	1	1	29	28	0	1
20	15	0	0	2	0	0	4	2	1	0
21	0	0	0	0	0	0	0	0	0	0
22	44	0	0	1	1	1	9	2	2	0
23	16	0	0	0	0	0	3	0	0	0
24	3	0	0	0	0	0	0	0	0	0
25	5	0	0	0	0	0	0	0	0	0
26	47	0	0	1	0	0	7	2	1	0
27	19	0	0	0	0	0	0	1	0	0
CSUM	918	46	13	73	41	35	335	220	138	33

ZONE	21	22	23	24	25	26	27	RSUM
1	0	0	0	0	0	0	1	65
2	0	0	0	0	0	0	0	18
3	0	0	0	0	0	0	0	19
4	0	0	0	0	0	0	0	43
5	0	0	0	0	0	0	0	24
6	0	1	0	0	0	0	1	142
7	0	0	0	0	0	0	0	52
8	0	1	0	0	0	0	0	126
9	2	2	0	0	0	1	2	309
10	0	0	0	0	0	0	0	0
11	10	36	7	3	5	22	35	862
12	0	0	0	0	0	0	0	28
13	0	0	0	0	0	0	0	1
14	1	1	0	0	0	0	1	71
15	0	1	0	0	0	0	0	50
16	0	0	0	0	0	0	0	16
17	8	12	2	0	1	5	0	484
18	3	2	0	0	0	1	2	213
19	2	1	0	0	0	0	0	140
20	0	0	0	0	0	0	0	39
21	0	0	0	0	0	0	0	0
22	0	0	2	0	0	2	4	84
23	0	4	0	0	0	1	0	32
24	0	0	0	0	3	15	7	30
25	0	0	0	3	0	45	13	71
26	0	4	1	28	97	0	112	314
27	0	2	0	3	7	29	0	67
CSUM	34	75	16	39	118	129	185	

TRIP LENGTH DISTRIBUTION AND FRICTION FACTOR

TL	TRIPS	F-FACTOR
1	123.44	479.73
2	394.05	251.54
3	176.36	168.82
4	123.63	125.35
5	119.83	98.38
6	242.89	79.96
7	141.91	66.58
8	141.67	56.43
9	108.38	48.47
10	94.61	42.09
11	793.17	36.86
12	0.0	0.0
13	232.04	28.85
14	99.97	25.73
15	49.69	23.05
16	18.29	20.73
17	87.34	18.70
18	19.07	16.92
19	32.31	15.35
20	16.55	13.96
21	7.63	12.73
22	30.89	11.62
23	0.0	0.0
24	0.0	0.0
25	0.0	0.0
26	56.42	8.22
27	0.0	0.0
28	19.72	6.97
29	0.0	0.0
30	62.46	5.93
31	5.62	5.48
32	0.0	0.0
33	0.0	0.0
34	15.90	4.35
35	75.12	4.03
36	0.0	0.0
37	12.77	3.47
38	0.0	0.0
39	0.0	0.0
40	9.30	2.79
41	0.0	0.0
42	0.0	0.0
43	0.0	0.0
44	0.0	0.0
45	0.0	0.0
46	1.97	1.82
47	0.0	0.0
48	0.0	0.0
49	0.0	0.0
50	0.0	0.0
51	0.0	0.0
52	0.0	0.0
53	0.0	0.0
54	0.0	0.0
55	0.0	0.0
56	0.0	0.0

