NORTH DAKOTA RAIL LINE-SEGMENT BENEFIT-COST MODEL: NORTH DAKOTA RAIL SERVICES PLANNING STUDY

by

Denver D. Tolliver

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UPPER GREAT PLAINS TRANSPORTATION INSTITUTE
NORTH DAKOTA STATE UNIVERSITY
P. O. BOX 5074
FARGO, NORTH DAKOTA 58105

NOVEMBER 1989

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NORTH DAKOTA RAIL LINE SEGMENT MODEL:
SUMMARY OF CHANGES AND REVISIONS

Each year, the state of North Dakota invests substantial sums of money in the rehabilitation of light-density rail lines. The funds are either drawn from a revolving loan account maintained by the North Dakota State Highway Department (NDSHD), or consist of federal grants under the Local Rail Services Assistance Act (LRSA).

In investing rail funds, the NDSHD is the guardian of the public interest. The scarce funds are invested so that they improve the economic welfare of the state, yielding positive or net societal benefits. An economic analysis of each potential project is typically undertaken, which assesses the benefits and costs of each alternative. The analyses are performed with the assistance of a computer model developed and maintained at the Upper Great Plains Transportation Institute (UGPTI). The purpose of this paper is to highlight the scope, functions, and history of the rail analysis process, and to describe two technical publications which detail the methodology and data requirements.

HISTORY AND BACKGROUND

In 1978, Congress passed the Local Rail Services Assistance Act, which appropriated federal funds for purposes of state rail planning and the preservation of light-density services. The law requires that each LRSA project application have an economic analysis attached, which details the projected benefits and costs of the proposed expenditure. To assist states in the development of analytical procedures, the Federal Railroad Administration (FRA) developed a set of benefit-cost guidelines (see: FRA, 1980). The guidelines were not prescriptive in nature, but were designed to allow states individual latitude within the overall benefit-cost framework.

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In 1980, the NDSHD contracted with the Upper Great Plains Transportation Institute and the Agricultural Economics Department of North Dakota State University to develop a rail-line evaluation model. During the course of the project, a specific benefit-cost methodology was developed for analyzing Class I carrier light-density lines in North Dakota. The methodology was translated into a computer program, and tested in 1982. Both the methodology and computer program are documented in a technical publication by Mittleider, Tolliver, and Vreugdenhil (1983), entitled "North Dakota Line-Segment Analytical Model (NOLAM) -- A Technical Description." This publication stills provides a good, baseline description of the rail benefit-cost methodology and primary data sources.

NOLAM was accepted by the FRA as a thorough, sound analysis procedure. The programs were used many times between 1981 and 1987 to evaluate potential Burlington Northern (BN) and Soo Line projects. Although the methodology and procedures in NOLAM were sound, several events occurred during the 1980's which obselesced certain of the model's functions, and necessitated an updating of the program. Accordingly, the NDSHD entered into a contract with the UGPTI to revise and expand NOLAM.

One of the major forces which obselesced NOLAM was the growth of local and regional railroads. The rail cost and operations procedures in NOLAM were not designed to analyze short-line carriers. The smaller railroads are really a separate sector of the industry, with distinctly different cost and economic characteristics. So, a separate costing procedure is needed if the NDSHD is to underwrite the rehabilitation of short-line segments.

In addition to a short-line costing subroutine, several other enhancements have been made to the original line analysis procedure. The modifications are described in the following section of the report. But before preceding, it should be reiterated that the basic

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methodology, analytic process, and data inputs have not changed. The description of NOLAM contained in the 1983 publication by Mittleider, Tolliver, and Vreugdenhil, is still one of the primary documents detailing the North Dakota rail-line evaluation procedure.

SUMMARY OF CHANGES

As noted previously, the primary change in the analysis procedure is the addition of a short-line railroad costing subroutine. The short-line algorithm is analogous to the Class I carrier routine of NOLAM. Both procedures follow essentially the same process. First, a set of unit costs describing light-density railroad activities is computed. Second, an operating model is formulated which predicts the annual levels of key output or service measures, such as the number of train-hours and car-days on-branch. Third, the annual service units are multiplied by the unit costs to estimate annual railroad costs. The major difference between the Class I subroutine of NOLAM and the new short-line costing algorithm lies in the computation of unit costs. In the following paragraphs of the report, the local/regional railroad costing procedure is described, followed by a discussion of other revisions to NOLAM which have concurrently been made.

