PN-ABC-467

Postharvest Grain Systems R&D

Special Report No. 26
December 1989

TRANSPORTATION LINEAR PROGRAM FOR USE ON MS-DOS MICROCOMPUTERS

RELEASE 2

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TRANSPORTATION LINEAR PROGRAM FOR USE ON MS-DOS MICROCOMPUTERS

RELEASE 2

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UNITED STATES DEPARTMENT OF STATE

AID/DAN-4144-A-00-5095-00
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Contribution Number 90-232-C, Kansas State Agricultural Experiment Station, Kansas State University, Manhattan, Kansas

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SECTION I

INTRODUCTION

The Fortran computer model for Transportation Linear Programming contained herein represents direct adaptation of the corresponding Fortran IV program for mainframe computer previously published by the Kansas State University Food and Feed Grains Institute under predecessor agreements with the U. S. Agency for International Development. The compiled microcomputer version of the Transportation Linear Program incorporates all features of the latest version of the mainframe program while providing additional flexibility to the microcomputer user.

Differences between the mainframe version and the current microcomputer version include the following:

1. Input steps for command instructions and data input are modified to better suit microcomputer users, especially those familiar with popular electronic spreadsheet software such as LOTUS 1-2-3.

2. Results of computational routines can be stored in disk files for access by subsequent runs and/or programs, so that user options are enhanced.

3. The Alternative Math library used to Link the current program facilitates rapid computation with sufficient accuracy for accounting purposes better than other math libraries and can operate on all IBM-compatible hardware, whether or not a 8087 coprocessor is available. For those who have an 8087 coprocessor, a version linked with the 8087 library is available.

4. The micro version is dimensioned for up to 200 origins by 15 destinations, or vice versa rather than the 500 origins by 20 destinations of the mainframe version because of capacity limits of the Heath Fortran 77 DOS compiler. Usually transportation LP problems can be structured to overcome this limitation; only very large problems necessitate resorting to the mainframe version of the TRLP program.

5. A separate menu-driven program is provided for reading the commands and options for the problem from keyboard input and creating a command file to direct TRLP runs for optimum distribution patterns. The default command values displayed by this read program can be updated and retained for subsequent runs.

Each program in the microcomputer version of the family of computer programs for feasible agribusiness development is being published as a separate manual, replacing Volume II, Computer Programs, for mainframe computers. At this writing, five other manuals are available in this form. They are "IRR Feasibility Analysis Program for Use on MS-DOS Microcomputers, Release 2" (plus a corresponding program and manual in the Spanish language), "Information for Using Fortran Programs with MS-DOS Microcomputers", "Proforma Financial Analysis Program for Use on MS-DOS

Microcomputers", "Regression Projection Programs with Multiple Options for Use on MS-DOS Microcomputers, A. Master Projections" and "Regression Projection Programs with Multiple Options for Use on MS-DOS Microcomputers, B. Proration Projections". The manuals are available with or without the corresponding program and instructional diskettes. Volume 1 containing text and charts of Special Report No. 2, "User's Guide to Computerized System for Feasible Agribusiness Development", is equally appropriate for microcomputer and mainframe analysis.

The Transportation Linear Program (TRLP) and the accompanying programs, TRANS and RATES, operate on any MS-DOS microcomputer with at least 264 K bytes of memory. They can handle problems of up to a total of 50 origins by 60 destinations (or any combination thereof which does not exceed 3000), up to 48 different transport modes, and up to 60 storage periods (recursive runs). A short main program is used to assign dimensions to the arrays in the transportation linear programming subprogram so that the full core capacity can be used, regardless of whether the problem has (1) many origins and fewer destinations, (2) many destinations and fewer origins, or (3) about the same number of origins and destinations. The RATES program is used to search and find the least-cost mode for each link in multi-modal networks, and the TRLP program keeps track of the individual modes selected in the optimum solution. Program output is formatted for up to 96 columns of width so that 12 pitch printer setting is required for output to standard 8.5-inch paper.

The user-supplied parameters and commands to the Transportation Linear Program are menu driven. The separate front program, TRANS, is used to read the commands from keyboard input in response to monitor prompts, and create a command input file for the Transportation Program called INPUT.TLP. As guide to the user, TRANS reads default commands from a default file called DEFAULT.TLP and presents them as screen displays for acceptance or replacement through keyboard input. This input file to TRANS is in the same format as the output file for use by TRLP, INPUT.TLP, so that with problems for which the commands in the default file need not be changed, the DEFAULT.TLP file can be renamed to INPUT.TLP (with DOS) and used directly for the TRLP run.

The input data file to TRLP of supply quantities by origin and demand quantities by destination is prepared in the format of I8, I8, F16.0, 4X, 4A4. The transfer costs by link between nodes are read in the parallel format of I8, I8, F16.2, 4X, I4. These formats make it easy to create the data input files with popular electronic spreadsheet programs such as LOTUS, by setting the column-width to 8, 8, 16, 4, and 16 (or 4 for the rates), and saving the spreadsheet as a print file so that it can be read by TRLP as an ASCII data file. In the case of multi-modal problems, the sort and select program, RATES, reads the transfer costs by link for each mode in this same rate format, and creates the least cost rate file, NINP3, in the same format as well. Such file then can be combined with the file of supply and demand quantities with DOS (e.g., COPY QUANTITY.TLP +NINP3 TRLPDATA.RUN) for the final data input to the Transportation Linear Program.

When you have prepared the TRLP input data file, TRLPDATA.RUN, and are ready to make the run for determining the least-cost distribution pattern, start by first calling TRANS to create the commands file. This is done by being sure that the two files, TRANS.EXE and DEFAULT.TLP, are on the logged drive, and then enter TRANS <return>. The program menu then will be displayed, and you will be prompted for the information and commands for your run. The listed default values serve

as patterns for your entries. When the commands have been entered ready for program execution, you will be reminded that the program will now prepare the INPUT.TLP file for the Transportation Linear Program run. Upon completion of this step, the program will prompt you to call TRLP (TRLPA or TRLP87) for the run to determine the least-cost distribution pattern.

To make a trial run with TRLP, REName one set of the files provided with the program diskette, say INPUTTLP.ONE and TRLPDATA.ONE, to INPUT.TLP and TRLP-DATA.RUN, respectively, and then type TRLPA (or TRLP87 if you have the 8087 version of the program) <return>. After you have made the run, don't forget to rename the files back to INPUTTLP.ONE and TRLPDATA.ONE. Otherwise when you copy back the data file for your own problem from the work disk to the program disk, the original will be lost as it is replaced by your INPUT.TLP and TRLPDATA.RUN files. This same procedure should be followed to retain input data files for problems you have run in the past, retaining then as INPUTTLP.III and TRLPDATA.III, and INPUTTLP.IV and TRLPDATA.IV, etc., for example, so that INPUT.TLP and TLRPDATA.RUN always are open for the current run, and no data file will be lost by over copying.

The sequential steps for Transportation Linear Program runs to solve for optimum distribution patterns are as follows:

1. Prepare your data file of (1) supply quantities, (2) demand quantities and (3) transfer rates for the M supply points, N demand points and M x N links connecting these points in your problem. List this input in the specified columnar format of 2 I 8, F 16.0, 4 A 4, 4 X, and 16 A 1 (or I 4 for the transfer rates), with no blank lines between the supply quantity section and the demand quantity section, nor between the demand quantity section and the rates section.

2. Select a default file to serve as pattern for your commands, e.g., DEFAULT.ONE, and rename the file to DEFAULT.TLP. Be sure this file is on the same disk as your TRANS.EXE file, if necessary by copying it over with the DOS resident command, COPY.

3. Logged in the drive containing these file and enough empty capacity on the disk for the program to write the INPUT.TLP file, enter TRANS <return>.

4. Follow the screen Menu prompts to enter the information and commands for your problem. You can follow the menu in any order, and can make changes any time up until the program execution command.

5. Upon completion of the TRANS run, you will be prompted to call the TRLP program to solve for the least-cost distribution pattern. Before doing so, be sure that the three disk files, TRLPA.EXE (or TRLP87.EXE if you have the coprocessor version), TRLPDATA.RUN (from Step 1) and INPUT.TLP (from Step 4) all are on the logged drive.

6. Initiate the Transportation Linear Program run by entering TRLPA (or TRLP87) <return>.

7. Remember that the program printout requires 96 horizontal spaces, so plan for wide paper or set your printer to 12-pitch font before executing the program. Then to echo the output to your printer, enter <Ctrl> P before keying <return> in Step 6. Alternatively, to direct the printed output to a disk file, enter a routing command such as > B:MYFILE.OUT prior to keying <return> in Step 6.

SECTION II

GENERAL DESCRIPTION OF THE TRANSPORTATION LINEAR PROGRAM

The transportation linear programming model is designed for use in determining feasible agribusiness development. It includes features often not included in other versions of transportation LP models. The recursive feature is included so that the volumes assigned to storage in the solution for the previous period are added to the supply quantities available for distribution in the current period. Shadow prices are generated so that the marginal costs are known for locations where capacity restrictions are encountered in the optimum solution. The program tracks the transfer mode so that the least-cost combinations of transport, storage and processing transfers used in the optimum solution are identified. A short main program is used to assign dimensions to the arrays in the transportation linear programming subprogram so that the full core capacity can be used, regardless of whether the problem has (1) many origins and fewer destinations, (2) many destinations and fewer origins, or (3) about the same number of origins and destinations. The maximum limit of origins times destinations for which the program is dimensioned is 3,000.

The program is designed to handle relatively large problems efficiently. If problems need to be run for many iterations to find the optimum solution, the intermediate results can be stored in a disk file, and the program rerun from that point. The degeneracy check is unaffected by the problem size. A unique closed loop routine is used to select the leaving basic variable in application of linear programming total optimizing conditions. Marketing system capacity restrictions can be handled as "dummy" demand points which are specified by the user. Separate recursive solutions can be made month-by-month so as to reflect the time dimension endogenously without multiplying the programming matrix by a factor such as 12 squared.

Two auxiliary programs are provided to accompany the Transportation Linear Program, TRLP. The first, TRANS.EXE is a front program for reading the user commands for his problem from keyboard entries and creating a file of these commands for reading by TRLP. The second, RATES.EXE is used to select the minimum cost rate for each link in problems for which several alternative transfer modes or channels are available. Each is described briefly.

<u>TRANS Program for Keyboard Entry of Commands</u>

The program for reading the information and commands for the optimization problem to be run is called by entering TRANS <return>. It needs an input file, DEFAULT.TLP from which to display on the monitor example entries for the user to follow in keying the commands for his problem. The TRANS read program does not make mathematical computations of any kind; it simply organizes the user commands and prepares the command input file, INPUT.TLP, for subsequent use in the optimization run.

Four types or categories of information are to be entered via the TRANS program. They are (1) size and type of problem, (2) command options, (3) output options, and (4) mode identifications. Default values for each of the categories are

displayed on the monitor screen in sequence. Responding keyboard entries are made for the items in each category in turn.

Size and type of problem: Information on the size and type of problem includes number of supply points (M), number of demand points (N), maximum number of iterations to be executed toward problem solution in this run (NOITER), indication of a continuation run (ID), and indication of whether mode identifications to be incorporated in the run (MOD).

Command options: Information to be supplied in this category includes number of passes in the run, including recursive solutions (NPASS), identification of year and or month represented (NYEAR), whether a disk file of output is needed (LOAD), whether the run is for recursive solution (IRECUR), whether the previous transfer costs are to be used for recursive problem (ISAME), request for printing of shadow prices and marginal costs (ISHADW), and number of different transfer modes or channels included in the problem (NN).

Output options: Instructions in this category include 0 to print or 1 to skip print of optional output tables including: differences in quantities of supply and demand (NODIFF), intermediate solution (NOPREL), transfer rates (NORATE), initial near-optimum solution (NOINIT), optimum distribution pattern by point of origin (NOORIG), optimum distribution pattern by destination point (NODEST), optimum distribution pattern by transfer mode (NOMODE), transfer rates by mode (MORATE), optimum distribution pattern by mode from origins (MOORIG), and optimum distribution pattern by mode to destinations (MODEST).

Mode identification: When mode identification is indicated by input of 1 for MOD in the first category, the program requests identification of the mode name for each of the number of modes indicated at NN in the command options. The mode names are made by entries not exceeding 16 characters, such as TRUCK TRANSPORT or DIRECT TRANSFER.

RATES Program for Combining Multi-Modal Rate Files

The program for reading the rate files via the alternative transfer modes in the problem and selecting the lowest cost rate for each link is called by entering RATES <return>. It needs a small default file, COMMANDS.TLP, plus a single input file, RATES.TLP, in the same format as the rates read by TRLP, i.e., I8, I8, F16.2, I8. The information included in each entry of the rates file is supply point number, destination point number, transfer rate for the link, and mode identification number. The entries for the mode covering most all links (e.g., highway transport) are listed in the file first, followed in sequence by the entries for the other modes. No blank space is included between entries from one mode to the next.

The default file for the RATES program, COMMANDS.TLP, lists default values for number of supply points, number of demand points, number of modes, and for each mode included, the mode number, mode identification, and total number of links. The defaults serve as guides to the user for inputing comparable information for his problem.

When called, the RATES program first displays an information screen on the monitor, and instructs to proceed when ready by keying <return>. It then moves to the parameters screen for keyboard input by the user (three-digit integer numbers followed by one blank space) of number of supply points, number of demand points, and number of modes. When this information is entered and <return> keyed, the program moves to the screen for entry of total number of links and mode name for each mode in succession. After the last such entry is made and <return> keyed, the program proceeds to select the lowest-cost rate for each link and create a file called NINP3 containing these rates together with the supply point and demand point identification and the mode number for each low-cost rate. The NINP3 file is in the format for reading by the Transportation Linear Program, and can be combined with the file of supply and demand quantities to form the input file for TRLP (e.g., COPY QUANTITY.TLP+NINP3 TRLPDATA.RUN).

TRLP Program for Least-Cost Solutions

The Transportation Linear Program (TRLP) for determining least-cost distribution patterns incorporates a spatial equilibrium model for allocating quantities of supply at given points among demand locations so as to minimize the "global" total distribution cost. The total number of supply points multiplied by the total number of demand points which can be handled by the program is 3,000. The program handles alternative transfer modes or marketing channels, with capacity for up to 48 different modes. It includes a recursive feature for allocating distribution between storage outlets and utilization outlets, and adding quantities in storage to current supply quantities for the subsequent period. Because the recursive problems are run sequentially (e.g., by month from harvest through the marketing season), the problem size is not increased by incorporation of recursive runs.

The program consists of a short main program and one major subroutine, TRLP. The main program reads the dimensions and characteristics of the problem from the users' INPUT.TLP file (created with the TRANS program), and sets up the programming problem for the TRLP Subroutine. All of the analytical steps of the program are performed by the subroutine.

Information and Commands Read from INPUT.TLP

The information read by the main program from the INPUT.TLP file at Step 1 includes the following:

M	=	number of supply points
N	=	number of demand points
NOITER	=	maximum number of iterations
ID	=	indication of a continuation run: Yes = 1, No = 0
MOD	=	mode identification included in the run: Yes = 1, No = 0.

The information is read in integer format of 5 I 4 as created in the TRANS run.

The remaining commands and information from the INPUT.TLP file are read by the TRLP Subroutine. The Step 2 commands are read in comparable integer format, and include:

NPASS	=	number of passes, including recursive runs
NYEAR	=	identification of month and/or year of data set
LOAD	=	make a data file of the program output: Yes = 1, No = 0
IRECUR	=	use prior storage quantities for recursive run: Yes = 1, No = 0

ISAME	=	use same transfer rates as prior run: Yes = 1, No = 0
ISHADW	=	print table of shadow prices and marginal costs: Yes = 1, No = 0
NN	=	number of different modes included

The Step 3 commands read by the program are those controlling printed output, including:

NODIFF	=	skip printing quantity differences in quantities; Yes = 1, No = 0
NOPREL	=	skip printing intermediate results; Yes = 1, No = 0
NORATE	=	skip printing transport rates; Yes = 1, No = 0
NOINIT	=	skip printing initial pattern; Yes = 1, No = 0
NOORIG	=	skip printing origin sort; Yes = 1, No = 0
NODEST	=	skip printing destination sort; Yes = 1, No = 0
NOMODE	=	skip printing mode sort; Yes = 1, No = 0
MORATE	=	skip printing rates by mode; Yes = 1, No = 0
MOORIG	=	skip printing mode by origin; Yes = 1, No = 0
MODEST	=	skip printing mode by destination; Yes = 1, No = 0

These commands are included in the INPUT.TRLP file created with TRANS, and are read in the comparable I 4 integer format.