57	0.0	0.0
58	0.0	0.0
59	0.0	0.0
60	0.0	0.0

CALIBRATION ITERATION = 8

O/D TABLE AFTER ITERATION 8

ZONE	1	2	3	4	5	6	7	8	9	10
1	0	2	3	4	1	3	0	1	3	0
2	1	0	4	1	0	0	0	0	0	0
3	1	2	0	4	0	1	0	0	1	0
4	3	2	10	0	1	2	0	0	2	0
5	0	0	1	1	0	2	0	0	1	0
6	2	0	2	1	2	0	8	5	21	1
7	0	0	0	0	0	8	0	2	10	0
8	1	0	0	0	0	8	3	0	10	1
9	4	1	3	2	3	35	16	11	0	2
10	0	0	0	0	0	0	0	0	0	0
11	23	8	4	14	13	76	21	54	93	69
12	0	0	0	0	0	1	0	1	1	0
13	0	0	0	0	0	0	0	0	0	0
14	0	0	0	0	0	2	0	1	4	0
15	0	0	0	0	0	0	0	0	1	0
16	0	0	0	0	0	0	0	0	0	0
17	6	1	3	2	2	17	4	11	25	4
18	2	0	1	0	1	12	3	4	30	1
19	1	0	0	0	0	5	1	1	11	0
20	4	0	0	0	0	1	0	0	1	0
21	0	0	0	0	0	0	0	0	0	0
22	0	0	0	0	0	1	0	1	2	0
23	0	0	0	0	0	0	0	0	0	0
24	0	0	0	0	0	0	0	0	0	0
25	0	0	0	0	0	0	0	0	0	0
26	1	0	0	0	0	1	0	0	2	0
27	0	0	0	0	0	0	0	0	1	0
CSUM	57	23	39	38	31	187	63	100	231	86

ZONE	11	12	13	14	15	16	17	18	19	20
1	27	0	0	0	0	0	4	2	1	4
2	5	0	0	0	0	0	0	0	0	0
3	2	0	0	0	0	0	1	0	0	0
4	15	0	0	0	0	0	1	0	0	0
5	10	0	0	0	0	0	1	1	0	0
6	62	1	0	2	0	0	9	9	3	0
7	19	0	0	0	0	0	2	2	1	0
8	71	2	0	1	0	0	10	5	2	0
9	128	2	0	6	1	1	23	37	14	2
10	0	0	0	0	0	0	0	0	0	0
11	0	19	7	26	18	16	159	64	35	12
12	13	0	0	0	0	0	6	0	0	0

13	1	0	0	0	0	0	0	0	0	0
14	27	0	0	0	0	0	10	6	4	2
15	24	0	0	0	0	1	10	1	1	0
16	8	0	0	0	0	0	2	0	0	0
17	236	13	1	14	11	8	0	47	38	4
18	69	1	0	6	1	1	34	0	27	1
19	40	1	0	4	1	1	29	29	0	1
20	15	0	0	2	0	0	4	2	1	0
21	0	0	0	0	0	0	0	0	0	0
22	44	0	0	1	1	1	9	2	2	0
23	16	0	0	0	0	0	3	0	0	0
24	3	0	0	0	0	0	0	0	0	0
25	5	0	0	0	0	0	0	0	0	0
26	47	0	0	1	0	0	7	2	1	0
27	19	0	0	0	0	0	0	1	0	0
CSUM	918	46	13	73	41	35	335	220	138	33

ZONE	21	22	23	24	25	26	27	RSUM
1	0	0	0	0	0	0	1	65
2	0	0	0	0	0	0	0	17
3	0	0	0	0	0	0	0	19
4	0	0	0	0	0	0	0	44
5	0	0	0	0	0	0	0	24
6	0	1	0	0	0	0	1	142
7	0	0	0	0	0	0	0	52
8	0	1	0	0	0	0	0	126
9	2	2	0	0	0	1	2	309
10	0	0	0	0	0	0	0	0
11	10	37	7	3	5	22	35	862
12	0	0	0	0	0	0	0	28
13	0	0	0	0	0	0	0	1
14	1	1	0	0	0	0	1	71
15	0	1	0	0	0	0	0	50
16	0	0	0	0	0	0	0	16
17	8	12	2	0	1	4	0	484
18	3	2	0	0	0	1	2	213
19	2	1	0	0	0	0	0	140
20	0	0	0	0	0	0	0	40
21	0	0	0	0	0	0	0	0
22	0	0	2	0	0	2	4	84
23	0	4	0	0	0	1	0	31
24	0	0	0	0	3	15	7	30
25	0	0	0	3	0	46	13	71
26	0	4	1	28	97	0	112	313
27	0	2	0	3	7	29	0	67
CSUM	34	75	16	39	118	129	185	