Short-Line Subroutine

In this project, a set of on-branch and off-branch unit costs have been estimated for grain short-line carriers in the Upper Great Plains. There are two primary sources of data for the unit costs: (1) nationwide survey data, and (2) actual operating and expense data for the Red River Valley & Western (RRV&W) railroad.

The RRV&W data file was compiled in 1988, as part of the Wahpeton-to Oakes and Carrington-to-New Rockford LRSA applications. During the course of the benefit-cost studies, a variety of operating statistics, such as annual train-miles and locomotive-hours,

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were developed for each RRV&W train route. Annual transportation expenses (e.g. crew salaries, fringe benefits, highway vehicle costs, radios and supplies, etc.) were compiled from RRV&W accounting data. Then, using the operating statistics and accounting expenses, a set of transportation unit costs were computed. Most of the unit costs were based on train-miles of operation. Locomotive ownership and maintenance unit costs (exclusive of fuel) were computed from capital lease payments made by the RRV&W in 1988. Other operating unit costs were calculated in a similar manner.

In the revised model, capacity, line-related unit costs -- normalized maintenance of way, net liquidation value, and property taxes per mile -- are computed from economic-engineering formulas, or from actual expense data for each line. Locomotive fuel expenses are estimated using a modified Davis formula and current unit prices for diesel fuel. The overall short-line analysis procedure, including a description of the locomotive fuel and capacity cost calculations, is detailed in a technical publication by Tolliver and Lindamood entitled "An Analysis of the Benefits and Costs of Rehabilitating the Wahpeton-to-Independence Rail Line", UGPTI, 1989.

Improvements In On-Branch Costing Procedures

In NOLAM, branch-line normalized maintenance of way (NMOW) costs were typically derived through engineering judgement. Roadmasters or track supervisors from the participating railroad were asked to supply estimates of NMOW before and after rehabilitation.

Engineering judgement is still a primary source of maintenance cost data in the line analysis procedure. However, professional judgement is now supplemented by a maintenance of way costing model. The model is an economic-engineering formula, which involves four basic steps:

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1. The lives of various rail assets are projected through deterioration models

2. The quantities of assets replaced over time are estimated

3. The costs of the renewals or maintenance activities are estimated from unit costs and productivity factors

4. All future expenditures are translated into present dollars

The asset life models are described in Appendix E of Tolliver and Lindamood (1989).

If professional engineering and model projections diverge, then the inputs and assumptions are carefully reviewed and appraised. If the two types of estimates cannot be reconciled, an average of the figures is typically used. This approach is currently followed in the estimation of both short-line and Class I carrier maintenance of way costing. However, different unit costs and productivity factors are used for each type of railroad.

Locomotive fuel costs in NOLAM are estimated from system average data. So, a separate fuel costing subroutine has been developed, and is currently being used in the analysis procedure. For each segment of a line, the train resistance is calculated from a modified Davis formula. The tractive effort is then computed from the velocity and horsepower needed to overcome the train resistance. Next, taking acceleration and deceleration into account, the number of horsepower-hours (HPH) needed to traverse the segment is calculated. In the following step of the procedure, the efficiency rating of a typical branch-line locomotive unit is used, in conjunction with the HPH requirements, to project the gallons of fuel consumed. The quantity consumed is then multiplied by the cost per gallon to derive locomotive fuel expenses. Again, the same procedure is applicable to both Class I and local lines.

Off-Branch Costing Procedures

The rail off-branch costing procedure involves essentially the same methodology described in NOLAM. However, several improvements have been made. First, current Rail Form A's have been obtained for all Class I carriers, and are being maintained in a data base accessible by the program. Second, waybill data are now used to derive more accurate estimates of off-branch parameters, such as: (1) volumes to particular markets, (2) average length of haul, (3) car-type characteristics, and (4) non-grain traffic attributes. The off-branch costing procedure is detailed in Mittleider, Tolliver, and Vreugdenhil (1983), and Tolliver and Lindamood (1989).

Truck Costing Procedure

NOLAM contains an agricultural truck costing procedure. However, the unit costs are outdated (they are at 1980 levels). Plus, unit costs for non-agricultural truck-types are not included in the model. Both shortcomings have been addressed in this revision.