The Step 4 input read from the INPUT.TRLP file by TRLP is the mode identifications in problems for which MOD at Step 1 is 1. This is a listing of the mode numbers and names for as many different modes as indicated by NN at Step 2.

Quantities and Rates Read from TRLPDATA.RUN

The data input for the problem is read by TRLP from the TRLPDATA.RUN file located in the same disk drive as the TRLPA.EXE (or TRLP87.EXE) and INPUT.TLP files. The read sequence for the data is (1) the list of supply quantities by source, (2) the list of demand quantities by destination, and (3) the list of transfer costs from origin point to destination point. The number of supply entries should match that specified at M (Step 1), and the number of demand entries should match that specified at N. Entries should be included for origins points with zero quantities available as well as for destinations with no quantity demanded. The number of transfer rates or costs in the list should be equal to M x N, even though for some links the entry may be zero, and for others it may be a very high number to indicate that actual movement over the link is highly unlikely.

Supply quantities are read in the format I8, I8, F16.0, 4X, 4A4. Each entry includes the period, the origin number, the supply quantity, and the origin name. The entries are listed in order from the supply point with lowest number to that with the highest number. The numbers need to be sequential, but do not need to be consecutive. Systematic supply point numbering schemes often are quite helpful. For example, 21 and 121 might be the same location, but 21 supply from current purchase and 121 supply from storage inventory, or 21 might be brown rice (in equivalent polished rice quantity) and 121 polished rice.

Demand quantities also are read in the format I8, I8, F16.0, 4X, 4A4. Each entry includes the period, the destination number, the demand quantity, and the destination name. These entries also are listed in order from demand point with lowest number to that with the highest number. The numbers need to be sequential, but do not need to be consecutive. Locations in the problem which serve as

both supply points and demand points should be assigned the same number on both lists.

Transfer costs are read from the TRLPDATA.RUN file in the format I8, I8, F16.2, I8. Entries include origin number, destination number, transfer cost, and mode number (if applicable). They are listed in sequence, starting with the lowest numbered origin to the lowest numbered destination, moving to the lowest numbered origin to the highest numbered destination, and finally to the highest numbered origin to the highest numbered destination. Total entries should be M x N, each being the lowest cost transfer rate among the alternative modes for that link. Links for which more than one transfer cost needs to be retained should be identified by separate origin numbers (or separate destination numbers, or both). Links which carry one transfer cost up to a specified volume and a different transfer cost thereafter should be identified separately in the same manner, with appropriate quantities of supply (and/or demand) assigned to each component.

Internal Program Checks

The Transportation Linear Program has a number of internal checks designed to avoid faulty or misleading results, excessive computational time and other problems. Some of them are corrected internally, with no message given. Others cause a program interrupt, and provide a written message of the problem on the monitor screen. The latter are in addition to the runtime error interrupts and messages which may be detected by the Fortran compiler or by DOS. The following list is a brief summary of the key internal program checks of TRLP.

Degeneracy problems sometimes can be encountered in linear programming formulations. The TRLP handles such problems in the section determining the basic near-optimum solution by subtracting a small amount from the trouble supply cell and adding a equal small amount to the final supply cell. No printed message is given, but the result often can be detected by comparing the solution distribution quantities with the supply quantities as given for the problem.

Excessive iterations which may be encountered are handled in TRLP by checking on the number of iterations as computation progresses, and comparing the result with the maximum number of iterations specified by the user at NOITER (Step 1). If the maximum is encountered, the program creates a file of intermediate results (NINP4), and stops the iteration process toward solution at that point. If ordered by the user (NOPRLL Step 3 is 0), the intermediate results also are printed. The next step is up to the user. If continuation of the iteration process is desired, the TRLP program is called again with specification of 1 at ID and a larger number than the previous entry at NOITER (Step 1). Unless again restricted by NOITER, TRLP will proceed to solution of the problem and printing of the output. If no solution is obtained within the new NOITER, the above process is repeated, again leaving the next step to the user. Experience with the program indicates that solutions to the vast majority of problems are achieved within 100 iterations or less, or computation time on modern microcomputers of a matter of minutes.

Dimensions of problem too large are checked at the start of the run by the main program. If the dimensions are larger than can be handled by the program, or are not properly specified by the input at Step 1, the run will be stopped automatically. When this happens, the following message will appear on the screen:

--- The total multiplier of supply and demand points is over 3,000 or equal 0; the program is terminated automatically.

This kind of problem is corrected by checking to see that the number of supply points and number of demand points are properly entered at Step 1. If so, and the product of the two exceeds 3,000, then the problem will need to be redesigned so that either M or N is reduced to yield a product of 3,000 or less.

Links out of sequence in the data input are recognized by the program, and when encountered the following kind of message will be displayed on the screen:

LINK 15 130 IS OUT OF SEQUENCE,

where in this illustration 15 is the origin point and 130 is the destination point of the link. The usual problem is that the entry for the immediately prior link has been omitted, or a duplicate entry has been made. The problem causes interruption of the run. The recourse is to discover the error and correct the input file, normally using the DOS line editor program, EDLIN.

Supply point of sequence in the data input for recursive problems is recognized by the program, and will cause display of the following message:

POINT 15 IS OUT OF SEQUENCE,

where 15 in this example is the origin point. The usual problem is comparable to that for the link sequence message, and the recourse to correct it is the same.

Incorrect number of supply point entries in data input for recursive problems also is detected by the program and will cause the following monitor display:

IN RECURSIVE FUNCTION SUPPLY INPUT DOES NOT MATCH THE NUMBER
SPECIFIED IN THE FUNCTION; IT IS 17,

where 17 is the number of supply point entries for the recursive problem found by the program. Detection of this problem causes program interrupt. It is corrected by comparing the number displayed in the message with the entry at M in Step 1, and then making the necessary corrections in the TRLPDATA.RUN file, normally with EDLIN.

Incorrect number of supply points in the TRLPDATA.ONE file for other than recursive problems is detected by the program, and also will cause program interrupt. In such cases only the following general message is displayed:

POSSIBLE INTERRUPTION OF CASES:
(1) The number of origins or destinations does not match M and N
(2) Input data might not be in the specified read format
(3) Invalid supply or demand identification or out of sequence
(4) Mode identification number and name not listed in the separate file

User recourse is to check the number of supply point entries in the data input file with the number specified at M in Step 1, and make needed corrections.

Incorrect number of demand point entries in the TRLPDATA.ONE file is detected, and the general interruption message shown above is displayed. User recourse is to check the number of demand point entries in the data input file with the number specified at N in Step 1, and make needed corrections.

Incorrect period specification in supply or demand entries in the TRLPDATA.ONE file is detected and causes display of the general interruption message shown

above. User recourse is to check the period numbers listed in the data input file with that specified at NYEAR in Step 2, and make the needed corrections. If this problem is encountered in a recursive run, the difficulty may be in the way the periods have been designated. The TRLP program automatically adds 100 to the previous NYEAR for each recursive run, on the assumption that the monthly periods are designated as 0790, 0890, etc. If the sequential recursive runs are for annual periods, designations such as 1990, 1991, etc. will not work. Something like 9000, 9100, etc. can be used to overcome such difficulty.

Input data in the wrong format will cause the TRLP program to stop and display the general interruption message. Such problems can be detected readily by a listing of the TRLPDATA.RUN file, either by printing it (say with the DOS TYPE and <Ctrl> P commands, or the PRINT command), or by listing it on the monitor with the TYPE command combined with | MORE or with <Ctrl> S to view one screen at a time.

The read format used by the program for the supply and demand quantity data by location is I 8, I 8, F 16.0, 4X, 4 A 4. That used for the transfer costs is I 8, I 8, F 16.2, 4 X, I 4. The listings should appear as follows:

0190	22	12500	Fort Dodge
0190	23	4750	Webster City
0190	115	45780	Des Moines
0190	118	13400	Davenport
22	115	43.20	3
22	118	67.18	3
23	115	48.70	2

Improper mode identification in the INPUT.MPJ file causes program interrupt and display of the general interruption message. Usual user recourse is to list the INPUT.MPJ file and check for input errors. Corrections can by made to the file with EDLIN, or alternatively, a new file can be created with the TRANS.EXE program as outlined above.

Sequence of Analytical Routines

The sequence of analytical routines within the Transportation Linear Program moves from reading of structural commands for the problem through to determination of the optimum pattern and presentation of the results. Ten major steps are performed in sequential order by the program. In summary, they are as follows:

1. Read the instructions and commands for the problem from the INPUT.TLP file created with the front program, TRANS.

2. Read the supply quantities, demand quantities and transfer rates from the TRLPDATA.RUN file.

3. Check balance of supply and demand quantities, and assign the residual to a dummy supply or demand cell.

4. Find the initial near-optimum solution, following Edward Russell's extension of Dantzig's algorithm.

5. Calculate the shadow prices by supply point (column) and demand point (row) which are associated with the initial near-optimum solution.

6. If maximum specified number of iterations encountered, store the intermediate result to disk file, NINP4; read this file in subsequent run and proceed to optimum solution.

7. Continue iterations for leaving basic variable until applications of "global" criteria insure that no further reduction in total distribution cost is possible.

8. Print the requested listings and output of the problem solution.

9. Create disk file of the solution output, OUTPUT.TLP, if requested.

10. Set up commands for the subsequent recursive run, if requested, and return to Step 2. When all is complete come to normal end of program.

Options and Uses of the Programs

There are some seven major options and corresponding uses of the Transportation Linear Program and the accompanying auxiliary programs. Moving from the most direct and simplest to the more complex applications, the major options include (1) spatial equilibrium, (2) multi-modal distribution, (3) recursive solution for storage (and processing) equilibrium, (4) solutions under projected conditions and scenarios, (5) constrained versus unconstrained solutions, (6) equilibrium with modified distribution network, and (7) projected benefits from system improvement. There are many possible formulations and sub-options under each of these seven major uses, but the seven serve to illustrate the uses of the TRLP software quite well.

Spatial equilibrium. Spatial equilibrium distribution problems represent the most obvious and direct application of the Transportation Linear Program model. When a set of supply quantities is given for a list of specific locations, a set of needed demand quantities is given at another set of locations, and transfer costs are known for each link between supply point and demand point, the distribution pattern giving the minimum total cost is a classic application. The solution shows how the product should be moved or distributed across the physical space network to insure that costs are minimized. In this kind of formulation no attention is given to transfer mode, there being only one rate given for each link in the problem. No consideration is given to time, either for the supply quantities or for the distribution to the demand points. The sole focus is on least-cost geographic distribution, or spatial equilibrium.

Even though the equilibrium solution for a given problem may cover an entire operating year, and the distribution between nodes may actually consist of many individual shipments, perhaps by more than one transport mode, this kind of static formulation and the resulting solution are very useful for many real world problems. Even though actual shipments don't parallel the solution distribution exactly, and actual total distribution cost is somewhat higher than that indicated by the solution, the equilibrium pattern can be a most useful guide to understand-

ing, planning and evaluating actual shipment patterns. The other six applications represent nothing more than extensions of the concept of spatial equilibrium in a timeless environment.

Multi-modal distribution. Multi-modal considerations come into play for many real world marketing and distribution problems which involve choices among alternative ways to get from origin M to destination N. In the simplest case, alternative transport modes may be available, such as highway, railroad and waterway. In more complex cases there may be alternative routes and marketing channels as well. Movement from origin M to destination N may involve movement through time (storage) and change in form (processing) as well as movement through space.

The TRLP programs address problems with these kinds of dimensions as multi-modal, requiring that the mode be identified for each link and its associated rate in the network. The final value used as cost in each link for the optimum distribution solution is taken to be the least costly alternative. The RATES program is designed to search the alternative modes and select the best for each link. The TRLP program keeps track of the selected mode associated with individual links, and displays the mode or market channel in the program output. Given these modifications in concept and problem formulation, the linear programming solution is determined in the same way and subject to the same interpretation as the pure spatial equilibrium case.

Recursive solution for storage (and processing) equilibrium. The recursive option of TRLP permits consideration of the time dimension and certain kinds of form change (processing). Because changes in time through storage, and many changes in form through the marketing-distribution process are irreversible (i.e., storage runs from time 0 to time 1, but not the reverse, and rice milling moves from rough rice to milled rice, but not the reverse), the recursive concept fits very well. The annual distribution of a crop from production point to final utilization point with the recursive feature can be treated as twelve sequential recursive runs. Equilibrium distribution for the first harvest month is allocated between current utilization and storage for later utilization. Supply quantities in storage from the first month are added to current production the second month to obtain totals for allocation among current utilization and storage the second month, and so on.

In the formulation of recursive problems the quantities by point of origin need to be identified in terms of time (and form) as well as place. The demand quantities by destination need to be identified in the same way. Each link and its associated cost needs to include spatial transfer, storage (say for one month), and processing (say from rough rice to brown rice or to polished rice). The mode identification needs to include the market channel or route for going from source M to destination N. This might include such descriptions as DIRECT UTILIZATION, TRANSPORT ONLY, STORAGE ONLY, or TRANSPORT & STORAGE. Or to also reflect three-stage processing, it might involve a set of modes such as STOR-PROC-SHIP, STOR-SHIP-PROC, PROC-SHIP-STOR, PROC-STOR-SHIP, SHIP-STOR-PROC, SHIP-PROC-STOR, STOR-SHIP, SHIP-STOR, PROC-SHIP, SHIP-PROC, STOR-PROC, PROC-STOR, STOR ONLY, PROC ONLY, SHIP ONLY, DIRECT USE.

It is convenient to structure recursive problems such that the transfer costs from source M to destination N are constant for a given link from one month to the next. Then the monthly supply quantities and monthly demand quantities can be supplied

for each month in succession at the outset in the TRLPDATA.RUN file, and the twelve monthly solutions will appear in sequence without further input or interaction by the user.

Solutions under projected conditions and scenarios. Any of the first three alternative kinds of distribution problem for optimization can be formulated under projected future conditions as well as for current conditions. Supply quantities and demand quantities may be volumes projected for year 2000 rather than those for 1990, for example. The transfer costs by link can reflect projected values considering such factors as changes in technology, improvements in the marketing-distribution network and changing relative prices. Once the projected entries have been made, the entries to the program and the program solution are made in the same way as those for current conditions.

The solutions for future periods can be very enlightening and rewarding for planning purposes. When one's interest is in longer-term development, a series of optimum solutions under projected conditions for say 1995, 2000, 2005, 2010 and 2020 may be invaluable in pinpoint the time, location and type of constraints or restrictions which will become limiting unless something is done to alleviate them.

Constrained versus unconstrained solutions. Most problems formulated for Transportation Linear Programming analysis reflect a host of constraints in the system. Supply quantities might be different if certain constraints could be removed. The same goes for demand quantities. And in particular, the transfer costs by link are determined under a whole set of constraints brought about by the infrastructural network over which the system operates. It may be very rewarding to know how the optimum distribution pattern and total distribution cost would change if certain specific constraints were removed from the system. This can be accomplished by "pretending" the constraint or constraints of concern are not existent, budgeting the resulting change in quantities of supply and/or demand, and in transfer costs by link, and rerunning the problem.

The comparison of results for the unconstrained solution relative to the one under existing constraints can indicate a great deal to those concerned. Comparison of the total transfer cost shows how costly the constraint to the system. Comparison of the two optimum distribution patterns will show which links and nodes would gain in volume (and economic activity), and which would lose under the alternative, and by how much. The social and political overtones of such knowledge can be staggering.

Equilibrium with modified distribution network. Formulation of problems for equilibrium analysis under a modified distribution network is somewhat parallel to that for unconstrained solutions. The difference is that the focus with modified distribution network analysis is on a changing network, either because of known future changes, or for evaluation of possible future changes. But the analysis and interpretation is made in the same way, that is by comparing the results under the simulated network with those under the existing one. And as in the unconstrained case, the comparison shows not only how much difference one could expect, but who would benefit and who would lose, and by how much.

This kind of formulation becomes even more powerful when applied to several possible modification scenarios in the distribution network. Comparison of results not only with the base or existing case, but also among possible alternative modifications, can lead to design of highly desirable modifications in the distribution network which might not be discovered in any other way.

Projected benefits from system improvement. The development of a schedule of projected net benefits for a proposed scenario for modification of distribution network or removal of specific network constraints involves a combination of the "with and without improvement" comparison and "projected conditions" formulations. One needs to make the comparative runs with and without the improvements not only for the current time period, also under projected conditions for a series of projected years into the future. Then by subtracting the least-cost distribution cost with the improvement from that without the improvement for a series of years, the schedule of net benefits attributable to the improvement can be estimated. If such schedule is discounted at the real opportunity cost of capital, the benefit schedule can be reduced to a single value. One can then say, for example, that the proposed improvement is feasible if it can be developed at a cost of $5 Billion (if that is the discounted present value of the benefits) or less; otherwise it is infeasible.