TRIP LENGTH DISTRIBUTION AND FRICTION FACTOR

TL	TRIPS	F-FACTOR
1	125.68	495.96
2	396.80	257.99
3	176.84	172.38
4	123.82	127.62
5	119.39	99.93
6	242.53	81.09
7	141.08	67.43
8	141.83	57.08
9	107.90	49.00
10	94.09	42.51
11	792.78	37.21
12	0.0	0.0
13	230.35	29.09
14	100.20	25.94
15	49.47	23.23
16	18.06	20.88
17	87.47	18.84
18	18.89	17.04
19	32.18	15.46
20	16.46	14.06
21	7.53	12.82
22	30.96	11.70
23	0.0	0.0
24	0.0	0.0
25	0.0	0.0
26	56.65	8.28
27	0.0	0.0
28	19.42	7.02
29	0.0	0.0
30	62.55	5.97
31	5.50	5.52
32	0.0	0.0
33	0.0	0.0
34	15.72	4.38
35	74.93	4.06
36	0.0	0.0
37	12.64	3.50
38	0.0	0.0
39	0.0	0.0
40	9.34	2.81
41	0.0	0.0
42	0.0	0.0
43	0.0	0.0
44	0.0	0.0
45	0.0	0.0
46	1.97	1.84
47	0.0	0.0
48	0.0	0.0
49	0.0	0.0
50	0.0	0.0
51	0.0	0.0
52	0.0	0.0
53	0.0	0.0
54	0.0	0.0
55	0.0	0.0
56	0.0	0.0

57	0.0	0.0
58	0.0	0.0
59	0.0	0.0
60	0.0	0.0

CALIBRATION ITERATION = 9

O/D TABLE AFTER ITERATION 9

ZONE	1	2	3	4	5	6	7	8	9	10
1	0	2	3	4	1	3	0	1	3	0
2	1	0	4	1	0	0	0	0	0	0
3	1	2	0	4	0	1	0	0	1	0
4	3	2	10	0	1	2	0	0	2	0
5	0	0	1	1	0	2	0	0	1	0
6	2	0	2	1	2	0	8	5	21	1
7	0	0	0	0	0	8	0	2	11	0
8	1	0	0	0	0	8	3	0	10	1
9	4	1	3	2	3	35	16	11	0	2
10	0	0	0	0	0	0	0	0	0	0
11	23	8	4	14	13	76	21	54	93	69
12	0	0	0	0	0	1	0	1	1	0
13	0	0	0	0	0	0	0	0	0	0
14	0	0	0	0	0	2	0	1	4	0
15	0	0	0	0	0	0	0	0	1	0
16	0	0	0	0	0	0	0	0	0	0
17	6	1	3	2	2	17	4	11	25	4
18	2	0	1	0	1	12	3	4	30	1
19	1	0	0	0	0	5	1	1	11	0
20	4	0	0	0	0	1	0	0	1	0
21	0	0	0	0	0	0	0	0	0	0
22	0	0	0	0	0	1	0	1	2	0
23	0	0	0	0	0	0	0	0	0	0
24	0	0	0	0	0	0	0	0	0	0
25	0	0	0	0	0	0	0	0	0	0
26	1	0	0	0	0	1	0	0	2	0
27	0	0	0	0	0	0	0	0	1	0
CSUM	57	23	39	38	31	187	63	100	231	86

ZONE	11	12	13	14	15	16	17	18	19	20
1	27	0	0	0	0	0	4	2	1	4
2	5	0	0	0	0	0	0	0	0	0
3	2	0	0	0	0	0	0	0	0	0
4	15	0	0	0	0	0	1	0	0	0
5	10	0	0	0	0	0	1	1	0	0
6	62	1	0	2	0	0	9	9	3	0
7	19	0	0	0	0	0	2	2	1	0
8	71	2	0	1	0	0	10	5	1	0
9	127	2	0	6	1	1	23	38	13	2
10	0	0	0	0	0	0	0	0	0	0
11	0	19	7	26	18	16	159	63	34	12
12	13	0	0	0	0	0	6	0	0	0

13	1	0	0	0	0	0	0	0	0	0
14	27	0	0	0	0	0	10	6	4	2
15	24	0	0	0	0	1	10	1	1	0
16	8	0	0	0	0	0	2	0	0	0
17	236	13	1	14	12	8	0	47	38	4
18	69	1	0	6	1	1	34	0	27	1
19	39	1	0	4	1	1	29	29	0	1
20	15	0	0	2	0	0	4	2	1	0
21	0	0	0	0	0	0	0	0	0	0
22	44	0	0	1	1	1	9	2	1	0
23	16	0	0	0	0	0	3	0	0	0
24	3	0	0	0	0	0	0	0	0	0
25	5	0	0	0	0	0	0	0	0	0
26	47	0	0	1	0	0	6	2	1	0
27	19	0	0	0	0	0	0	1	0	0
CSUM	918	46	13	73	41	35	335	220	138	33