Updated unit costs have been estimated for North Dakota agricultural truckers by Dooley, Wilson, and Bertram (1989). Costs for bulk and dry fertilizer, lumber, sand and gravel, and other types of traffic have been developed by the author. The non-grain unit costs have been computed from economic-engineering data developed by Northwest Economic Associates (1982), which have been updated and adjusted to fit North Dakota's operating and tax environment.

Most of the other revisions in the line analysis procedure relate to changes in data base management, programming, or data collection. Some of the most important features of the new computer program are described in the following section of the paper.

PROGRAM DESIGN AND FUNCTIONS

The primary purpose of this section is to describe the computer procedures, data files, and related software which comprise the North Dakota Rail Line Segment Model (NDRLSM). Much of the discussion builds on the basic design and program function concepts explained in the following paragraphs.

Five fundamental calculations must be made in order to estimate the benefits of a project. They are:

1. Cost savings on existing traffic

2. Changes in consumers' surplus

3. Changes in producers' surplus

4. Changes in highway replacement and rehabilitation costs

5. Changes in local spending levels.

The theoretical concepts and analytic methods underlying the computations are highlighted in Mittleider, Tolliver, and Vreugdenhil (1983). The discussion in this section focuses on the computer programs and procedures, and their relationships to each other.

Each of the fundamental computations requires a range of input values and/or complex intermediate calculations. The primary data manipulations and calculations form a natural basis for delineating the program into modules (or phases), and subroutines.

Major Computations

The five fundamental computations result in eight principal data calculations. For each line, the following totals must be computed under both the base case and the rehabilitation scenario:

1.   Annual rail volume
     a) Cwt
     b) Carloads

2.   Annual truck volume
     a) Cwt
     b) Annual trips

3.   Annual rail revenues

4.   Annual rail costs
     a) On-branch
     b) Off-branch

5.   Annual truck revenues

6.   Annual truck costs

7.   Highway route attributes
     a) Miles
     b) Strength
     c) Condition

8.   Annual truck equivalent single axle loads (ESALs).

The calculation of each value requires the computation of many individual items which are summed to obtain line totals. For example, rail revenues include freight revenues for single-car, multiple-car, and trainload shipments over a wide range of destinations. Similarly, rail costs consist of car ownership, locomotive, maintenance of way, clerical, and a host of other cost components, each of which must be estimated.

Program Phases Or Modules

The rail line-segment modeling process may be thought of as involving three major phases:

1.   Data base creation and unit cost or factor computation,

2.   Line segment data entry, parameter modification, and benefit-cost caluclations,

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3. Interpretation and report generation.

The NDRLSM utilizes both primary and secondary data sources. Primary data are generally collected by survey (or other form of measurement) for a carrier, a line, or some other relevant unit. An example of a primary data source is the questionnaire administered to the owning railroad to obtain non-grain traffic levels. An example of a secondary data source is the UGPTI grain and oilseed shipment data base which contains raw (or crude) shipment statistics for each grain elevator in North Dakota.

The NDRLSM uses a sizable array of secondary data sources. The purpose of Phase I procedures is to operate on the raw data sources and create usable output data sets which can be used during line benefit-cost computations. Phase I procedures are, in essence, "library procedures." Their end purpose is to create formatted data sets which are stored in a tape "library" for repeated, subsequent use by the benefit-cost model.

Phase II procedures compute benefits and costs for a given line-segment. They include procedures designed to input data, display and update files, or perform necessary functional calculations.

The purpose of Phase III procedures is to generate a set of tables, graphs, and statistics for a given line-segment. They utilize the output of Phase II procedures, as well as some of the Phase I-created library files.

Phase II procedures are discussed in depth later in the paper. But first, the individual Phase I procedures are highlighted.

Phase I Procedures

All Phase I procedures follow a common process.

1. A file containing raw data is created or obtained from a secondary source.

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2. A SAS program procedure operates on the raw data file, manipulating the data items, performing computations, reformatting records, or carrying-out other related activities.

3. A formatted SAS data set is created by the procedure on tape (or cartridge).

Each procedure is typically executed only once a year, or when new data are available. However, the series of data sets which the procedures create are used in subsequent line analyses throughout the year.