In structuring this kind of analysis with the TRLP program, it rarely will be necessary to develop projections of quantities by node and rates by link and make the optimization runs for every year in the economic horizon. Normally the comparative analysis can be made for say 4, 5 or 6 year intervals, and the net benefits for the intervening years estimated by interpolation. Because the relative present values are greater, it is more important to have optimum distribution solutions most frequently in the early years of the planning horizon.

SECTION III

CONCEPT OF OPTIMUM MARKETING AND DISTRIBUTION PATTERNS

Transportation linear programs such as TRLP represent a subset of general linear program models which assumes for a given run that supply quantities and demand quantities are specified by location. Ordinarily TLP models are formulated to minimize total distribution costs over a specified marketing network subject to a set of constraints regarding the network. Like all other linear programming models, the TRLP model assumes linear relationships. Optimum solutions are "none better" distribution patterns, but may not be unique in the sense of mathematical optimum.

The concept and assumptions of TLP models fit the needs of product marketing and distribution quite well. At a given time, products come from primary production in specified geographic patterns and in specified forms. The volume of demand for products follows some different but also definable pattern in space, time and form. The cost of transferring a product from supply point to demand point in time, space and form can be estimated for alternative marketing networks. Given such information, a transportation linear programming model can be formulated to solve for the least-cost global distribution pattern over the network, providing solution transfer volumes from supply point to demand point for a minimum total transfer "bill" in time (storage patterns), place (transport patterns) and form (processing, conditioning, and packaging patterns).

Even relatively small real-world problems tend to become analytically large when all possible alternative types of transfer in time, place and form are considered. Alternative modes (methods of transfer) come into play. Intermediate "reshipment" points may be included in the network. Capacity restrictions plague most distribution networks so that more than one "optimum" mode from each point M to every point N may need to be considered. Various LP model formulations and specifications have been developed to help overcome the problems of computational size. One of these is the application of the recursive LP feature to cope with the time (and sometimes form) dimension of real-world applications. This enables the monthly distribution of a grain crop to be studied as 12 sequential problems rather than as one large problem, for example. Because storage can move only in one direction (forward in time), storage problems can be formulated to fit recursive solutions quite easily. The same goes for many kinds of grain processing as well. Polished rice can be generated from either paddy or brown rice, but paddy or brown rice cannot be generated from polished rice, for example.

The compiled TRLP program contained herein is designed for use in determining feasible agribusiness development for an area, district, state or nation. For this reason it includes features not always included in transportation LP models. The program tracks mode so that least-cost combinations of transport, storage and processing used as input to the final optimizing run can be tracked and identified. Shadow prices are generated at user request so that marginal costs are known for locations where capacity limits are encountered. The recursive feature is used in such way that volumes assigned to storage (processing) in the previous solution are added to current (processed) supplies for distribution in the current period.

Even though this kind of linear programming model reflects static mathematical optimizing techniques, the TRLP Model can be used effectively for simulating the consequences of both (1) uncertainties which are beyond the control of those in charge, and (2) capacity limits and other constraints which could be eliminated from an existing marketing network. The impacts of uncertainty are tested by inserting alternative quantity and/or unit cost data which reflect ranges of possible situations, and noting the changes in optimum outcome as result. The impacts of specific constraints such as capacity limits in the network are studied by running the model under the assumption that the specific constraint has been removed, and comparing the result with that for the case with the constraint included. By comparing the "with and without" optimum solutions, one gets an estimate of the cost of that constraint (e.g., the benefits to be had if the constraint were removed). Furthermore, comparison of the distribution patterns under the two solutions provides insight as to how the benefits of removing this constraint would be distributed. Such information can be very useful for formulating priority development projects for feasibility study, and for judging where and how the funding for project implementation might come.

Illustration of the Concept of Spatial Equilibrium

The concept of spatial equilibrium can be illustrated by any product which is produced or otherwise available in varying quantities at one set of locations, and is needed for utilization in varying quantities at another set of locations. Given the two sets of quantities and a set of transfer costs from each origin point to each destination point, spatial equilibrium is indicated when the product is moved over the "network" from origin to destination in such a way that the total cost of the distribution is minimized. The givens for the spatial equilibrium problem are (1) the supply quantities by source, (2) the demand quantities by destination, and (3) the transfer costs by link from source to destination. The solution is the distribution pattern of shipments from origin to destination which minimizes total distribution cost. The following example from case one of the manual will serve to illustrate the concept.

Supply Quantities by Source

An illustrative set of supply quantities by source is shown in the accompanying Figure 1. The origins are indicated by number across the top of the chart, extending from 21 to 30, with a extra column designated by asterisk should there be need for a "dummy" origin to balance the total supply quantity with the total demand quantity in the problem. The numbers on the last line of the chart are column totals, and represent the total quantities available at each origin point. In this example the given quantities range from 350 at origin 22 to 870 at origin 25. The combined total quantity available at the ten origin points for distribution among the alternative destination points is 6,130, as indicated by the corner total in Figure 1.

In this simplified form the supply quantities at each origin point need not reflect the time dimension. They could be total marketable surplus at each point for a crop year, for example, so that the spatial equilibrium covers an entire season. Alternatively, they might be the quantities at each location for a single harvest month, ready for spatial equilibrium solution for the first month in a series of solutions through the total marketing year.

Fig. 1. Illustrative Quantities by Nodes of Origin and Destination

DESTINATION	ORIGIN 21	22	23	24	25	26	27	28	29	30	*	TOTAL
21												150
22												500
23												0
24												0
25												320
26												240
27												300
28												0
29												250
30												600
121												300
122												400
123												350
124												750
125												0
126												150
127												470
128												0
129												490
130												750
*												110
TOTAL	650	350	490	615	870	530	690	715	820	400	0	6130
												6020

GIVEN:

Demand quantities by destination and

Supply quantities by origin

FIND:

Optimum distribution pattern

Demand Quantities by Destination

The associated set of demand quantities by individual demand point is illustrated by the rows in Figure 1. There are 20 numbered destination points in the illustration, extending from 21 to 30, and 121 to 130. An additional line designated by asterisk is included should a dummy demand point be needed to balance the combined demand quantities at all destinations with the total supply quantities at all origins. In this case, the dummy demand cell is needed because the total demand quantity at the 20 destinations is 6,020 compared to the total supply quantity at the 10 origins of 6,130. The balance of 110 is assigned to the dummy demand cell on the asterisk line of Figure 1.

The given demand quantities in the problem illustrated vary from 150 each at destinations 21 and 126 to 750 each at destinations 124 and 129. Demand quantities are zero at five of the destination points in the example. The zeros do not pose a problem for the linear programming solution. In concept, if the data represent monthly quantities of demand, then those locations may require demand quantities in subsequent months, and thus come into play in recursive solutions, even though they will not enter into the spatial equilibrium indicated for the quantities shown in Figure 1.

Distribution Costs Linking Sources to Destinations

The other set of given information needed for the spatial equilibrium problem is the transfer costs connecting supply origin points to destination points in the network. This information for the illustrated case is shown in Figure 2. These are freight rates or unit costs for each cell in the table. Note the diagonal zero values for the rate from origin 21 to destination 21, origin 22 to destination 22, etc. These entries reflect the fact that origins and destinations are the same location in the formulation illustrated, so that the transfer cost is zero. The zero entries are needed nonetheless to fill out the total transfer cost matrix for every origin to every destination. Also needed are the full set of rates rather than just the half matrix, even though in the example the rate from origin 22 to destination 21 is the same as that from origin 21 to destination 22, and so on throughout the network.

Fig. 2. Given Freight Rates from Origin M to Destination N

DESTINATION	ORIGIN 21	22	23	24	25	26	27	28	29	30	*	TOTAL
21	0.0	7.2	5.9	7.0	15.6	27.9	28.8	26.3	29.7	57.8		
22	7.2	0.0	8.7	9.8	18.4	30.7	31.6	29.1	32.5	60.6		
23	5.9	8.7	0.0	3.3	17.1	29.4	30.3	27.8	31.2	59.3		
24	7.0	9.8	3.3	0.0	18.2	30.5	31.4	28.9	32.3	60.4		
25	15.6	18.4	17.1	18.2	0.0	12.3	13.2	10.7	14.1	42.2		
26	27.9	30.7	29.1	30.5	12.3	0.0	22.8	20.7	21.4	52.2		
27	28.8	31.6	30.3	31.4	13.2	22.8	0.0	16.5	19.9	48.0		
28	26.3	29.1	27.8	28.9	10.7	20.7	16.5	0.0	3.4	31.5		
29	29.7	32.5	31.2	32.3	14.1	21.4	19.9	3.4	0.0	28.1		
30	57.8	60.6	59.3	60.4	42.2	52.2	48.0	31.5	28.1	0.0		
121	5.0	11.9	11.0	12.2	21.4	32.9	33.9	31.0	34.5	61.5		
122	11.9	4.8	13.6	14.9	23.9	35.2	36.5	34.0	37.6	65.8		
123	11.0	13.6	5.1	8.6	22.4	34.0	35.4	32.9	36.0	64.7		
124	12.2	14.9	8.6	5.2	23.0	35.6	36.7	33.4	37.3	65.1		
125	21.4	23.9	22.4	23.0	5.1	17.6	18.8	15.6	19.7	47.0		
126	32.9	35.2	34.0	35.6	17.6	4.9	27.8	25.4	29.0	57.3		
127	33.9	36.5	35.4	36.7	18.8	27.8	4.7	21.4	25.0	52.6		
128	31.0	34.0	32.9	33.4	15.6	25.4	21.4	5.0	8.6	36.9		
129	34.5	37.6	36.0	37.3	19.7	29.0	25.0	8.6	5.4	38.6		
130	61.5	65.8	64.7	65.1	47.0	57.3	52.6	36.9	33.6	5.3		
*												
TOTAL												

As with the supply and demand quantities, the time dimension does not need to be considered in the transfer rates for the spatial equilibrium problem. However, in the formulation illustrated, destinations 121 through 130 represent the same locations as destinations 21 through 30, but after one month's storage. The demand quantities for these destinations reflect available storage capacities, and the transfer costs for origin 21 to destination 121, origin 22 to destination 122, and

so on represent storage costs only. The rates for links such as 21 to 122 reflect transport plus storage, illustrating the manner in which problems can be structured for recursive solution and temporal as well as spatial equilibrium. The linear programming solution reflects the minimum total distribution cost, regardless of the interpretation of the quantities in Figure 1 and the unit costs in Figure 2.

Minimum-Cost Distribution Pattern

The minimum-cost distribution pattern associated with the given quantities in Figure 1 and given transfer costs in Figure 2 is shown in Figure 3. The two-layer diagonal pattern in the solution evident from the spatial equilibrium is direct result of the pattern of transfer rates in Figure 2. Most supply points supply themselves first, because of the zero transfer cost. Next each supply point tends to supply storage at its own location because the storage cost (say from 21 to 121) is lower that the shipment cost to other locations. However, there are some exceptions, as one would expect because of global conditions to insure spatial equilibrium. For example, note in Figure 3 that destination 29 receives 30 units from origin 26 to make up its total demand quantity of 250 after it ships 600 units to destination 30.

Fig. 3. Solution of Optimum Distribution for Minimum Transport Cost

DESTINATION	ORIGIN 21	22	23	24	25	26	27	28	29	30	*	TOTAL
21	150											150
22		150	5		345							500
23												0
24												0
25					320							320
26						240						240
27					80		220					300
28												0
29						30			220			250
30									600			600
121	300											300
122	200	200										400
123			350									350
124			135	615								750
125												0
126						150						150
127							470					470
128												0
129								490				490
130					125			225		400		750
*						110						110
TOTAL	650	350	490	615	870	530	690	715	820	400	0	6130
												6130

It will be noted that the border total quantities in Figure 3 are identical to those in Figure 1. This is a necessary condition for equilibrium solution, because every origin point must exhaust its supply and every destination point must meet its requirement in order for the system to be satisfied. It will be further noted that the excess supply of 110 allocated to the dummy demand cell designated by asterisk is "supplied" by origin 26. This means that at the margin in this solution, origin 26 is in the least favorable position among the origin locations to supply the demand locations, and is stuck with a "not shipped" quantity of 110 units.

System-Wide Total Distribution Costs

The system-wide total distribution costs associated with the spatial equilibrium distribution in Figure 3 are shown in Figure 4. The values in the individual cells of Figure 4 are obtained by applying the equilibrium quantities in Figure 3 to the corresponding transfer rates in Figure 2. Blank cells on the chart indicate no shipments on that link; zero entries in indicate shipments, but at no cost because the unit value in Figure 2 is zero.

Fig. 4. Solution of Minimal Total Transport Cost Meeting Requirements

DESTINATION	ORIGIN 21	22	23	24	25	26	27	28	29	30	*	TOTAL
21	0											0
22		0	44		6348							6391
23												0
24												0
25					0							0
26						0						0
27					1056		0					1056
28												0
29						642			0			642
30									16860			16860
121	1500											1500
122	2380	960										3340
123			1785									1785
124			1161	3198								4359
125												0
126						735						735
127							2209					2209
128												0
129								4214				4214
130					5875			8303		2120		16298
*						0						0
TOTAL	3880	960	2990	3198	13279	1377	2209	12517	16860	2120	0	59389

It is interesting to note in this solution that total transfer costs for spatial equilibrium are heavily concentrated on certain links. Over 28 per cent of total

distribution cost over the network is incurred on the link from origin 29 to destination 30. About 14 per cent is incurred from origin 28 to destination 130, while 10.7 per cent is incurred from origin 25 to destination 22 and 9.9 per cent from origin 25 to destination 130. This pattern is unique to the problem illustrated, but the concentration of transfers and costs over certain "busy" links is common in product distribution patterns everywhere.

The total distribution cost under spatial equilibrium in this example of 59,389 could be transport cost only, or it could include storage, processing and other marketing costs as well, depending upon the formulation of the linear programming problem. Conceptualization of the problem is reflected in the "best" rates for each link in Figure 2; given these values, the total distribution cost for the optimum distribution is the sum of the products of quantity times rate in the individual cells. Actually as formulated in this example, the total transfer costs include local use for those cells with entries of zero in Figure 4, transport only for the cells with non zero entries to destinations 21 through 30, storage only for links connecting origins to destinations with the same number plus 100 (e.g., from 21 to 121), and transport plus storage for the remaining links to destinations with numbers greater than 100.

Optimum Distribution in Multi-Modal Environments

The concept of linear programming solutions for spatial equilibrium illustrated in Figures 1 to 4 needs to be modified only slightly for conceptualization of product distribution in multi-modal or multi-marketing-channel environments. As indicated above, the transfer rates by link as illustrated in Figure 2 need not represent only one means of moving from origin M to destination N. Each such transfer rate can be the lowest cost among several alternative "modes" of transferring the product from M to N. In a simplified case where three alternative shipment modes--truck, rail and barge--are available from all origins to all destinations, the rate in each cell in Figure 2 can be the truck, rail or barge rate, which ever is lowest. The multi-modal linear programming model needs to be able to identify which mode is selected for use with each link, and to present solution distribution patterns sorted by mode, but otherwise the problem and model to solve it are the same as for the simple spatial equilibrium case.

In the more general multi-modal case, several alternative modes are available, but not all of the modes are applicable to all links in the network. Some links may be served by only one mode, say highway transport, some may be served by two, and others may be served by three or more of the alternative modes. Such complication does not change the basic concept of selection of the least-cost mode and corresponding rate for each cell in Figure 2. The TRLP program and the accompanying RATES program for generating the least-cost network handle this "unbalanced" multi-modal situation without difficulty, as outlined in Section II of the manual. For such problems the most convenient procedure with RATES is to list the rates for the major transfer mode first, and follow with those for modes which serve only selected links. TRLPCase.Egy presented herein illustrates the use of the two programs for this kind of multi-modal environment.

The alternative modes in multi-modal configurations need not be confined to different means of transport. They may be completely different marketing and

distribution channels. The TRLPCase.Two contained herein illustrates transport and storage alternatives with the different modes being (1) Local Use, (2) Direct Haul, (3) Storage Only and (4) Direct & Storage. More complex configurations of alternative channels can include different combinations of first stage processing, storage, transport, and second stage processing, for example. Computationally, multi-channel optimization problems of this sort are handled in TRANS and TRLP in the same way as any other multi-modal configuration.