ZONE	21	22	23	24	25	26	27	RSUM
1	0	0	0	0	0	0	1	65
2	0	0	0	0	0	0	0	17
3	0	0	0	0	0	0	0	19
4	0	0	0	0	0	0	0	43
5	0	0	0	0	0	0	0	24
6	0	1	0	0	0	0	1	142
7	0	0	0	0	0	0	0	52
8	0	1	0	0	0	0	0	125
9	2	2	0	0	0	1	2	309
10	0	0	0	0	0	0	0	0
11	10	37	7	3	5	22	36	862
12	0	0	0	0	0	0	0	28
13	0	0	0	0	0	0	0	1
14	1	1	0	0	0	0	1	71
15	0	1	0	0	0	0	0	50
16	0	0	0	0	0	0	0	16
17	8	12	2	0	1	4	0	484
18	3	2	0	0	0	1	2	213
19	2	1	0	0	0	0	0	140
20	0	0	0	0	0	0	0	40
21	0	0	0	0	0	0	0	0
22	0	0	2	0	0	2	4	84
23	0	4	0	0	0	1	0	32
24	0	0	0	0	3	15	7	30
25	0	0	0	3	0	46	13	71
26	0	4	1	28	98	0	112	314
27	0	2	0	3	7	29	0	67
CSUM	34	75	16	39	118	129	185	

TRIP LENGTH DISTRIBUTION AND FRICTION FACTOR

TL	TRIPS	F-FACTOR
1	126.93	505.33
2	398.34	261.69
3	177.11	174.42
4	123.92	128.91
5	119.13	100.82
6	242.32	81.73
7	140.62	67.91
8	141.92	57.46
9	107.63	49.29
10	93.79	42.75
11	792.56	37.40
12	0.0	0.0
13	229.40	29.23
14	100.33	26.05
15	49.35	23.33
16	17.93	20.97
17	87.54	18.91
18	18.80	17.11
19	32.11	15.52
20	16.41	14.12
21	7.48	12.87
22	30.99	11.75
23	0.0	0.0
24	0.0	0.0
25	0.0	0.0
26	56.78	8.31
27	0.0	0.0
28	19.25	7.04
29	0.0	0.0
30	62.61	6.00
31	5.43	5.55
32	0.0	0.0
33	0.0	0.0
34	15.62	4.40
35	74.82	4.08
36	0.0	0.0
37	12.56	3.52
38	0.0	0.0
39	0.0	0.0
40	9.37	2.83
41	0.0	0.0
42	0.0	0.0
43	0.0	0.0
44	0.0	0.0
45	0.0	0.0
46	1.96	1.85
47	0.0	0.0
48	0.0	0.0
49	0.0	0.0
50	0.0	0.0
51	0.0	0.0
52	0.0	0.0
53	0.0	0.0
54	0.0	0.0
55	0.0	0.0
56	0.0	0.0

57	0.0	0.0
58	0.0	0.0
59	0.0	0.0
60	0.0	0.0

K-FACTOR TABLE

ZONE	1	2	3	4	5	6	7	8	9	10
1	1.0	2.0	1.5	8.8	1.0	1.0	1.0	1.0	1.0	1.0
2	1.0	1.0	1.0	1.0	7.6	1.0	1.0	1.0	1.0	1.0
3	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	2.7	1.0
4	5.5	1.0	1.0	1.0	1.0	1.0	1.0	1.0	6.7	1.0
5	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	3.1	1.0
6	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	3.9	1.0
7	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	3.1	1.0
8	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	4.0	1.0
9	0.7	2.1	0.9	1.0	1.6	3.9	1.5	2.8	1.0	3.3
10	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
11	0.8	1.5	6.9	0.7	1.7	0.3	1.0	1.2	0.8	1.0
12	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	2.3	1.0
13	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
14	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
15	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.4	1.0
16	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
17	0.5	2.0	1.0	0.7	1.0	0.3	1.0	0.1	0.1	0.7
18	1.2	1.0	1.0	1.0	1.0	3.4	4.5	1.0	1.0	2.4
19	3.2	1.0	1.0	1.0	1.0	2.5	3.8	1.7	1.0	1.0
20	0.8	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.6	13.5
21	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
22	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.2	1.0
23	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
24	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
25	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
26	4.1	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
27	1.9	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0