Grain Shipment Procedure (GRNLIB)

North Dakota branch lines are heavily grain-dependent. Fortunately, a data base already exists (the UGPTI/PSC grain and oilseed shipment file) which can be used to compute rail and truck shipments from a given branch line in the state. This is the function of the GRNLIB procedure.

The GRNLIB procedure creates a SAS shipment file from raw UGPTI/PSC data. The file contains the cwts shipped to out-of-state markets and to in-state processors for the most current four-year period. Unlike the raw UGPTI data base, the output shipment file is organized on a calendar-year basis. This file (called GRNSHIP) is keyed by year, line-segment, city, commodity, and mode.

The GRNLIB procedure also creates a second SAS data set: a transshipment file called TRNSHIP. This data set is keyed by year and city. It contains the annual cwts shipped to other elevators for subsequent reshipment by rail and truck.

Nongrain Traffic Procedure (NONGRN)

Nongrain traffic on North Dakota branch lines consists primarily of fertilizers, farm machinery, lumber and related products, or other farm products (such as potatoes or sugar beets). Unlike grain traffic, there is no ready-made data base of nongrain shipments. So, annual volumes must be collected by survey.

Traffic data collection involves compromises among confidentiality, specificity, and practicality criteria. Both railroads and shippers consider traffic data to be proprietary in nature. Both feel that they may be harmed by the release of specific market, rate, or other information.

The design of the nongrain data collection process is essentially as follows. First, an attempt is made to obtain the needed data from the owning railroad. A survey is administered to the carrier which asks for the number of carloads originated and terminated at each station on the line during the latest calendar year, by STCC. These data should be easy for the carrier to compile. In fact, the owning railroad may already have accumulated the data at the station level. So, the resource cost should be minimal. If the carrier refuses to supply individual station data (for confidentiality or other purposes), they are requested to supply the aggregate data at the line-segment level. In such instances, the shipment origins and terminations are assumed to occur at the midpoint of the line-segment.

If the carrier will not or cannot supply the data at the line-segment level, then shippers on the line will be asked to supply as much data as possible. There are potential problems with a shipper survey. Small, branch-line shippers may not have detailed computerized shipment data. So, in some instances, they may not be able to supply the needed data even if they wish to do so. In other instances, shippers may be able to

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provide some or all of the data, but only at high resource costs. Potential shipper surveys are further complicated by the fact that the number, name, and location of rail shippers (other than grain elevators) is not readily available (unless volunteered by the carrier). All things considered, the preferred source of nongrain shipment data is the owning railroad.

Short-Line Unit Cost Procedure (SHRTLIB)

The SHRTLIB procedure computes a set of variable and fixed unit costs for existing local or regional carriers. The procedure uses special study factors and data discussed previously. The basic purpose of the procedure is to create a SAS data set called SHRTUNIT, which is used by the main costing procedure.

Grain Waybill Library Procedure (GWBLIB)

The GWBLIB procedure creates a file of rail waybill cost and performance factors from the most recent waybill tapes. These factors are used to adjust UGPTI grain shipment data.

UGPTI shipment statistics give only broad general market areas for destinations other than Minneapolis and Duluth. Furthermore, UGPTI data do not give the number of annual carloads and the types of equipment used. The waybill sample is used to determine the frequency of termination points within broad geographic groupings, as well as the equipment types used. For example, the PSC destination territory of Midland and SW States involves 17 different states and many individual markets. This information is not specific enough to cost the shipments. The ND waybill sample gives the actual destination stations within each broad market. The procedure GWBLIB computes the

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frequency distribution of the principal markets within the Midland/SW category at the

Business Economic Analysis (BEA) level (or below). These frequencies are then used to

factor the UGPTI data into BEA termination areas.

The record structure of the output file (GRNWB) is given in Table 1.