Restrictions of handling capacity often enter into multi-modal problems so that the least-cost mode for given links may not be able to handle unlimited volumes. For example, water routes may freeze or close for other reasons during certain seasons. Specialized rail cars and/or locomotives may not be available in unlimited capacity, especially in certain seasons. Loading and unloading rates per hour or per 24-hour period may be limited, and so on. Configurations to reflect such constraints may need to list more than one transfer cost for some links in the network, each with some capacity limits. Solutions can use the lowest cost rate for the link up to a specified volume, and thereafter the second lowest rate, and so on. Subject to the over-all capacity limits of the model, this is handled by showing the link (say origin 25 to destination 130 in Figure 2) as two or more links in the network, each with its own rate and its own supply quantity and/or demand quantity. One or more of such sublinks may be used in the optimum solution, depending on the comparative advantage of the supply point served by the links in reaching alternative demand outlets.

Temporal Equilibrium through Recursive Solutions

Usually distribution problems for temporal equilibrium through recursive solution are conceptualized as a series of monthly spatial equilibrium solutions, each of which involves distribution between current utilization and allocation to storage for later utilization. Such configurations fit the case of commodities such as food grains which are harvested only in certain months but utilized in consumption more or less uniformly throughout the year. Starting with the first harvest month, the commodity is distributed between current use outlets and storage locations in the network. In the second harvest month, the quantities placed into storage from the previous month are added to the current harvest to obtain total supply quantities by location. These totals for the second month again are distributed optimally between current utilization and available storage locations. The process is repeated throughout the crop year in a series of recursive solutions.

The designation of origin points, destination points and transfer rates shown in Figures 1 and 2 illustrates formulation of a problem for the first harvest month of recursive temporal solution. Demand points with storage capacity also are designated as supply points so that quantities in storage can be added to current quantities at the proper locations for next month's recursive solution. This is illustrated by the numbering of demand points as 21 and 121, 22 and 122, etc. in Figure 1. The transfer rates reflect combinations of transport and storage charges as appropriate for each link. Note that the rate from origin 22 to destination 23 in Figure 2 reflects shipment only, while that from origin 22 to destination 122 reflects storage only, and that from origin 22 to destination 123 represents transport plus storage.

One should not expect the sum of a series of 12 monthly recursive solutions to yield the same optimum distribution pattern as that of a single annual solution for spatial equilibrium through a series of storage points. The conceptual problems are different. The single annual formulation is based on the assumption that total annual supply quantities and total annual demand quantities at each location are known when distribution decisions are made. The monthly recursive formulation consists of twelve "independent" distribution solutions, each benefitting from knowledge of previous distributions, but not of current supply and demand quantities for future months. For this reason total transport costs, total storage costs and the sum of storage plus transport costs over a year's time usually are somewhat higher for the 12 monthly equilibria than for the single annual spatial equilibrium solution. For situations to which they apply, the recursive configurations normally are more realistic, for they simulate a series of sequential distribution decisions more or less the same as they are made in the real world.

The TRLPCase.Two presented in Section VIII of the manual illustrates temporal solution under recursive formulation of the transport and storage distribution problem for two consecutive months. If followed by comparable solutions for the remaining ten months of the crop year, the case would show a full year's application for this kind of problem. As indicated above, that case also uses the multi-modal feature of the Transportation Linear Program to distinguish between transport, storage and combinations of the two.

Simulation of Benefits from Market Network Enhancement

The case illustrated in Figures 1 to 4 as well as the above discussion of optimum distribution in multi-modal environments and in recursive formulations for the combination of storage (and processing) plus transport take the distribution network of links connecting origins with destinations as given. Given the distribution network and unit costs associated with each link, the formulations illustrated optimize distribution patterns over the network, but do not address potentials for enhancing the network. Formulations designed to simulate the benefits of possible specific network enhancement represent another powerful use of TRLP and accompanying software programs.

Existing networks representing the possible "paths" from origin point to destination point in the system reflect many kinds of constraints in possible routes, in storage capacities, in handling and flow capacities, in locations of receiving, loading, storage and processing facilities, and so on. Usually distribution networks would be improved if there were a high-capacity bridge where none now exists, if there were a modern seaport where there is none, if there were adequate storage capacity where existing capacity is inadequate, if an existing roadway were converted to a modern freeway, etc., for example. The question becomes one of how much could be saved in total distribution costs were improvements made to reduce or eliminate existing bottlenecks and constraints in the network. Formulations to answer this kind of question involve two optimum distribution solutions, one the "constrained" solution over the network as it is, and the other the "unconstrained" solution over a hypothetical new network with specific improvements. Such formulations involve use of an optimizing linear programming technique as simulation methodology to answer if-then kinds of questions.

The impacts of bottlenecks, imperfections and other constraints in an existing network are identified by comparing the optimum distribution with specific improvements in the network to the optimum distribution without the specific improvements. The saving in the optimized total distribution cost between the two represents a direct estimate of the annual (or for whatever period covered by the with and without LP solutions) cost of the constraint under study. Putting it the other way, the difference in total distribution cost under the two solutions indicates the potential annual benefit of removing the constraint. The annual benefit can be capitalized at the opportunity cost of capital to estimate the maximum capital expenditure for feasible investment to eliminate the constraint.

Further insight can be gained by comparing the nature of the optimum distribution patterns for the with and without cases. Links over which flows would increase under optimum patterns with specific network improvements would benefit by the improvement. Links which would decrease in usage under optimum distribution with the network improvement may lose if the improvement were made. The with improvement optimum may point to some other bottleneck which then would become limiting if the first improvement were made. Another simulation test with both constraints removed might show far greater savings and much more favorable impact on optimum distribution patterns. A series of simulation runs of this kind often can lead to discovery of high-priority high-payoff improvements in the distribution network that otherwise might be overlooked.

Illustrative Cases Included in the Manual

Three case examples are included in the manual. Each case is described briefly in an opening page, and then the program input and output files for that case are reproduced to serve as guides for the user. The cases are presented in the following order:

1. TRLPCASE.ONE Bicol (Philippines) Rice Marketing Patterns
2. TRLPCASE.TWO Bicol Rice Storage and Marketing
3. TRLPCASE.EGY Egyptian Wheat and Flour Distribution

TRLPCASE.ONE serves as an introductory case to assist the user in becoming familiar with TRLP and how to use it. It is structured as a single-mode timeless spatial equilibrium problem among ten municipalities in the Province of Camarines Sur, Bicol Region of the Republic of the Philippines. Figures 1 to 4 as discussed above relate to this case. In the program output, most of the optional schedules for this kind of formulation are produced to illustrate the kind of information that can be provided. This includes the shadow price and marginal cost table (which is printed only for this case). For most user applications to spatial distribution problems, only selected ones of the optional output tables would be requested.

TRLPCASE.TWO illustrates use of both the MODE and the RECURSIVE Options for solution of the abstracted Bicol post-harvest system for rice in the Philippines. It extends the data in Case One to include a sequential recursive solution for the second harvest month. The multi-modal feature of the model is applied to distinguish local use, transport only, storage only, and transport plus storage in the optimum distribution. As in the usually true for recursive formulations, the same set of transfer rates (e.g., the values in Figure 2) used in the first harvest month also are used the recursive solution for the second month.

TRLPCASE.EGY introduces the use of MODE in full-scale application to a specific country case. It involves solution of the optimum distribution of imported wheat and flour in Egypt for year 2000 from six simulated ports to 76 milling and baking points throughout the country. The alternative modes include truck transport, rail transport, and barge transport. The case illustrates the use of the RATES program to search the rates by link for the alternative modes, and select the lowest rate for each cell with identification of the mode to which it applies. The case also illustrates use of the total iterations limit to halt the program before reaching final solution, store the intermediate output and then proceed to the optimum solution in a subsequent run.

SECTION IV

BUILDING DATA INPUT FILES FOR THE TRLP PROGRAM

As described in the concept of spatial equilibrium in Section III, above, the data requirements for transportation linear programming problems include (1) supply quantities by origin point, (2) demand quantities by destination point, and (3) transfer rates linking each origin point to the destination points. The data in each of these three categories are read by TRLP in sequence from a single formatted computer disk file called TRLPDATA.RUN. The user must take care to prepare this input data file in the proper format, making the entries in proper sequence without duplication and without omission of the specified M supply points, N demand points and M x N rates linking them together. The formats used for the input follow a pattern of eight-space column widths so that the entries can be made with electronic spreadsheet software such as LOTUS by setting the global column width at 8 before proceeding with the entries.

Before creating the data files, it is important to conceptualize the problem for analysis carefully and completely. Once thoroughly conceptualized, problem formulation, data specification and data entry will flow in logical sequence, following the guidelines outlined below.

Conceptualizing the Optimum Distribution Problem

There are many alternative ways to conceptualize and specify any product distribution problem for linear programming optimization. Subject to the capacity limits of the compiled microcomputer version of TRLP (M x N not exceeding 3,000, number of modes 48 or less and virtually any number of sequential recursive runs), the user has many options for the design of his problem. The kinds of decisions in problem conceptualization include (1) definition of the commodity to be distributed, (2) definition of the network boundaries, (3) definition of origin points, (4) definition of destination points, (5) definition of routes and links in the network, (6) selection of one of the seven major configuration options described in Section II, (7) definition of time period to be covered by the solution(s), and (8) definition of modes or market channels to be included. The decisions regarding each of these eight factors are closely interrelated. All are governed by the nature and purpose of the analysis, the specific objectives, the availability of data, the potential payoff, and the resources which can be directed to the analysis. Some of the key issues related to each of the eight factors are outlined below.

Definition of the commodity to be distributed. This decision is one of the first to be considered, because the commodity definition determines how origins and destinations can be specified and defines the class for transport rates by link. The commodity studied can be the same basic commodity in different forms such as wheat and flour or paddy, brown and polished rice if appropriate conversion factors are used to bring the quantities and rates to a common base (such as milled rice equivalent). It can be a group of related and partially interchangeable commodities such as alternative feed grains if the quantities and rates are converted to common denominator (such as wheat equivalent or kilocalories of food energy). At the other extreme, it may be a very specific commodity such as frozen

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sliced peaches in 9-ounce paper cartons packaged in cases of 144 units per case and 80 cases per bundle.

Definition of the network boundaries. Determination of the total scope of the problem or network boundaries from first origin point to final destination point needs to come early in the problem formulation as well. Is it to cover the municipalities of a single province as does TRLPCASE.ONE, an entire nation as does TRLPCASE.EGY, or something between these two extremes? Do the boundaries reflect differences in form and time as well as differences in place? For example, the first origin point may be raw product at harvest time at first assembly point while final destination is consumption ready eight months later at an urban consumption center. Conceptual decisions in this regard provide the framework for definition of origins, destinations and links in the problem.

Definition of origin points. The list or origin points to be included follows from the problem formulation. For example in TRLPCASE.ONE the origins are first assembly points for rough rice; in TRLPCASE.EGY the origins are the existing and potential Egyptian seaports capable of handling bulk cargos of wheat. Origin points for interior grain shipments might be country elevators, origin points for shipments of bulk coal might be mining points, origin points for petroleum fuels might be refinery locations, etc. The origins need to be defined in a manner such that unique supply quantities and unique transfer rates to alternative destinations can be defined for each location. To keep problem dimensions within bounds, two or more individual origins often can be combined to a common origin point in the formulation without serious loss of detail.

Definition of destination points. The list of destination points also flows from the problem formulation, and follows guidelines similar to those for the list of origin points. In the TRLPCASE.ONE formulation they are the same municipalities as the origin points, both for the current period and after one month's storage. In the TRLPCASE.EGY they are the flour milling and distribution points throughout the country. For interior grain shipments they might be terminal elevator and processing points, for bulk coal shipments they might be electric power plants and other coal-burning industrial plants, for petroleum fuels they might be bulk distribution hubs, and so on. The destination points also need to be defined so that clear demand quantities and transfer rates from alternative origins are available for each point.

Definition of routes and links. The routes and links connecting each origin point to the alternative destination points need to be defined so that one and only one link connects each two points in the network. That link should be the least-cost way of getting from origin M to destination N. If several alternative routes and modes are available, only the least-cost one should be selected in the rate network for input to the TRLP program (see Figure 2). If more than one rate is to be considered for a given link (perhaps because of capacity or other limits), then an additional origin (or destination) point should be created to accommodate the added link and assigned appropriate supply and/or demand quantity to reflect existing capacity limits. In multi-modal problems selection of the least-cost rate for each link is accomplished by the separate program, RATES.

Selection of configuration option. Another key decision in problem formulation for transportation linear programming analysis is the choice of configuration

option from among the seven major alternatives outlined under Options and Uses of the Programs in Section II. The options include (1) timeless single-mode spatial equilibrium, (2) multi-modal distribution, (3) recursive solution to reflect storage (and/or processing), (4) solutions under projected conditions, (5) constrained versus unconstrained solutions, (6) solutions with modifications in the distribution network, and (7) projected benefits from system improvement. Descriptions of these options and the manner in which each is configured for application of transportation linear programming analysis are included in Section II.

Definition of time period. Definition of the time period to be covered by optimum distribution solution needs to be determined before assembling supply and demand quantities for input to the TRLP program. Annual solutions for a crop year or fiscal year are common when allocations to storage (and/or processing) are not to be included. This is the case for TRLPCASE.EGY, for example. Monthly or quarterly solutions are used in recursive formulations to reflect movements into and out of storage (and/or processing) points. Monthly periods are used in the TRLPCASE.TWO shown in the manual. For either timeless spatial equilibrium solutions or recursive solutions, any elapsed time period can be used for the supply quantities and demand quantities to be considered. The user needs to make this determination so as to make solution to the distribution problem at hand the most meaningful.

Definition of market channels and modes. For multi-modal configurations thought needs to be given to the definition of market channels and modes. Two of the many ways that this can be done are illustrated by TRLPCASE.TWO and TRLPCASE.EGY. In TRLPCASE.TWO the modes or channels are Local Use, Transfer Only, Storage Only, and Transfer + Storage. The quantities and transfer rates are defined accordingly (see Figures 1 and 2). In TRLPCASE.EGY the alternative modes are Truck Transport, Barge Transport and Rail Transport. The differences for the wheat flour rates over the applicable links are reflected by different demand points and different rates for the applicable mode, rail transport. The flour quantities and rates are converted to wheat equivalent so as to be comparable to the quantities and rates for wheat distribution. These are just two illustrations of the many possible ways that the alternative market channels and modes can be defined for problem solution. Remember, up to 48 different modes or channels can be used in a given problem, so that there is great opportunity for imaginative formulation of market channels and modes.

Construction of the Input Data File

The data input of supply quantities, demand quantities and transfer rates are read by the Transportation Linear Program from a single input data file called TRLPDATA.RUN. The input file needs to be located on the same drive as the TRLP.EXE program and the input command file, INPUT.TLP. Because the data input file and the input command file must be consistent or the program will not run, the two files for a problem should be named with common extension for storage until they are to be used to make the TRLP run. For the case problems in the manual the sets are stored as TRLPDATA.ONE and INPUTTLP.ONE, TRLPDATA.TWO and INPUTTLP.TWO, and TRLPDATA.EGY and INPUTTLP.EGY, for example. Then just prior to making a run, the files for the problem used in the run can be renamed to TRLPDATA.RUN and INPUT.TLP, using the DOS command REN[ame]. After the run is completed, the two files should

be renamed back to their archive designations so that they will not be lost by overcopying files for new problems onto them.

The order to be followed in providing the data input to the TRLPDATA.RUN file is (1) supply quantities by origin, proceeding in order from the origin with lowest number to origin with highest number, (2) demand quantities by destination, proceeding in order from destination with lowest number to destination with highest number, and (3) transfer rates by link, listed in order starting with the link from the first supply point to the first demand point, proceeding to that from the first supply point to the last demand point, and finally to the link from the last supply point to the last demand point. All three components are ASCII or DOS files. They can be created with the DOS editor, EDLIN, or alternatively, they can be created with software such as LOTUS, DBASEIII, or even a word processor package such as Word Perfect, and saved as unformatted ASCII files.

Supply Quantities by Source Node

Supply quantity information is the first to be read from the input data file by the program. Values for IYEAR, NS, S and KODES are read for the specified M supply points in the format of 4X, I4, 4X, I4, F16.0, 4X, 4A4. This format is illustrated by the following sample entries for the first three supply points shown in Figure 1:

IYEAR	NS	S	KODES
0185	21	650.	NAGA CITY
0185	22	350.	CAMALIGAN
0185	23	490.	GAINZA

IYEAR should be identical for all points in the given data set. It will be checked by the program, and erroneous entry of the period designation for one or more of the supply points will cause the program to interrupt. NS represents the unique identification number for each supply point location; the entries are listed in numerical order for all M points specified in the program commands for the problem. The S entry is the supply quantity available at each point. The entries here are made in decimal values, or as integer numbers right justified on column 32 of the input file. KODES is the 16-character name of the supply point location. The names are left-justified starting in column 37 on each line of the input.