ZONE	11	12	13	14	15	16	17	18	19	20
1	0.2	1.0	1.0	1.0	1.0	1.0	0.6	1.1	5.3	0.6
2	2.7	1.0	1.0	1.0	1.0	1.0	9.2	1.0	1.0	1.0
3	40.2	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
4	1.3	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
5	5.3	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
6	0.5	1.0	1.0	1.0	1.0	1.0	1.0	3.7	3.5	1.0
7	0.4	1.0	1.0	1.0	1.0	1.0	1.0	5.4	2.9	23.2
8	1.2	1.0	1.0	1.0	1.0	1.0	1.0	2.2	1.5	1.0
9	0.8	1.8	1.0	1.0	1.0	1.0	0.2	0.1	1.0	1.0
10	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
11	1.0	0.8	0.8	0.0	1.1	0.1	1.2	1.9	2.1	0.2
12	4.2	1.0	1.0	1.0	1.0	1.0	0.4	1.0	1.0	1.0
13	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
14	0.1	1.0	21.5	1.0	1.0	1.0	17.7	0.6	1.0	1.0
15	1.3	1.0	1.0	3.9	1.0	1.0	2.0	1.0	1.0	1.0
16	0.1	1.0	1.0	1.0	1.0	1.0	33.6	1.0	1.0	1.0
17	0.8	1.9	2.1	5.1	1.8	4.1	1.0	0.7	0.6	1.3
18	3.3	1.0	1.0	0.4	1.0	1.7	0.2	1.0	1.0	4.6
19	3.6	1.0	1.0	1.0	1.0	1.0	0.5	0.1	1.0	8.1
20	0.3	1.0	1.0	1.0	1.0	1.0	1.2	1.5	14.1	1.0
21	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
22	1.3	1.0	1.0	1.0	1.0	1.0	2.1	1.0	1.5	1.0
23	2.1	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0

24	14.2	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
25	0.2	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
26	0.3	1.0	1.0	1.0	1.0	1.0	0.7	1.0	1.0	1.0
27	0.3	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0

ZONE	21	22	23	24	25	26	27
1	5.2	1.0	1.0	1.0	1.0	1.5	1.0
2	1.0	1.0	1.0	1.0	1.0	1.0	1.0
3	1.0	1.0	1.0	1.0	1.0	1.0	1.0
4	1.0	1.0	1.0	1.0	1.0	1.0	1.0
5	1.0	1.0	1.0	1.0	1.0	1.0	1.0
6	1.0	1.0	1.0	1.0	1.0	1.0	1.0
7	1.0	1.0	1.0	1.0	1.0	1.0	1.0
8	1.0	1.0	1.0	1.0	1.0	1.0	1.0
9	1.0	1.0	1.0	1.0	1.0	0.6	1.0
10	1.0	1.0	1.0	1.0	1.0	1.0	1.0
11	1.4	1.0	1.8	6.2	0.7	0.3	0.1
12	1.0	1.0	1.0	1.0	1.0	1.0	1.0
13	1.0	1.0	1.0	1.0	1.0	1.0	1.0
14	1.0	7.3	1.0	1.0	1.0	1.0	1.0
15	1.0	1.0	1.0	1.0	1.0	1.0	1.0
16	1.0	1.0	1.0	1.0	1.0	1.0	1.0
17	2.1	2.0	1.0	1.0	1.0	1.6	1.0
18	1.0	0.8	6.4	1.0	1.0	0.7	1.0
19	1.0	1.6	1.0	1.0	1.0	1.0	1.0
20	1.0	5.1	1.0	1.0	1.0	1.0	1.0
21	1.0	1.0	1.0	1.0	1.0	1.0	1.0
22	1.0	1.0	1.0	1.0	1.0	4.5	1.0
23	1.0	1.0	1.0	58.8	1.0	1.0	1.0
24	1.0	1.0	1.0	1.0	1.0	1.0	1.6
25	1.0	1.0	1.0	1.0	1.0	37.3	1.0
26	1.0	1.0	1.0	0.3	1.0	1.0	2.4
27	1.0	1.0	1.0	1.0	3.5	1.9	1.0

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