TABLE 1. RECORD STRUCTURE OF THE GRAIN WAYBILL FILE*	
VARIABLE	DESCRIPTION
COMM	Commodity code
PNWBEAS	Number of PNW BEA's on record
SEATTLE	Percentage of PNW cwts terminated in Seattle
PORTLAND	Percentage of PNW cwts terminated in Portland
YAKIMA	Percentage of PNW cwts terminated in Yakima
BOISE CITY	Percentage of PNW cwts terminated in Boise City
POCOTELLO	Percentage of PNW cwts terminated in Pocotello
MSWBEAS	Number of Midlands/SW BEA's on record
AMARILLO	Percentage of MSW cwts terminated in Amarillo
DENVER	Percentage of MSW cwts terminated in Denver
SALT LAKE CITY	Percentage of MSW cwts terminated in Salt Lake
PHOENIX	Percentage of MSW cwts terminated in Phoenix
LOS ANGELES	Percentage of MSW cwts terminated in Los Angeles
SAN DIEGO	Percentage of MSW cwts terminated in San Diego
STOCKTON	Percentage of MSW cwts terminated in Stockton
FRESNO	Percentage of MSW cwts terminated in Fresno
BILLINGS	Percentage of MSW cwts terminated in Billings
GREAT FALLS	Percentage of MSW cwts terminated in Great Falls
OMWBEAS	Number of Other Minnesota & Wisconsin BEA's
MILWAUKEE	Percentage of OMW cwts terminated in Milwaukee
APPLETON	Percentage of OMW cwts terminated in Appleton

TABLE 1. RECORD STRUCTURE OF THE GRAIN WAYBILL FILE*	
VARIABLE	**DESCRIPTION**
DULUTH	Percentage of OMW cwts terminated in Duluth
MINNEAPOLIS	Percentage of OMW cwts terminated in Minneapolis
OTHBEAS	Number of Other BEA's
CHICAGO	Percentage of OTH cwts terminated in Chicago
CAR-TYPE 1	Main ICC car-type
PCTCTY 1	Percent of shipments in car-type 1
CAR-TYPE 2	Second ICC car-type
PCTCTY 2	Percentage of shipments in car-type 2
CAR-TYPE 3	Third ICC car-type
PCTCTY 3	Percent of shipments in car-type 3

*The BEA's shown in this table are samples of potential BEA's, and do not constitute an inclusive list.

Nongrain Waybill Library (NGWLIB) Procedure

There is no station-specific secondary source of data for nongrain shipments. Consequently, a carrier survey must be administered to estimate the rail nongrain carloads originated and terminated on-line during the latest calendar year. The carrier survey provides on-line shipment origins and terminations, but does not supply the traffic characteristics, revenues, or other data needed by the NDRLSM.

The purpose of the NGWLIB procedure is to estimate a set of mean statistics from the rail waybill sample and store them in a SAS data set, on tape. The major waybill statistics and performance factors computed are:

1.   Mean revenue

2.   Mean distance

3.   Mean load factor

4.   Mean tare weight.

There are several factors which may cause variations in the statistics within the state waybill subsample. The first is the railroad.[1] The second is the car-type.[2] The third is geographic distribution. Certain parts of state are closer to or have better access to particular markets. Consequently, the off-line origin and termination points, the distances, and the revenues may vary between regions.

The general method of handling variability within the ND waybill subsample is to compute values within each subgroup. For example, car type variations in the waybill sample are handled by computing values for each subgroup in the sample. For instance, if a particular type of fertilizer is shipped in tank cars (as a solution) and in covered hopper cars (in bulk), waybill performance factors and statistics are computed for each subgroup. Geographic and railroad differences are handled similarly.

The record format of the nongrain waybill library data set generated by the NGWLIB procedure is shown in Table 2.

TABLE 2. STRUCTURE OF THE NONGRAIN WAYBILL LIBRARY DATA	
VARIABLE	**DESCRIPTION**
COMM	Commodity
RR	Railroad Abbreviation
BEA	Business Economic Analysis area

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[1]The off-line origin and termination points may differ among carriers. In addition, route, cost, and equipment factors may vary. Together, these variations may affect mean revenues and distances.

[2]Each car-type has a unique load factor and tare weight. Furthermore, the off-line origin or termination points for the commodity may differ among car types, causing or accentuating variations in revenues and distances.