Demand Quantities by Destination Node

The corresponding demand information is read from the TRLPDATA.RUN file, starting on the line immediately following the last line entry of supply quantity data. Values for IYEAR, ND, D and KODED are read for the specified N demand points in the same format as that used for reading the supply information. Entries for the first three demand points shown in Figure 1 are illustrated below:

IYEAR	ND	D	KODED
0185	21	150.	NAGA CITY-1
0185	22	500.	CAMALIGAN-1
0185	23	0.	GAINZA-1

IYEAR is uniform by data set, but ND is unique to each demand point. Entries are made in sequence for the total number of demand points specified by N in the input

commands for the problem. The entries at D are the demand quantities needed at each point, entered as decimal numbers, or as integer numbers right justified on column 32 of the input file. KODED is the 16-character name of the demand point location. The names are left-justified starting in column 37 on each line of the input.

Marketing Costs by Distribution Link

Transfer cost information from supply point to demand point (and mode identification, if applicable) is read from the TRLPDATA.RUN file immediately following the entry for the last demand quantity. The items read in this section include origin point (NODE1), destination point (NODE2), transfer cost (T) and mode identification number (MODE), if applicable. The entries are read in the format of 4X, I4, 4X, I4, F16.2, 4X, I4. The full transfer cost matrix of M x N entries is needed as input even though the transfer cost may be the same from origin 6 to destination 16, say, as from destination 16 to origin 6. This step is omitted for successive recursive runs for which ISAME is specified as 1, so that the same transfer rates used previously are applied in the recursive run.

Entries for the first six links illustrated in Figure 2 are shown below:

NODE1	NODE2	T	MODE
21	21	0.00	1
21	22	7.20	2
21	23	5.90	2
21	24	7.00	2
21	25	15.60	2
21	26	27.90	2

The supply and demand location numbers to identify each link are entered as integers. The transfer rate for each link is entered as decimal number, or if entered as integer, whole number right justified in column 30 (as per the 2(4X,I4), F16.2 format). Mode identification numbers, if used, are entered as integer numbers right justified in column 40 of the input file. Internal program checks are made to insure that an entry is included to link each supply point to all demand points, and that there are no duplicate links.

Using LOTUS to Create Input Data Files

The LOTUS systems disc contains the Software package for creating and manipulating electronic spreadsheets, or LOTUS Worksheets (WKS or WK1). LOTUS Worksheets can be copied into a print file (LOTUS.PRN) so that they are recognized as standard ASCII files for reading as formatted data files by the TRLP and other Fortran programs.

LOTUS is widely used and recognized, and has many uses in its own right, including file management and graphics as well as electronic spreadsheets. Easy to follow references and manuals have been developed by users and are readily available at local book stores. No one will regret investing the time and energy necessary to become familiar with LOTUS. Using LOTUS to create data files for other programs adds further to the usefulness of this software.

LOTUS Worksheets are keyed by lettered columns and numbered rows like a road map. Data appearing in cells are stored as formulas, even though they appear as numbers in the displayed worksheet, making it easy to up-date the data files by changing a few base numbers in the formulas. Copy, move, erase, insert, change format, adjust column width, and other worksheet manipulations are relatively easy with LOTUS, so that the user is in no way bound to the standard or default spreadsheet pattern.

Creating File Using TRLPData.One Example

The following example of preparation of the input data file, TRLPDATA.ONE, for the TRLP Program with LOTUS 1-2-3 is designed to give the user an introduction to this software and how to use it. The steps are listed in numbered sequence for reference and use in self instruction.

1. Bring up LOTUS 1-2-3
   a. Type LOTUS <return>
   b. When the LOTUS options appear in the screen window, place the cursor on 1-2-3 and Key <return>
   c. Key <return> again in response to the prompt Press any Key
   *. An alternative short-cut procedure is to type 123 and key <return> at Step a.

2. Set up LOTUS Worksheet for Global Column-Width of 8 spaces
   a. Type / W G C 8 <return>

3. Enter Supply Input Data from Figure 1, Starting with Row 1
   a. Put Cursor on A1 cell and type 0185 <right arrow> 21 <right arrow> <right arrow> 650 <right arrow> ' NAGA CITY <return>
   b. Enter the remaining supply input data from Figure 1 to lines 2 through 10 in the same manner.

4. Enter Demand Input Data from Figure 1, Starting with Row 11
   a. Put Cursor on A1 cell and type 0185 <right arrow> 21 <right arrow> <right arrow> 150 <right arrow> ' NAGA CITY-1 <return>
   b. Enter the remaining supply input data from Figure 1 to lines 12 through 30 in the same manner.

5. Enter the Transfer Costs from Figure 2, Starting with Row 31

   a. Put cursor on cell A31 and enter 21 <right arrow> 21 <right arrow> <right arrow> .00 <return>
   b. Continue in the same manner to enter the remaining values in the first column of Figure 2 to the file on lines 32 through 50
   c. Enter the values in the second (Origin 22) column of Figure 2 in the same manner on lines 51 through 70
   d. Enter the values in the third (Origin 23) column of Figure 2 in the same manner on lines 71 through 90
   e. Enter the values in the fourth (Origin 24) column of Figure 2 in the same manner on lines 91 through 110
   f. Enter the values in the fifth (Origin 25) column of Figure 2 in the same manner on lines 111 through 130

g. Enter the values in the sixth (Origin 26) column of Figure 2 in the same manner on lines 131 through 150
h. Enter the values in the seventh (Origin 27) column of Figure 2 in the same manner on lines 151 through 170
i. Enter the values in the eighth (Origin 28) column of Figure 2 in the same manner on lines 171 through 190
j. Enter the values in the ninth (Origin 29) column of Figure 2 in the same manner on lines 191 through 210
k. Enter the values in the tenth (Origin 30) column of Figure 2 in the same manner on lines 211 through 230

6. Save the Worksheet File
   a. Type / F S TRLPDATA <return> and wait for save to complete

7. Save the Print File
   a. Type / P[rint] F[ile] TRLPDATA <return>
   b. Type O[ptions] M[argin] L[eft] 0 <return>
   c. Type M[argin] R[ight] 76 <return>
   d. Type M[argin] T[op] 0 <return>
   e. Type M[argin] B[ottom] 0 <return>
   f. Type O[ther] U[nformatted] Q[uit]
   f. Type R[ange] A1..D230 <return>
   g. Type G[o] and wait for file to be created
   h. Type Q[uit] and wait for file to be copied to your disc
   i. If you want to preserve the print (file) settings on your diskette with the worksheet file, you may do so by resaving the worksheet file at this point (/ F S <return> R)

   (You should now have two new files on your disk, TRLPDATA.WK1 and TRLPDATA.PRN. The first is a Lotus worksheet which can be used with LOTUS as any other such file. The second is an ASCII data file corresponding to TRLPDATA.ONE. After backing out of LOTUS, this TRLPDATA.PRN file can be RENamed TRLPDATA.RUN to serve as input for running the Transportation Linear Program, TRLP.EXE.

8. Quit LOTUS
   Back out of LOTUS by successive Quit and End commands by typing first letters or by Cursor and <return>; for example, type
   / Q Y E
   The A> or B> signal at the left side of the screen indicates that you are back under DOS control.

Using the TRLPDATA.PRN File as Input to Run TRLP

1. Insert disk with the TRLP.EXE and INPUT.TLP files in Drive A (If there is no INPUT.TLP file on the disk, REN[ame] INPUTTLP.ONE INPUT.TLP; if there is an INPUT.TLP file, but it is for another problem [it is of different size and creation date than INPUTTLP.ONE], first REN[ame] the INPUT.TLP file, and then REN[ame] the INPUTTLP.ONE file as indicated above)

2. Logged in Drive A type REName TRLPDATA.RUN TRLPDATA.ONE <return>

3. Logged in Drive B copy the TRLPData.Prn file to Drive A as TRLPData.Run as follows:
   Type COPY TRLPDATA.PRN A:TRLPDATA.RUN and key <return>

4. Prepare your printer and make the run:
   Type TRLP <Ctrl P> and key <return>

The results should be comparable to those shown for TRLPData.One in this Manual.

Using RATES to Create Least-Cost Mode Network

For multi-modal problems the Transportation Linear Program keeps track of the chosen mode for each link in the network, and for those links used in the optimum solution, it will print the least-cost distribution pattern sorted by mode. The TRLP program does not sort from the alternatives to select the lowest cost mode for individual links, however. Rather the assumption is that the lowest-cost rate for each link already has been selected and entered to the rate matrix used as input to the TRLP (see Figure 2). A separate sort program is used to scan the rates by cell for the alternative modes and select the lowest cost transfer rate together with the mode to which it applies. The program for doing this is RATES.EXE.

RATES is a separate program to be used with multi-modal problems to select the least-cost mode for every link in the network and create the rate matrix for input to the TRLP program. RATES responds to a series of user commands from keyboard input in response to monitor prompts, and then reads a set of rates from each of the modes specified by the user commands. The alternative rates are scanned and the lowest-cost ones retained in the least-cost rates file for input to TRLP. User commands requiring keyboard input include number of supply points, number of demand points, number of modes, and for each of the modes included, the mode identification number, the name or description of the mode, and the total number of links served by that mode. The monitor prompts for the keyboard input are carried in a default file named COMMANDS.TLP. The rates for the alternative modes are read by the program from a user file named RATES.TLP in the same format as that for the rates read by TRLP, namely 4X, I4, 4X, I4, F16.4, 4X, I4. The output file created by RATES for input to TRLP is in this same format; the output file is named NINP3.

Preparation of Input Data Files

The input data files of the transfer rates by link for each of the alternative modes in the multi-modal problem are prepared in the same manner and in the same format as is the rate matrix for direct entry to the TRLP as discussed above in Construction of ... Marketing Costs by Distribution Link. The format is illustrated by the six sample entries shown in that section; the procedure is illustrated in Step 5 of the example using LOTUS, as outlined above.

It is not necessary for all links in the network to be represented by all modes; generally this is not the case. Unbalanced numbers of links creates no problem for the sort routine used in RATES. The rates for the "master mode" including most of the links in the total network (e.g., truck transport) are entered first, and the transfer costs for this master mode will be retained as the least-cost mode except the case of links for which a cheaper rate for another mode is found. The

rates for the number of links specified in the keyboard input for each of the subsequent modes are read in sequence. Within each mode, the links are listed from the first origin to all destinations to the last origin to all destinations. Links not applicable to a given mode are omitted. In the run, whenever a lower cost rate is found, the mode associated with it is substituted for the original one as the chosen mode for that link.

An example of the complete rate input to RATES is shown in connection with the TRLPCase.Egy presented in Section IX of the manual. In that case, there are three modes, (1) Truck Transport, (2) Barge Transport and (3) Rail Transport. The total numbers of links for the three modes are 456, 43 and 23, respectively. Entries in the input data file, RATES.TLP include 456 lines for mode 1, 43 lines for mode 2, and 23 for mode 3, in that order. All entries are in the same format, and no blank line or space is left between entries for the different modes.

Providing the Keyboard Entries

When the data file, RATES.TLP, has been completed it is transferred to the disk containing the RATES.EXE and COMMANDS.TLP files, and enough unused space on the same diskette for the output file, NINP3. The program run is initiated by keying RATES <return>. The information screen reproduced below will appear on the monitor screen.

TRANSPORTATION LINEAR PROGRAM WITH MODE AND SHADOW PRICES
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Department of Agricultural Economics
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* This program reads default parameters and command instructions from the COMMANDS.TLP disk file for screen display to guide the user in keyboard entry of corresponding information for his problem.

* The program then reads the user-supplied information from the screen and proceeds to the 'highway' rate file to begin selection of the least-cost mode.

* The corresponding rate files for the remaining modes are read in sequence, and a substitution made each time a lower rate is found.

* The resulting least-cost rate file is prepared for use with the TRLP Program in solving for the optimum shipment pattern.

Pause.
Please press <return> to continue.

After reading this information, the user keys <return> and the commands screen reproduced below will appear on the monitor. As indicated by the prompt, the number of supply points, the number of demand points and number of modes included in the problem are entered in sequence. Each is entered as a three-digit number; <return> is keyed after all three entries are made. In the example included in Section IX, the entries are 006 076 003 <return>. Following this the number of

links and mode name for each mode come up in succession for keyboard entry or reentry, as shown below.

PARAMETERS AND COMMANDS FOR THE RUN

Enter three-digit number followed by one space for each item, and then return.

1 Number of supply points: 6

2 Number of demand points: 76

3 Number of modes included: 3

SELECTIONS:

006 076 003 <return>

MODE Identification for No. 1 with 456 total links is TRUCK TRANSPORT

Correct to ____ links and mode name of _____.

456 TRUCK TRANSPORT <return>

MODE Identification for No. 2 with 43 total links is BARGE TRANSPORT

Correct to ____ links and mode name of _____.

043 BARGE TRANSPORT <return>

MODE Identification for No. 3 with 23 total links is RAIL TRANSPORT

Correct to ____ links and mode name of _____.

023 RAIL TRANSPORT <return>

After the entry for the last mode and the keying of <return> the RATES program proceeds to the creation of the file of rates for the least-cost mode of each link in the network, NINP3. This may take a minute or two, depending upon the size of the file. When it is completed, the message shown below will appear on the monitor indicating that the run has been finished and the file generated.

The Least-Cost Rate File is now completed

Call TRANS for command input to the TRLP Program.

Stop - Program terminated.

Combining File with Supply and Demand Quantity Files

Upon completion of the above steps, the file generated by the RATES run needs to be combined with that containing the supply quantities by source and the demand quantities by destination to make the single data input file needed for the TRLP

run. The input file of supply and demand quantities normally is generated manually by the user following the guidelines indicated under Construction of the Input Data File--Supply Quantities by Source Node and Demand Quantities by Destination Node, above. Because it is generated manually the name of the file containing the input quantities can be anything the user chooses. If is called TRLPDATA.RUN, it will need to be renamed to something else before executing the command to combine the files. For example, the following command might be used: REN TRLPDATA.RUN TRLPDATA.QQ.

As indicated above, the name assigned to the least-cost rate file created with the RATES program is NINP3. After the quantities part of the total input file to TRLP has been completed, and renamed if necessary, then the DOS copy command will make the combined input file for input to the TRLP program. When logged in the drive containing the files the command is COPY TRLPDATA.QQ+NINP3 TRLPDATA.RUN.

SECTION V

USING TRANS TO PREPARE THE COMMANDS FOR TRLP OPTIMIZATION

Nature and Purpose of TRANS

The TRANS Program is a separate computer routine for reading the commands and instructions for making least-cost distribution runs with TRLP. The program reads default values from a disk file, DEFAULT.TLP, reads user commands from keyboard input in response to screen prompts, and creates the command input file for the Transportation Linear Program, INPUT.TLP. TRANS does not make mathematical computations of any kind; it simply organizes the user commands and prepares the command input file for subsequent use in the optimization run.

It should be noted that the output file created by TRANS, INPUT.TLP, is in the same format as DEFAULT.TLP, so that after one has become familiar with the program, the input can be prepared by editing a copy of DEFAULT.TLP (say with the DOS editor, EDLIN) and then renaming it to INPUT.TLP for direct reading by the Transportation Linear Program, TRLP.

To invoke TRANS, two files are needed on the logged drive together with enough disk space for creation of a third. The needed files to run TRANS are Trans.Exe and Default.Tlp. Both of these are provided on the master disk supplied with the Transportation Linear Programming package. The new file to be created by the run is called INPUT.TLP, as indicated above. When ready, the run is initiated by entering TRANS followed by <return>.

The program will bring up a series of screen displays on the monitor, each of which shows the default commands at that step, and prompts the user to enter the comparable commands for his problem. Each provides specific instructions as to the number of digits to be entered at each command together with the spacing between entries. These instructions must be followed exactly or the run will not be completed, because the commands are read from the keyboard input in specified format as well as in sequence. When all of the requested input at each step has been provided, one proceeds to the next step by keying <return>. When the commands for the last step have been entered, <return> is keyed again for signalling TRANS to proceed with program execution.

Even though there are only four sets of commands accessed from the master screen, the user who is not familiar with the program may find it difficult to enter all commands for completing the run without making an entry error and having to start over. A good way to overcome this problem is to make the entries one or two steps at a time, and accepting the default values for the remaining steps by keying <return> at the prompts for them. The TRANS program will then proceed to create a "first pass" version of the output file, INPUT.TLP. That file then can be renamed to the new DEFAULT.TLP for the subsequent run with TRANS to make the remaining changes in the default entries. Two or three such passes should result in the final INPUT.TLP for use in the optimization run with TRLP. In following this procedure, remember that once a command screen has been brought up from the master menu, it is necessary to re-enter the commands shown on the screen, even

Previous Page Blank

if they are to remain the same as the default values. The default values included on screens not recalled from the master menu will be retained without re-entry.

Introductory Screen and Master Menu

Introduction to the Use of TRANS

The first screen to appear on the monitor after calling the TRANS Program is that reproduced on the opposite page. It represents the explanatory introduction to the program and its use.

As indicated by the instruction at the bottom of the screen, when ready one simply keys <return> to proceed to the next screen from this step.

Master Menu for Command Selections

Four types or categories of information are to be entered via the TRANS program. They are (1) size and type of problem, (2) command options, (3) output options, and (4) mode identifications. Default values for each of the categories are displayed on the monitor screen in sequence. Responding keyboard entries are made for the items in each category in turn.

The four screens providing instructions for entering the commands in each of these areas are accessed from the master screen shown on the opposite page by entering the screen number and keying <return>. Normally, one proceeds from the master screen in sequence, starting with No. 1, but it is not necessary to do so. The individual command screens may be accessed in any order. One or more of them may be accessed for a second or third time to "clean up" the entries as needed.

It is not necessary to call all four command screens; those not called will retain the default commands from the DEFAULT.TLP file. However, once a numbered screen has been called, all commands at that screen must be re-entered, even those which are not to be changed.

Monitor Display of Program Introduction

TRANSPORTATION LINEAR PROGRAM WITH MODE AND SHADOW PRICES
Richard Phillips and Joe M. Tiao
Department of Agricultural Economics
Kansas State University

* This program reads default parameters and command instructions from the DEFAULT.TLP disk file for screen display to guide the user in keyboard entry of corresponding information for his problem.

* The program then reads the user-supplied information from the screen and creates the INPUT.TLP file of this command information for use in the TRLP run.

* The INPUT.TLP file created by the program follows the same format as the DEFAULT.TLP file. This enables the user who needs to make no changes from the previous commands to simply rename the file (with DOS) rather than using TRANS to build the INPUT.TLP file for the TRLP run.

Pause.
Please press <return> to continue.

Monitor Display of Master Menu

PARAMETERS AND COMMANDS TO BE SPECIFIED FOR THE LP RUN

Enter Code Number of Menu Selection and Key <return>.

1 Size of Problem and Type of Run

2 Command Codes for the Problem

3 Print Option Selections

4 Mode Identification, If Used

SELECTION:
1

Dimensions and Special Features for the Run

The monitor displays reproduced on the opposite page are for making the command inputs specifying the size of the problem and type of run, and for entering the codes to direct the type of run to be made.

Dimensions and Type of Analysis

Information on the size and type of problem includes the following:

M	=	Number of supply points
N	=	Number of demand points
NOITER	=	Maximum number of iterations to be executed toward problem solution in this run
ID	=	indication of a continuation run
MOD	=	indication of whether mode identifications are to be incorporated in the run.

Special Features to Be Incorporated in the Run

Information to be supplied in this category includes the following:

NPASS	=	number of passes in the run, including recursive solutions
NYEAR	=	identification of year and/or month represented
LOAD	=	whether a disk file of output is needed
IRECUR	=	whether the run is for recursive solution
ISAME	=	whether the previous transfer costs are to be used for recursive problem
ISHADW	=	request for printing of shadow prices and marginal costs
NN	=	number of different transfer modes or channels included in the problem.

Monitor Display of Screen 1 for Dimensions and Analysis

DIMENSIONS OF PROBLEM AND TYPE OF ANALYSIS:

Enter three-digit value for each command in succession, with one blank space between entries.

1	NUMBER OF SUPPLY POINTS IN PROBLEM:	10	
2	NUMBER OF DEMAND POINTS IN PROBLEM:	20	
3	MAXIMUM NUMBER OF ITERATIONS IN RUN:	100	
4	CHECK INCOMPLETE RESULTS FROM PRIOR RUN:	0	(Yes = 001, No = 000)
5	MODE IDENTIFICATION INCLUDED IN DATA:	1	(Yes = 001, No = 000)

SELECTIONS:

010 020 100 000 001

Monitor Display of Screen 2 for Special Features

COMMANDS AND SPECIAL FEATURES FOR THE TRLP RUN:
Enter required digits for each item with one space between entries.

1	Total number of passes included in the run:	2	(Enter two-digit number)
2	Month and/or year of data set:	185	(Enter four-digit number)
3	Store output to disk file:	0	(Put 1 for Yes, 0 for No)
4	Add supply quantities for recursive run:	0	(Enter as above)
5	Use previous rates for recursive run:	0	(Enter as above)
6	Print shadow prices and marginal costs:	0	(Enter as above)
7	Number of modes identified in problem:	4	(Enter two-digit number)

SELECTIONS:

02 0185 0 0 0 0 04

Output Options and Mode Identification

The monitor displays reproduced on the opposite page are for specifying the output options for the run and providing the identification for each mode with multi-modal problems.

Designation of Output Options to Be Printed

Instructions in this category include 0 to print or 1 to skip print of optional output tables including the following:

NODIFF = differences in quantities of supply and demand

NOPREL = intermediate solution output

NORATE = transfer rates by link

NOINIT = initial near-optimum solution

NOORIG = optimum distribution pattern by point of origin

NODEST = optimum distribution pattern by destination point

NOMODE = optimum distribution pattern by transfer mode

MORATE = transfer rates by mode

MOORIG = optimum distribution pattern by mode from origins

MODEST = optimum distribution pattern by mode to destinations.

Designation of Mode Identification

When mode identification is indicated by input of 1 for MOD at screen No. 1, the program requests identification of the mode name for each of the number of modes indicated at NN in the command options. The mode names are made by entries not exceeding 16 characters, such as TRUCK TRANSPORT or DIRECT TRANSFER, as illustrated by the screen reproduced on the opposite page.

Monitor Display of Screen 3 for Output Options

SELECTION OF OUTPUT OPTIONS TO PRINT:

Enter one-digit selection (Yes = 1, No = 0) for each option in sequence, with one space between entries.

1	Skip printing difference in quantities	0
2	Skip printing intermediate results	0
3	Skip printing transportation rates	1
4	Skip printing initial solution	1
5	Skip printing solution by origin	1
6	Skip printing solution by destination	0
7	Skip printing solution sorted by mode	0
8	Skip printing rates by mode	1
9	Skip printing origin solution by mode	0
10	Skip printing destination solution by mode	0

SELECTIONS:

0 0 1 1 1 0 0 1 0 0 <return>

Monitor Display of Screen 4 for Mode Identification

MODE Identification for No. 1 is LOCAL USE

New identification is:

LOCAL USE <return>

MODE Identification for No. 2 is DIRECT HAUL

New identification is:

DIRECT HAUL <return>

MODE Identification for No. 3 is STORAGE ONLY

New identification is:

STORAGE ONLY <return>

MODE Identification for No. 4 is DIRECT & STORAGE

New identification is:

DIRECT & STORAGE <return>

Program Execution and Normal Completion of the Run

Following entry of the identification for the last of the modes included and keying of <return>, or for problems in which modes are not identified, following the entry of <return> at Screen 3, the TRANS program will create the INPUT.TLP file of commands for the TRLP run on the logged drive. When this has been done the following message will appear on the monitor screen:

```
 The INPUT.TLP file now completed

 Call TRLP for problem solution.

Stop - Program terminated.
```

SECTION VI

USING TRLP TO SOLVE FOR MINIMUM COST DISTRIBUTION

Once the data file for the least-cost distribution problem (TRLPDATA.RUN) has been completed as described in Section IV, and the commands entered to create the INPUT.TLP file as outlined in Section V, the linear programming run is made by calling the TRLP program. In order to complete the run the three active disk files, TRLP.EXE, TRLPDATA.RUN, and INPUT.TLP, need to be on the logged disk drive. If your run may require more iterations than the maximum specified, or if you are requesting an output file of the solution, be sure that there is sufficient space on this disk for the NINP4 and/or OUTPUT.TLP files as well. Your TRLP problem will create the NINP4 file if the required number if iterations for optimum solution exceeds that specified for NOITER at Step 1 of TRANS. It will create the OUTPUT.TLP file if LOAD is indicated at Step 2 of TRANS (see Section V). When the files are in order and the needed disk space insured, the linear programming solution for your problem is initiated by preparing your printer and then keying TRLPA (or TRLP87 if you are using the program version compiled for use with an 8087 coprocessor) <return>.

The Input Files INPUT.TLP and TRLPDATA.RUN

The two program input files for the problem are INPUT.TLP and TRLPDATA.RUN. The first of these, INPUT.TLP, is created by keyboard input in response to screen prompts with the separate program, TRANS.EXE. The second is the data input file of supply quantities, demand quantities and transfer rates. The commands contained in INPUT.TLP must be consistent with the input data in TRLPDATA.RUN, and vice versa, or program interrupt will be encountered (see Section II, subsection on Internal Program Checks).

The Input.Tlp File

The INPUT.TLP file is created with TRANS.EXE by keyboard entry in response to prompts from screen menus, as described in Section V. That program reads default values from the DEFAULT.TLP file, and creates the INPUT.TLP file in the same I4 and A4 formats as those of the default file. When making small changes in commands, the user has the option of editing the DEFAULT.TLP file or a previous INPUT.TLP file with EDLIN, and then renaming to INPUT.TLP, rather than calling TRANS.

The content and organization of an INPUT.TLP file are illustrated by the following listing of the file for the TRLPCASE.TWO example contained in Section VIII of the manual.

```
 10  20 100   0   1
  2 185   0   0   0   0   4   0   0   1   1   1   0   0   1   0   0
      1    LOCAL USE
      2    DIRECT HAUL
      3    STORAGE ONLY
      4    DIRECT & STORAGE
```

The TRLPData.Run File

The TRLPDATA.RUN file contains the listing of supply quantities by origin, the listing of demand quantities by destination and the transfer rates from origin to destination. As described in Section IV, the file must be developed by the user with EDLIN or with a commercial software package such as LOTUS, DBase, or Word Perfect. The input data are listed in an I 8, F 8 type of format. As described in Section IV, least-cost transfer rates in multi-modal problems can be selected with the separate program, RATES, and copied into the TRLPDATA.RUN file.

The content and organization of a TRLPDATA.RUN file are illustrated by the following partial listing of the data file for the TRLPCASE.TWO example contained in Section VIII of the manual.

0185	21	650	NAGA CITY
0185	22	350	CAMALIGAN
0185	23	490	GAINZA
0185	24	615	CANAMAN
0185	25	870	MAGARAO
0185	26	530	PILI
0185	27	690	OCAMPO
0185	28	715	BULA
0185	29	820	BAAO
0185	30	400	NABUA
0185	21	150	NAGA CITY-1
0185	22	500	CAMALIGAN-1
0185	23	0	GAINZA-1
0185	24	0	CANAMAN-1
0185	25	320	MAGARAO-1
0185	26	240	PILI-1
0185	27	300	OCAMPO-1
0185	28	0	BULA-1
0185	29	250	BAAO-1
0185	30	600	NABUA-1
0185	121	300	NAGA CITY-2
0185	122	400	CAMALIGAN-2
0185	123	350	GAINZA-2
0185	124	750	CANAMAN-2
0185	125	0	MAGARAO-2
0185	126	150	PILI-2
0185	127	470	OCAMPO-2
0185	128	0	BULA-2
0185	129	490	BAAO-2
0185	130	750	NAUBA-2
21	21	0.00	1
21	22	7.20	2
21	23	5.90	2
21	24	7.00	2
21	25	15.60	2
21	26	27.90	2
21	27	28.80	2
21	28	26.30	2

21	29	29.70	2
21	30	57.80	2
21	121	5.00	3
21	122	11.90	4
21	123	11.00	4
21	124	12.20	4
.	.	.	.
.	.	.	.
.	.	.	.
0285	21	150	
0285	22	350	
0285	23	370	
0285	24	950	
0285	25	0	
0285	26	0	
0285	27	430	
0285	28	250	
0285	29	115	
0285	30	220	
0285	21	400	
0285	22	200	
0285	23	150	
0285	24	0	
0285	25	190	
0285	26	450	
0285	27	500	
0285	28	0	
0285	29	600	
0285	30	300	
0285	121	0	
0285	122	250	
0285	123	415	
0285	124	250	
0285	125	150	
0285	126	0	
0285	127	350	
0285	128	100	
0285	129	175	
0285	130	500	

Sequence of Steps Followed by the TRLP Program

The sequence of steps within the TRLP Program moves from reading of structural commands for the problem through to determination of the optimum pattern and presentation of the results. The ten major steps performed in sequential order by the program are as follows:

1. Read the instructions and commands for the problem from the INPUT.TLP file created with the front program, TRANS.

2. Read the supply quantities, demand quantities and transfer rates from the TRLPDATA.RUN file.

3. Check balance of supply and demand quantities, and assign the residual to a dummy supply or demand cell.

4. Find the initial near-optimum solution, following Edward Russell's extension of Dantzig's algorithm.

5. Calculate the shadow prices by supply point (column) and demand point (row) which are associated with the initial near-optimum solution.

6. If maximum specified number of iterations encountered, store the intermediate result to disk file, NINP4; read this file in subsequent run and proceed to optimum solution.

7. Continue iterations for leaving basic variable until applications of "global" criteria insure that no further reduction in total distribution cost is possible.

8. Print the requested listings and output of the problem solution.

9. Create disk file of the solution output, OUTPUT.TLP, if requested.

10. Set up commands for the subsequent recursive run, if requested, and return to Step 2. When all is complete come to normal end of program.

Listing of the Source Program

The complete listing of the Fortran source program for TRLP is included in Appendix C of the Manual. It will be noted that a short main program is used to establish the maximum row and column dimensions for the problem, and that most of the functions of the program are performed by the TRLP Subroutine. No additional subroutines are called by TRLP or by the Main program.

Major components of the Transportation Linear Program include (1) main program, (2) commands read, (3) data read, (4) balance check, (5) initial solution, (6) intermediate result save, (7) iterations for optimum, (8) output generation, and (9) shadow price display. Each is outlined briefly below.

Main Program

The short main program encompasses lines 1 to 55 of the listing in Appendix C. Its function is to read the dimensions of the problem together with instructions for the type of run to be made, and set up the run for the TRLP Subroutine.

Commands Read

This section extends from line 125 to line 191. It reads the number of passes in the run; the period identification; the commands for a file of output, for recursive run, for using same rates, and for printing shadow prices; the number of modes in the problem; the omit commands for quantity difference, intermediate result, transport rates, initial pattern, origin sort, destination sort, mode

sort, rates by mode, mode by origin, and mode by destination; and, if applicable, the identification number and description of each mode included.

Data Read

The data read section extends from line 192 to line 313. Supply quantities for recursive problems are read and adjusted at lines 194-226. Supply quantities for other problems are read at lines 227-250, and demand quantities are read at lines 251-271. Transfer rates by link are read at lines 279-313.

Balance Check

This section encompasses lines 315-384 of the program listing in Appendix C. It checks the balance between total supply quantity and total demand quantity, and assigns any residual to a dummy supply cell (NOT SHIPPED) or dummy demand cell (NOT RECEIVED).

Initial Solution

The initial solution section of TRLP extends from line 385 to line 499. The algorithm used is adapted from Edward J. Russell's Extension of Dantzig's Algorithm for Finding an Initial Near-Optimum Basis for the Transportation Problem.

Intermediate Result Save

The section for storing intermediate results when the specified maximum number of iterations is encountered, and for reading the saved file in the subsequent run, extends from line 500 to line 569. The file used for this purpose is called NINP4.

Iterations for Optimum

The linear programming algorithm for the iterations to insure least-cost distribution pattern for problem solution is listed on lines 570 to 727. The sequential steps involved are (1) calculate shadow prices (lines 570-603), (2) find largest Z-T(i,j) as entering basic variable (lines 604-632), and (3) find leaving basic variable (one first reaching zero) (lines 633-727). The process through these routines is repeated until it is no longer possible to lower the total distribution cost for the problem.

Output Generation

The section of the TRLP program for printing the formatted output encompasses lines 728 through 834 of the Fortran source program listing in Appendix C. When requested, the disk file of results is generated as OUTPUT.TLP at lines 757-9. Routines for the optional printed output schedules come at lines 745-770, lines 779-796, and lines 806-823.

Shadow Price Display

When requested by the ISHADW command entry of 1 at the commands read step, the table of shadow prices and marginal costs associated with the optimum solution is printed at line 835 to line of 845 of the program listing. Although bulky, this

listing can be helpful in judging probable shifts in optimum distribution patterns were a given constraint or constraints to be removed from the distribution network. The printout can be omitted for those problems and configurations which are not seriously impacted by removable constraints in the distribution system.