TABLE 2. STRUCTURE OF THE NONGRAIN WAYBILL LIBRARY DATA	
VARIABLE	**DESCRIPTION**
CTYP 1	Main ICC Car Type
PCTYP 1	Percent of Tonnage in car-type 1
CTYP 2	Second ICC Car Type
PCTYP 2	Percent of Tonnage in Car-Type 2
MDIST 1	Mean Trip Distance: Car-Type 1
MDIST 2	Mean Trip Distance: Car-Type 2
MDIST 3	Mean Trip Distance: Car-Type 3
MTREV 1	Mean Total Revenue: Car-Type 1
MTREV 2	Mean Total Revenue: Car-Type 2
MTREV 3	Mean Total Revenue: Car-Type 3
MINCH 1	Mean Interchanges: Car-Type 1
MINCH 2	Mean Interchanges: Car-Type 2
MINCH 3	Mean Interchanges: Car-Type 3
MTARE 1	Mean Tare Weight: Car-Type 1
MTARE 2	Mean Tare Weight: Car-Type 2
MTARE 3	Mean Tare Weight: Car-Type 3
LF 1	Mean Load Factor: Car-Type 1
LF 2	Mean Load Factor: Car-Type 2
LF 3	Mean Load Factor: Car-Type 3
RRML 1	O/T Carrier Miles: Car-Type 1
RRML 2	O/T Carrier Miles: Car-Type 2
RRML 3	O/T Carrier Miles: Car-Type 3
R4ML 1	Region Four Miles: Car-Type 1
R4ML 2	Region Four Miles: Car-Type 2
R4ML 3	Region Four Miles: Car-Type 3
R7ML 1	Region Seven Miles: Car-Type 1
R7ML 2	Region Seven Miles: Car-Type 2
R7ML 3	Region Seven Miles: Car-Type 3

Grain Traffic Distances

The UGPTI/PSC destinations are a combination of specific processing or consumption points and broad market territories. Actual route miles may be estimated for Minneapolis/St. Paul and Duluth/Superior traffic using tariff distances and circuity factors. At both destinations, North Dakota shipments are assumed to terminate within the switching limits of the serving classification yard. So, specific origin-to-destination miles can be estimated with confidence. The computation of mileages for other market territories is more complicated. Both tariff distances and rail waybill sample data are used. The process is essentially as follows.

1. Broad UGPTI destination groupings are disaggregated into BEA's;

2. Major egress point from North Dakota are defined (e.g. Fargo, Grand Forks, Beach, Williston, etc.);

3. For each sample waybill observation, the following items are determined:

    a.) The egress point or gateway (which depends on the destination)
    b.) The mileage from origin to gateway
    c.) The total distance on the waybill record;

4. The mileage from the waybill origin to the gateway is computed and subtracted from the total distance on the waybill record;

5. The weighted-average distance from each N.D. gateway to each terminating BEA (TBEA) is computed for each grain and oilseed commodity group in the waybill sample;

6. The mileages are then "backed-up" to the regional classification yards in the state using tariff distances (this gives the weighted-average distance from each division point in the state to each TBEA for each commodity group;

7. When an individual branch line is analyzed, the distance from the station to the regional classification yard (the origin way train miles) is added to the classification yard-to-destination mileage to yield the expected distance from a given branch-line station to a given TBEA.

This process yields a statistically valid weighted-mean distance from a given N.D. branch-line station to each TBEA for high-volume commodities such as wheat, barley, and corn. In addition, the process should also yield reasonable means for lower-volume traffic such as sunflowers, oats, flax, etc. However, because of the smaller number of sample observations, the level of confidence of the computed means will be much lower.

Nongrain Traffic Mileages

The actual origins and destinations for nongrain traffic such fertilizers, farm machinery, potatoes, sugar beets and related products, lumber, or other shipments are unknown. On light-density branch lines, inbound fertilizer and machinery movements constitute the bulk of the rail traffic. The range of origins for these shipments can be determined, on a statewide or BEA basis, from the waybill sample. Using these "typical" origins, mean distances can be computed for each N.D. BEA from the waybill sample. Again, for large volume movements such as fertilizer, a high degree of confidence can be placed in the means.

Distances for nongrain originated traffic (such as potatoes) are computed in the same manner as grain shipments to other markets.

Rail Form A Library Procedure (RFALIB)

As noted previously, a new Rail Form A (RFA) data base has been obtained from the ICC. The date base presently contains 1987 data for all Class I carriers. However, it can be updated periodically by obtaining new source tapes from the Commission.

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The raw RFA tape contains all "A" and "B" core values for each carrier. The core values represent either unit costs, operating factors, account expenses, or related inputs used in the formula. For example, core location B(3261) is the cell address which contains the raw gross ton-mile unit cost.