SECTION VII

OPTIMUM DISTRIBUTION OF RICE IN BICOL REGION

Concept of Single-Mode Transportation LP Analysis

The concept and assumptions of Transportation Linear Programming models fit the needs of product marketing and distribution quite well. At a given time, products come from primary production in specified geographic patterns and in specified forms. The volume of demand for products follows some different but also definable pattern. The cost of transferring a product from supply points to demand points over the existing marketing network can be determined. Given such information, a transportation linear programming problem can be formulated for solution of the least-cost global distribution pattern over the network, as illustrated by Figure 3 in Section III. Such formulation represents a straight-forward determination of spatial equilibrium product distribution for a specified period of time, such as a month, a growing season or a crop year. The TRLP Case One for optimum distribution of rice in the Bicol Region of the Philippines serves to illustrate such formulation for determination of spatial equilibrium.

The concept of spatial equilibrium is applicable for any product which is produced or otherwise available in varying quantities at one set of locations, and is needed for utilization in varying quantities at another set of locations. Given the two sets of quantities and a set of transfer costs from each origin point to each destination point, spatial equilibrium is indicated when the product is moved over the "network" from origin to destination in such a way that the total cost of the distribution is minimized. The givens for the spatial equilibrium problem are (1) the supply quantities by source, (2) the demand quantities by destination, and (3) the transfer costs by link from source to destination. The solution is the distribution pattern of shipments from origin to destination which minimizes total distribution cost.

The specification of the supply quantities by source is illustrated by Figure 1 in Section III. In this example the given quantities range from 350 at origin 22 to 870 at origin 25. The combined total quantity available at the ten origin points for distribution among the alternative destination points is 6,130.

The associated set of demand quantities by individual demand point is illustrated by the rows in Figure 1. There are 20 numbered destination points in the illustration, extending from 21 to 30, and 121 to 130. In this case, a dummy demand cell is needed because the total demand quantity at the 20 destinations is 6,020 compared to the total supply quantity at the 10 origins of 6,130. The balance of 110 is assigned to the dummy demand cell on the asterisk line of Figure 1.

The transfer costs connecting supply origin points to destination points in the network are illustrated in Figure 2, Section III. These are freight rates or unit costs for each cell in the table. The full set of rates rather than just the half matrix is needed, even though in the example the rate from origin 22 to destination 21 is the same as that from origin 21 to destination 22, and so on throughout the network.

Description of the Case

The TRLPDATA.ONE Case was selected to introduce the user to the Transportation LP program because of its relative simplicity, and at the same time its illustration of many features which the program can address. Although hypothetical, the case is abstracted from actual study data of rice marketing in the BICOL region of the Philippines. The locations listed are municipalities of Camarines Sur Province there.

It is not the purpose in this manual to address directly the methodology for developing the estimates and projections upon which the input for the TRLP program is based. Suffice it to say that a series of worksheets for developing production estimates, population and consumption estimates, storage capacities, and transport routes and costs had to be completed prior to conducting the Linear Programming analysis. For our purposes here we take this information as given.

With respect to the transportation linear programming analysis, several characteristics of the case need to be recognized at the outset:

1. Estimates are abstracted from monthly figures for the region; the case represents the first month of the series.

2. The case is structured as a transhipment problem in that all ten supply locations are also demand locations. The points are numbered accordingly.

3. In addition to the demand for current consumption, each of the demand points has storage capacity and storage demand.

4. Transfer rates (unit costs) include both transportation rates and storage costs per unit. These are reflected in the numbering of the demand points, the first ten involving transport only, and the next ten involving storage as well.

5. The transportation linear programming algorithm is designed to minimize total distribution costs over the entire transport and storage network. The solution must take supply quantities by location as given, and meet demand quantity requirements at each location and time point.

6. In the problem as formulated, total supply quantity exceeds total demand quantity by 110 units. The program assigns this quantity to the supply location at the greatest comparative disadvantage for supplying demand locations in the network. A destination of 99999 NOT SHIPPED is assigned to this quantity by the program.

7. For this problem most of the optional output schedules of the program applicable to single mode problems are exercised in order to illustrate the appearance of the different schedules. Usually users would not request all of the optional schedules when running this kind of problem.

Program Commands and Data Input for the Case

The Bicol rice marketing problem input as structured for application of the TRLP program to solve for least-cost distribution consists of two input files, INPUT.ONE and TRLPDATA.ONE. The first is created with the front program, TRANS, through keyboard input in response to menu prompts provided by that program. The second is created manually as an ASCII file, either directly with EDLIN, or as a print (DOS) file with software such as LOTUS. The TRLPData file includes the supply quantities by origin, the demand quantities by destination, and the transfer rates from origin to destination. The two files as used to determine the optimum rice distribution pattern are reproduced below.

Input.One File

```
 10  20 100   0   0
  1 185   0   0   0   1   0   0   0   0   0   0   0   0   0   0   0
```

TRLPData.One File

0185	21	650	NAGA CITY
0185	22	350	CAMALIGAN
0185	23	490	GAINZA
0185	24	615	CANAMAN
0185	25	870	MAGARAO
0185	26	530	PILI
0185	27	690	OCAMPO
0185	28	715	BULA
0185	29	820	BAAO
0185	30	400	NABUA
0185	21	150	NAGA CITY-1
0185	22	500	CAMALIGAN-1
0185	23	0	GAINZA-1
0185	24	0	CANAMAN-1
0185	25	320	MAGARAO-1
0185	26	240	PILI-1
0185	27	300	OCAMPO-1
0185	28	0	BULA-1
0185	29	250	BAAO-1
0185	30	600	NABUA-1
0185	121	300	NAGA CITY-2
0185	122	400	CAMALIGAN-2
0185	123	350	GAINZA-2
0185	124	750	CANAMAN-2
0185	125	0	MAGARAO-2
0185	126	150	PILI-2
0185	127	470	OCAMPO-2
0185	128	0	BULA-2
0185	129	490	BAAO-2
0185	130	750	NAUBA-2
21	21	0.00	
21	22	7.20	
21	23	5.90	

21	24	7.00
21	25	15.60
21	26	27.90
21	27	28.80
21	28	26.30
21	29	29.70
21	30	57.80
21	121	5.00
21	122	11.90
21	123	11.00
21	124	12.20
21	125	21.40
21	126	32.90
21	127	33.90
21	128	31.00
21	129	34.50
21	130	61.50
22	21	7.20
22	22	0.00
22	23	8.70
22	24	9.80
22	25	18.40
22	26	30.70
22	27	31.60
22	28	29.10
22	29	32.50
22	30	60.60
22	121	11.90
22	122	4.80
22	123	13.60
22	124	14.90
22	125	23.90
22	126	35.20
22	127	36.50
22	128	34.00
22	129	37.60
22	130	65.80
23	21	5.90
23	22	8.70
23	23	0.00
23	24	3.30
23	25	17.10
23	26	29.10
23	27	30.30
23	28	27.80
23	29	31.20
23	30	59.30
23	121	11.00
23	122	13.60
23	123	5.10
23	124	8.60
23	125	22.40

23	126	34.00
23	127	35.40
23	128	32.90
23	129	36.00
23	130	64.70
24	21	7.00
24	22	9.80
24	23	3.30
24	24	0.00
24	25	18.20
24	26	30.50
24	27	31.40
24	28	28.90
24	29	32.30
24	30	60.40
24	121	12.20
24	122	14.90
24	123	8.60
24	124	5.20
24	125	23.00
24	126	35.60
24	127	36.70
24	128	33.40
24	129	37.30
24	130	65.10
25	21	15.60
25	22	18.40
25	23	17.10
25	24	18.20
25	25	0.00
25	26	12.30
25	27	13.20
25	28	10.70
25	29	14.10
25	30	42.20
25	121	21.40
25	122	23.90
25	123	22.40
25	124	23.00
25	125	5.10
25	126	17.60
25	127	18.80
25	128	15.60
25	129	19.70
25	130	47.00
26	21	27.90
26	22	30.70
26	23	29.40
26	24	30.50
26	25	12.30
26	26	0.00
26	27	22.80

26	28	20.70
26	29	21.40
26	30	52.20
26	121	32.90
26	122	35.20
26	123	34.00
26	124	35.60
26	125	17.60
26	126	4.90
26	127	27.80
26	128	25.40
26	129	29.00
26	130	57.30
27	21	28.80
27	22	31.60
27	23	30.30
27	24	31.40
27	25	13.20
27	26	22.80
27	27	0.00
27	28	16.50
27	29	19.90
27	30	48.00
27	121	33.90
27	122	36.50
27	123	35.40
27	124	36.70
27	125	18.80
27	126	27.80
27	127	4.70
27	128	21.40
27	129	25.00
27	130	52.60
28	21	26.30
28	22	29.10
28	23	27.80
28	24	28.90
28	25	10.70
28	26	20.70
28	27	16.50
28	28	0.00
28	29	3.40
28	30	31.50
28	121	31.00
28	122	34.00
28	123	32.90
28	124	33.40
28	125	15.60
28	126	25.40
28	127	21.40
28	128	5.00
28	129	8.60

28	130	36.90
29	21	29.70
29	22	32.50
29	23	31.20
29	24	32.30
29	25	14.10
29	26	21.40
29	27	19.90
29	28	3.40
29	29	0.00
29	30	28.10
29	121	34.50
29	122	37.60
29	123	36.00
29	124	37.30
29	125	19.70
29	126	29.00
29	127	25.00
29	128	8.60
29	129	5.40
29	130	33.60
30	21	57.80
30	22	60.60
30	23	59.30
30	24	60.40
30	25	42.20
30	26	52.20
30	27	48.00
30	28	31.50
30	29	28.10
30	30	0.00
30	121	61.50
30	122	65.80
30	123	64.70
30	124	65.10
30	125	47.00
30	126	57.30
30	127	52.60
30	128	36.90
30	129	38.60
30	130	5.30

Listing of Program Input

Supply Quantities

SUPPLY QUANTITIES BY ORIGIN FOR PROJECTED PERIOD 185

	SUPPLY POINT	QUANTITY
21	NAGA CITY	650.00
22	CAMALIGAN	350.00
23	GAINZA	490.00

24	CANAMAN	615.00
25	MAGARAO	870.00
26	PILI	530.00
27	OCAMPO	690.00
28	BULA	715.00
29	BAAO	820.00
30	NABUA	400.00
	TOTAL	6130.00

Demand Quantities

DEMAND QUANTITIES BY DESTINATION FOR PROJECTED PERIOD 185

	DEMAND POINT	QUANTITY
21	NAGA CITY-1	150.00
22	CAMALIGAN-1	500.00
23	GAINZA-1	.00
24	CANAMAN-1	.00
25	MAGARAO-1	320.00
26	PILI-1	240.00
27	OCAMPO-1	300.00
28	BULA-1	.00
29	BAAO-1	250.00
30	NABUA-1	600.00
121	NAGA CITY-2	300.00
122	CAMALIGAN-2	400.00
123	GAINZA-2	350.00
124	CANAMAN-2	750.00
125	MAGARAO-2	.00
126	PILI-2	150.00
127	OCAMPO-2	470.00
128	BULA-2	.00
129	BAAO-2	490.00
130	NAUBA-2	750.00
	TOTAL	6020.00

Transfer Costs

LISTING OF TRANSFER COST FROM ORIGIN TO DESTINATION

ORIGIN		DESTINATION		UNIT COST
21	NAGA CITY	21	NAGA CITY-1	.000
21	NAGA CITY	22	CAMALIGAN-1	7.200
21	NAGA CITY	23	GAINZA-1	5.900
21	NAGA CITY	24	CANAMAN-1	7.000
21	NAGA CITY	25	MAGARAO-1	15.600
21	NAGA CITY	26	PILI-1	27.900
21	NAGA CITY	27	OCAMPO-1	28.800
21	NAGA CITY	28	BULA-1	26.300
21	NAGA CITY	29	BAAO-1	29.700

21	NAGA CITY	30	NABUA-1	57.800
21	NAGA CITY	121	NAGA CITY-2	5.000
21	NAGA CITY	122	CAMALIGAN-2	11.900
21	NAGA CITY	123	GAINZA-2	11.000
21	NAGA CITY	124	CANAMAN-2	12.200
21	NAGA CITY	125	MAGARAO-2	21.400
21	NAGA CITY	126	PILI-2	32.900
21	NAGA CITY	127	OCAMPO-2	33.900
21	NAGA CITY	128	BULA-2	31.000
21	NAGA CITY	129	BAAO-2	34.500
21	NAGA CITY	130	NAUBA-2	61.500
22	CAMALIGAN	21	NAGA CITY-1	7.200
22	CAMALIGAN	22	CAMALIGAN-1	.000
22	CAMALIGAN	23	GAINZA-1	8.700
22	CAMALIGAN	24	CANAMAN-1	9.800
22	CAMALIGAN	25	MAGARAO-1	18.400
22	CAMALIGAN	26	PILI-1	30.700
22	CAMALIGAN	27	OCAMPO-1	31.600
22	CAMALIGAN	28	BULA-1	29.100
22	CAMALIGAN	29	BAAO-1	32.500
22	CAMALIGAN	30	NABUA-1	60.600
22	CAMALIGAN	121	NAGA CITY-2	11.900
22	CAMALIGAN	122	CAMALIGAN-2	4.800
22	CAMALIGAN	123	GAINZA-2	13.600
22	CAMALIGAN	124	CANAMAN-2	14.900
22	CAMALIGAN	125	MAGARAO-2	23.900
22	CAMALIGAN	126	PILI-2	35.200
22	CAMALIGAN	127	OCAMPO-2	36.500
22	CAMALIGAN	128	BULA-2	34.000
22	CAMALIGAN	129	BAAO-2	37.600
22	CAMALIGAN	130	NAUBA-2	65.800
23	GAINZA	21	NAGA CITY-1	5.900
23	GAINZA	22	CAMALIGAN-1	8.700
23	GAINZA	23	GAINZA-1	.000
23	GAINZA	24	CANAMAN-1	3.300
23	GAINZA	25	MAGARAO-1	17.100
23	GAINZA	26	PILI-1	29.100
23	GAINZA	27	OCAMPO-1	30.300
23	GAINZA	28	BULA-1	27.800
23	GAINZA	29	BAAO-1	31.200
23	GAINZA	30	NABUA-1	59.300
23	GAINZA	121	NAGA CITY-2	11.000
23	GAINZA	122	CAMALIGAN-2	13.600
23	GAINZA	123	GAINZA-2	5.100
23	GAINZA	124	CANAMAN-2	8.600
23	GAINZA	125	MAGARAO-2	22.400
23	GAINZA	126	PILI-2	34.000
23	GAINZA	127	OCAMPO-2	35.400
23	GAINZA	128	BULA-2	32.900
23	GAINZA	129	BAAO-2	36.000
23	GAINZA	130	NAUBA-2	64.700
24	CANAMAN	21	NAGA CITY-1	7.000

24	CANAMAN	22	CAMALIGAN-1	9.800
24	CANAMAN	23	GAINZA-1	3.300
24	CANAMAN	24	CANAMAN-1	.000
24	CANAMAN	25	MAGARAO-1	18.200
24	CANAMAN	26	PILI-1	30.500
24	CANAMAN	27	OCAMPO-1	31.400
24	CANAMAN	28	BULA-1	28.900
24	CANAMAN	29	BAAO-1	32.300
24	CANAMAN	30	NABUA-1	60.400
24	CANAMAN	121	NAGA CITY-2	12.200
24	CANAMAN	122	CAMALIGAN-2	14.900
24	CANAMAN	123	GAINZA-2	8.600
24	CANAMAN	124	CANAMAN-2	5.200
24	CANAMAN	125	MAGARAO-2	23.000
24	CANAMAN	126	PILI-2	35.600
24	CANAMAN	127	OCAMPO-2	36.700
24	CANAMAN	128	BULA-2	33.400
24	CANAMAN	129	BAAO-2	37.300
24	CANAMAN	130	NAUBA-2	65.100
25	MAGARAO	21	NAGA CITY-1	15.600
25	MAGARAO	22	CAMALIGAN-1	18.400
25	MAGARAO	23	GAINZA-1	17.100
25	MAGARAO	24	CANAMAN-1	18.200
25	MAGARAO	25	MAGARAO-1	.000
25	MAGARAO	26	PILI-1	12.300
25	MAGARAO	27	OCAMPO-1	13.200
25	MAGARAO	28	BULA-1	10.700
25	MAGARAO	29	BAAO-1	14.100
25	MAGARAO	30	NABUA-1	42.200
25	MAGARAO	121	NAGA CITY-2	21.400
25	MAGARAO	122	CAMALIGAN-2	23.900
25	MAGARAO	123	GAINZA-2	22.400
25	MAGARAO	124	CANAMAN-2	23.000
25	MAGARAO	125	MAGARAO-2	5.100
25	MAGARAO	126	PILI-2	17.600
25	MAGARAO	127	OCAMPO-2	18.800
25	MAGARAO	128	BULA-2	15.600
25	MAGARAO	129	BAAO-2	19.700
25	MAGARAO	130	NAUBA-2	47.000
26	PILI	21	NAGA CITY-1	27.900
26	PILI	22	CAMALIGAN-1	30.700
26	PILI	23	GAINZA-1	29.400
26	PILI	24	CANAMAN-1	30.500
26	PILI	25	MAGARAO-1	12.300
26	PILI	26	PILI-1	.000
26	PILI	27	OCAMPO-1	22.800
26	PILI	28	BULA-1	20.700
26	PILI	29	BAAO-1	21.400
26	PILI	30	NABUA-1	52.200
26	PILI	121	NAGA CITY-2	32.900
26	PILI	122	CAMALIGAN-2	35.200
26	PILI	123	GAINZA-2	34.000