Only a relatively small number of the core values are actually needed for the off-branch model. The purpose of the RFALIB procedure is to read the raw tape data set, extract the needed RFA inputs, assign variable names to the values, and store the results in a SAS data set, keyed by railroad abbreviation. The processed values can then be accessed by the main costing algorithm during a given application.

Grain Rate Library Procedure (GRTLIB)

Grain shipments comprise the majority of branch-line flows in rural North Dakota. Thus, grain rates are an important input to the revenue procedure. A set of rail tariffs for the BN and the Soo Line are maintained at the UGPTI. A SAS data file is created periodically from the tariffs, containing rail grain rates to major destinations. The file is keyed by city, commodity, and destination. The keys allows the file to be merged with the grain shipment file later in the program.

The purpose of this section of the report has been to describe the primary library procedures involved in Phase I of the modeling process. Collectively, the procedures create a SAS data library containing many of the inputs needed to analyze a line segment. The paper now turns to a description of Phase II of the process, which contains the actual computational algorithms.

Phase II

Phase II involves four major processes:

1. Line parameter input,

2. Default parameter modification,

3. Main program execution,

4. Output of results.

A set of inputs must be entered for each line analyzed. In essence, a collection of user-defined files are created for each run, containing the basic inputs needed to evaluate a particular segment. The files are "user-defined" in the sense that the program will not supply values or decide which files to use. The analyst must enter certain minimal parameters, without which the program will not execute. In addition, the analyst has the option of using default extended parameters or supplying his or her own values. Thus, unlike the Phase I library procedures, the analyst must exercise a great deal of discretion and independent judgement in Phase II of the program.

Some of the principal user-defined input files are described in the following section of the report.

Major Input Files

The primary input files are displayed in Table 3.

TABLE 3. USER FILES		
File Name	**Description**	**Status**
DIRECT	Station directory	Required
STATION	Station carload data	Required
STCC	Commodity volume	Required
LINE	Basic line-segment data	Required
EXTENDED	Default parameters	Optional

The purpose of the directory file is to keep track of the stations on the line, and allow direct access of other data files, by city. The station directory resembles the structure shown in Table 4.

TABLE 4. STATION DIRECTORY	
Station Name	**On-Line Distance**
City 1	10
City 2	20
City 3	30
City 4	40

The station data file contains most of the information necessary for costing. The station files are "m" x "n" matrices where the number of relevant (non-zero) rows is a variable which changes from station-to-station. The station file structure is illustrated in Table 5.

TABLE 5. STATION FILE STRUCTURE			
Variable	**Description**	**Range**	**Type**
ACT	Car Type Code	1-18	Integer
	RAILROAD CARS O/T		
RR 1	Unit Train Service	> = 0	Integer
RR 2	Multiple Car > = 20	> = 0	Integer
RR 3	Multiple Car < 20	> = 0	Integer
RR 4	Single Car	> = 0	Integer
	PRIVATE CARS O/T		
PL 1	Unit Train Service	> = 0	Integer
PL 2	Multiple Car > = 20	> = 0	Integer
PL 3	Multiple Car < 20	> = 0	Integer
PL 4	Single Car	> = 0	Integer
	TONS OF FREIGHT O/T		
TONS 1	Unit Train Service	> = 0	Integer
TONS 2	Multiple Car Service	> = 0	Integer
TONS 3	Single Car Service	> = 0	Integer
	AVG. CARS PER SHIPMENT	>= 0	Integer
ACPS 1	Unit Train Service	> = 0	Integer
ACPS 2	Multiple Car Service	> = 0	Integer
ACPS 3	Single Car Service	> = 0	Integer

As Table 5 illustrates, there are 18 possible car-types. However, a given station is not likely to use all 18 car-types. Four or five is a more realistic figure. It is not possible to predict which five car-types will be used. So, the dimensions of the matrix and the rows which are used may vary with each application.

The "LINE" file contains a set of variables related to the line-segment as a whole rather than to any particular station or class of equipment. The file consists of a combination of character, integer, real, and logical variables. The file layout is given in Table 6.

TABLE 6. LINE FILE STRUCTURE			
Variable	**Description**	**Type**	**Range**
RR	Railroad Initials	Char.	- - -
LEN	Length of line segment	Integer	> = 0
ANOVHT	Annual overhead (through) trains	Integer	> = 0
LTYPE	Line type (branch or main)	Logical	0, 1
CCROAD	Cost of Capital Rate: Road	Real	0-1
CCEQUIP	Cost of Capital Rate: Equip.	Real	0-1
PROPTAX	Property Tax Per Mile	Integer	> = 0
OWNSTAT	Ownership Status	Logical	0, 1

The variable OWNSTAT in Table 6 indicates whether the carrier owns the line-segment or operates under trackage rights. The type of railroad (short-line or Class I) is determined from the initials.

Table 7 shows the layout of the commodity file. The commodity code groupings represent general classifications or groups (e.g. grain).

TABLE 7. STCC FILE STRUCTURE			
Variable	**Description**	**Type**	**Range**
STCC	Standard Transportation Com. Code	Integer	1-66
TONS	Tons O/T On-Line	Integer	> = 0

In addition to the station, line-segment, and commodity files, a range of extended paramters are needed to analyze a line. The extended parameter file is shown in Table 8. Some of the parameters -- such as NMOW, NLV, crew size, and property taxes -- should be supplied for each application (and typically are). Most of the remaining extended parameters are computed internally by the algorithm.

TABLE 8. EXTENDED PARAMETERS			
Variable	Description	Type	Default
MYARD	Miles of yard track	Integer	0
MWAY	Miles of way switching track	Integer	.
NMOW	Normalized maintenance of way	Integer	6,500
REHAB	Annualized rehab. cost/mile	Integer	0
ROWFEE	Trackage right fees/year	Integer	0
CREWTYPE	Crew type (road or yard)	Logical	0
CREW	Crew size	Integer	4
YLTYPE	Type of yard locomotive	Logical	0
RLTYPE	Type of road locomotive	Logical	0
OHGTT	Weight of overhead trains	Real	.
SWITCH ENGINE MINUTES PER CAR			
SEM 1	Single car	Real	12
SEM 2	Multiple car <<20) factor	Real	.69
SEM 3	Multiple car <>=20) factor	Real	.40
SEM 4	Unit train factor	Real	.25
WTRNS	Annual way trains on-line	Integer	.
WTRND	Avg. distance per way trip	Integer	.
TONMLK	Ton miles lake transfer	Integer	0
TON ORE	Tons handled - ore terminals	Integer	0
TON COAL	Tons handled - coal terminals	Integer	0

TABLE 8. EXTENDED PARAMETERS			
Variable	**Description**	**Type**	**Default**
TONOTM	Tons handled - other marine	Integer	0
AUTOS	Autos loaded/unloaded on-line	Integer	0
USTH	Train hours on-line	Integer	0
USTHYD	Train hours - yard switching	Integer	0
USLHYD	Loco. yard switching hrs.	Integer	0
USLH	Road Locomotive hours	Integer	0
WORKCAP	Working capital per day	Integer	0
PROPT	Property tax per mile	Integer	366
NLV	Net liquidation values per mile	Integer	9,443

Computer Environment

NOLAM was written in FORTRAN 66. The revised computer algorithm is written in SAS. It is patterned after the process described in Tolliver, Mittleider, and Vreugdenhil (1983). Whereas, NOLAM executed under IBM-VSPC, the revised programs run under CMS, in batch mode. CMS is a better, more powerful operating environment.

The procedures were written in SAS to take advantage of the data management, file processing, and statistical capabilities of the software (as well as the CMS interface). The use of SAS permits the development of an integrated set of programs, starting with the creation of Phase I files, and culminating in a set of reports, graphs, and statistics. Once the numerical values have been computed in Phase II of the program, they are stored in SAS data sets. The output data sets are then accessed by SAS statistical or graphic procedures.

The purpose of this section of the report has been to highlight the computer software maintained at the UGPTI, noting major differences between the updated program and its

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predecessor, NOLAM. In conclusion, the basic benefit-cost methodology described in Tolliver, Mittleider, and Vreugdenhil (1983) remains unchanged. The purpose of Phase II of the Rail Services Planning (RSP) study is to update and improve the original model, and extend its capabilities to local and regional railroads. The revisions have been described in previous sections of the report. For a more detailed description of the short-line costing procedure, and revised maintenance of way and locomotive fuel subroutines, the reader is referred to Tolliver and Lindamood (1989).

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