26	PILI	124	CANAMAN-2	35.600
26	PILI	125	MAGARAO-2	17.600
26	PILI	126	PILI-2	4.900
26	PILI	127	OCAMPO-2	27.800
26	PILI	128	BULA-2	25.400
26	PILI	129	BAAO-2	29.000
26	PILI	130	NAUBA-2	57.300
27	OCAMPO	21	NAGA CITY-1	28.800
27	OCAMPO	22	CAMALIGAN-1	31.600
27	OCAMPO	23	GAINZA-1	30.300
27	OCAMPO	24	CANAMAN-1	31.400
27	OCAMPO	25	MAGARAO-1	13.200
27	OCAMPO	26	PILI-1	22.800
27	OCAMPO	27	OCAMPO-1	.000
27	OCAMPO	28	BULA-1	16.500
27	OCAMPO	29	BAAO-1	19.900
27	OCAMPO	30	NABUA-1	48.000
27	OCAMPO	121	NAGA CITY-2	33.900
27	OCAMPO	122	CAMALIGAN-2	36.500
27	OCAMPO	123	GAINZA-2	35.400
27	OCAMPO	124	CANAMAN-2	36.700
27	OCAMPO	125	MAGARAO-2	18.800
27	OCAMPO	126	PILI-2	27.800
27	OCAMPO	127	OCAMPO-2	4.700
27	OCAMPO	128	BULA-2	21.400
27	OCAMPO	129	BAAO-2	25.000
27	OCAMPO	130	NAUBA-2	52.600
28	BULA	21	NAGA CITY-1	26.300
28	BULA	22	CAMALIGAN-1	29.100
28	BULA	23	GAINZA-1	27.800
28	BULA	24	CANAMAN-1	28.900
28	BULA	25	MAGARAO-1	10.700
28	BULA	26	PILI-1	20.700
28	BULA	27	OCAMPO-1	16.500
28	BULA	28	BULA-1	.000
28	BULA	29	BAAO-1	3.400
28	BULA	30	NABUA-1	31.500
28	BULA	121	NAGA CITY-2	31.000
28	BULA	122	CAMALIGAN-2	34.000
28	BULA	123	GAINZA-2	32.900
28	BULA	124	CANAMAN-2	33.400
28	BULA	125	MAGARAO-2	15.600
28	BULA	126	PILI-2	25.400
28	BULA	127	OCAMPO-2	21.400
28	BULA	128	BULA-2	5.000
28	BULA	129	BAAO-2	8.600
28	BULA	130	NAUBA-2	36.900
29	BAAO	21	NAGA CITY-1	29.700
29	BAAO	22	CAMALIGAN-1	32.500
29	BAAO	23	GAINZA-1	31.200
29	BAAO	24	CANAMAN-1	32.300
29	BAAO	25	MAGARAO-1	14.100

29	BAAO	26	PILI-1	21.400
29	BAAO	27	OCAMPO-1	19.900
29	BAAO	28	BULA-1	3.400
29	BAAO	29	BAAO-1	.000
29	BAAO	30	NABUA-1	28.100
29	BAAO	121	NAGA CITY-2	34.500
29	BAAO	122	CAMALIGAN-2	37.600
29	BAAO	123	GAINZA-2	36.000
29	BAAO	124	CANAMAN-2	37.300
29	BAAO	125	MAGARAO-2	19.700
29	BAAO	126	PILI-2	29.000
29	BAAO	127	OCAMPO-2	25.000
29	BAAO	128	BULA-2	8.600
29	BAAO	129	BAAO-2	5.400
29	BAAO	130	NAUBA-2	33.600
30	NABUA	21	NAGA CITY-1	57.800
30	NABUA	22	CAMALIGAN-1	60.600
30	NABUA	23	GAINZA-1	59.300
30	NABUA	24	CANAMAN-1	60.400
30	NABUA	25	MAGARAO-1	42.200
30	NABUA	26	PILI-1	52.200
30	NABUA	27	OCAMPO-1	48.000
30	NABUA	28	BULA-1	31.500
30	NABUA	29	BAAO-1	28.100
30	NABUA	30	NABUA-1	.000
30	NABUA	121	NAGA CITY-2	61.500
30	NABUA	122	CAMALIGAN-2	65.800
30	NABUA	123	GAINZA-2	64.700
30	NABUA	124	CANAMAN-2	65.100
30	NABUA	125	MAGARAO-2	47.000
30	NABUA	126	PILI-2	57.300
30	NABUA	127	OCAMPO-2	52.600
30	NABUA	128	BULA-2	36.900
30	NABUA	129	BAAO-2	38.600
30	NABUA	130	NAUBA-2	5.300
99999	NOT SHIPPED		110.00	

Optimal Distribution Solution for 0185

Initial Solution by Origin

INITIAL SOLUTION SORTED BY ORIGIN FOR PROJECTED PERIOD 185

ORIGIN		DESTINATION		QUANTITY	UNIT COST	TOTAL COST
21	NAGA CITY	21	NAGA CITY-1	150.	.00	.00
21	NAGA CITY	121	NAGA CITY-2	300.	5.00	1500.00
21	NAGA CITY	122	CAMALIGAN-2	200.	11.90	2380.00
22	CAMALIGAN	22	CAMALIGAN-1	350.	.00	.00
23	GAINZA	22	CAMALIGAN-1	5.	8.70	43.50
23	GAINZA	123	GAINZA-2	350.	5.10	1785.00
23	GAINZA	124	CANAMAN-2	135.	8.60	1161.00

24	CANAMAN	124	CANAMAN-2	615.	5.20	3198.00
25	MAGARAO	22	CAMALIGAN-1	145.	18.40	2668.00
25	MAGARAO	25	MAGARAO-1	320.	.00	.00
25	MAGARAO	122	CAMALIGAN-2	200.	23.90	4780.00
25	MAGARAO	130	NAUBA-2	205.	47.00	9635.00
26	PILI	26	PILI-1	240.	.00	.00
26	PILI	126	PILI-2	150.	4.90	735.00
26	PILI	127	OCAMPO-2	80.	27.80	2224.00
26	PILI	129	BAAO-2	60.	29.00	1740.00
27	OCAMPO	27	OCAMPO-1	300.	.00	.00
27	OCAMPO	127	OCAMPO-2	390.	4.70	1833.00
28	BULA	129	BAAO-2	60.	8.60	516.00
28	BULA	130	NAUBA-2	545.	36.90	20110.50
28	BULA	99999	NOT SHIPPED	110.	.00	.00
29	BAAO	29	BAAO-1	250.	.00	.00
29	BAAO	30	NABUA-1	200.	28.10	5620.00
29	BAAO	129	BAAO-2	370.	5.40	1998.00
30	NABUA	30	NABUA-1	400.	.00	.00
			TOTAL	6130.		61927.00

Optimal Solution by Origin

OPTIMAL SOLUTION SORTED BY ORIGIN FOR PROJECTED PERIOD 185

ORIGIN		DESTINATION		QUANTITY	UNIT COST	TOTAL COST
21	NAGA CITY	21	NAGA CITY-1	150.	.00	.00
21	NAGA CITY	121	NAGA CITY-2	300.	5.00	1500.00
21	NAGA CITY	122	CAMALIGAN-2	200.	11.90	2380.00
22	CAMALIGAN	22	CAMALIGAN-1	150.	.00	.00
22	CAMALIGAN	122	CAMALIGAN-2	200.	4.80	960.00
23	GAINZA	22	CAMALIGAN-1	5.	8.70	43.50
23	GAINZA	123	GAINZA-2	350.	5.10	1785.00
23	GAINZA	124	CANAMAN-2	135.	8.60	1161.00
24	CANAMAN	124	CANAMAN-2	615	5.20	3198.00
25	MAGARAO	22	CAMALIGAN-1	345.	18.40	6348.00
25	MAGARAO	25	MAGARAO-1	320.	.00	.00
25	MAGARAO	27	OCAMPO-1	80.	13.20	1056.00
25	MAGARAO	130	NAUBA-2	125.	47.00	5875.00
26	PILI	26	PILI-1	240.	.00	.00
26	PILI	29	BAAO-1	30.	21.40	642.00
26	PILI	126	PILI-2	150.	4.90	735.00
26	PILI	99999	NOT SHIPPED	110.	.00	.00
27	OCAMPO	27	OCAMPO-1	220.	.00	.00
27	OCAMPO	127	OCAMPO-2	470.	4.70	2209.00
28	BULA	129	BAAO-2	490.	8.60	4214.00
28	BULA	130	NAUBA-2	225.	36.90	8302.50
29	BAAO	29	BAAO-1	220.	.00	.00
29	BAAO	30	NABUA-1	600.	28.10	16860.00
30	NABUA	130	NAUBA-2	400.	5.30	2120.00
			TOTAL	6130.		59389.00

Optimal Solution by Destination

OPTIMAL SOLUTION SORTED BY DESTINATION FOR PROJECTED PERIOD 185

ORIGIN		DESTINATION		QUANTITY	UNIT COST	TOTAL COST
21	NAGA CITY	21	NAGA CITY-1	150.	.00	.00
22	CAMALIGAN	22	CAMALIGAN-1	150.	.00	.00
23	GAINZA	22	CAMALIGAN-1	5.	8.70	43.50
25	MAGARAO	22	CAMALIGAN-1	345.	18.40	6348.00
25	MAGARAO	25	MAGARAO-1	320.	.00	.00
26	PILI	26	PILI-1	240.	.00	.00
25	MAGARAO	27	OCAMPO-1	80.	13.20	1056.00
27	OCAMPO	27	OCAMPO-1	220.	.00	.00
26	PILI	29	BAAO-1	30.	21.40	642.00
29	BAAO	29	BAAO-1	220.	.00	.00
29	BAAO	30	NABUA-1	600.	28.10	16860.00
21	NAGA CITY	121	NAGA CITY-2	300.	5.00	1500.00
21	NAGA CITY	122	CAMALIGAN-2	200.	11.90	2380.00
22	CAMALIGAN	122	CAMALIGAN-2	200.	4.80	960.00
23	GAINZA	123	GAINZA-2	350.	5.10	1785.00
23	GAINZA	124	CANAMAN-2	135.	8.60	1161.00
24	CANAMAN	124	CANAMAN-2	615.	5.20	3198.00
26	PILI	126	PILI-2	150.	4.90	735.00
27	OCAMPO	127	OCAMPO-2	470.	4.70	2209.00
28	BULA	129	BAAO-2	490.	8.60	4214.00
25	MAGARAO	130	NAUBA-2	125.	47.00	5875.00
28	BULA	130	NAUBA-2	225.	36.90	8302.50
30	NABUA	130	NAUBA-2	400.	5.30	2120.00
26	PILI	99999	NOT SHIPPED	110.	.00	.00
			TOTAL	6130.		59389.00

ITERATION = 7

Listing of Shadow Prices and Marginal Costs

THE MARGINAL COST FROM ORIGIN TO DESTINATION PERIOD 185

ORIGIN		DESTINATION		RATE	SUPPLY SHADOW PRICE	DEMAND SHADOW PRICE	MARGINAL COST
21	NAGA CITY	21	NAGA CITY-1	.00	.00	.00	.00
21	NAGA CITY	22	CAMALIGAN-1	7.20	.00	7.10	.10
21	NAGA CITY	23	GAINZA-1	5.90	.00	.00	5.90
21	NAGA CITY	24	CANAMAN-1	7.00	.00	.00	7.00
21	NAGA CITY	25	MAGARAO-1	15.60	.00	-11.30	26.90
21	NAGA CITY	26	PILI-1	27.90	.00	-19.20	47.10
21	NAGA CITY	27	OCAMPO-1	28.80	.00	1.90	26.90
21	NAGA CITY	28	BULA-1	26.30	.00	.00	26.30
21	NAGA CITY	29	BAAO-1	29.70	.00	2.20	27.50
21	NAGA CITY	30	NABUA-1	57.80	.00	30.30	27.50
21	NAGA CITY	121	NAGA CITY-2	5.00	.00	5.00	.00

21	NAGA CITY	122	CAMALIGAN-2	11.90	.00	11.90	.00
21	NAGA CITY	123	GAINZA-2	11.00	.00	3.50	7.50
21	NAGA CITY	124	CANAMAN-2	12.20	.00	7.00	5.20
21	NAGA CITY	125	MAGARAO-2	21.40	.00	.00	21.40
21	NAGA CITY	126	PILI-2	32.90	.00	-14.30	47.20
21	NAGA CITY	127	OCAMPO-2	33.90	.00	6.60	27.30
21	NAGA CITY	128	BULA-2	31.00	.00	.00	31.00
21	NAGA CITY	129	BAAO-2	34.50	.00	7.40	27.10
21	NAGA CITY	130	NAUBA-2	61.50	.00	35.70	25.80
21	NAGA CITY	99999	NOT SHIPPED	.00	.00	-19.20	19.20
22	CAMALIGAN	21	NAGA CITY-1	7.20	-7.10	.00	14.30
22	CAMALIGAN	22	CAMALIGAN-1	.00	-7.10	7.10	.00
22	CAMALIGAN	23	GAINZA-1	8.70	-7.10	.00	15.80
22	CAMALIGAN	24	CANAMAN-1	9.80	-7.10	.00	16.90
22	CAMALIGAN	25	MAGARAO-1	18.40	-7.10	-11.30	36.80
22	CAMALIGAN	26	PILI-1	30.70	-7.10	-19.20	57.00
22	CAMALIGAN	27	OCAMPO-1	31.60	-7.10	1.90	36.80
22	CAMALIGAN	28	BULA-1	29.10	-7.10	.00	36.20
22	CAMALIGAN	29	BAAO-1	32.50	-7.10	2.20	37.40
22	CAMALIGAN	30	NABUA-1	60.60	-7.10	30.30	37.40
22	CAMALIGAN	121	NAGA CITY-2	11.90	-7.10	5.00	14.00
22	CAMALIGAN	122	CAMALIGAN-2	4.80	-7.10	11.90	.00
22	CAMALIGAN	123	GAINZA-2	13.60	-7.10	3.50	17.20
22	CAMALIGAN	124	CANAMAN-2	14.90	-7.10	7.00	15.00
22	CAMALIGAN	125	MAGARAO-2	23.90	-7.10	.00	31.00
22	CAMALIGAN	126	PILI-2	35.20	-7.10	-14.30	56.60
22	CAMALIGAN	127	OCAMPO-2	36.50	-7.10	6.60	37.00
22	CAMALIGAN	128	BULA-2	34.00	-7.10	.00	41.10
22	CAMALIGAN	129	BAAO-2	37.60	-7.10	7.40	37.30
22	CAMALIGAN	130	NAUBA-2	65.80	-7.10	35.70	37.20
22	CAMALIGAN	99999	NOT SHIPPED	.00	-7.10	-19.20	26.30
23	GAINZA	21	NAGA CITY-1	5.90	1.60	.00	4.30
23	GAINZA	22	CAMALIGAN-1	8.70	1.60	7.10	.00
23	GAINZA	23	GAINZA-1	.00	1.60	.00	-1.60
23	GAINZA	24	CANAMAN-1	3.30	1.60	.00	1.70
23	GAINZA	25	MAGARAO-1	17.10	1.60	-11.30	26.80
23	GAINZA	26	PILI-1	29.10	1.60	-19.20	46.70
23	GAINZA	27	OCAMPO-1	30.30	1.60	1.90	26.80
23	GAINZA	28	BULA-1	27.80	1.60	.00	26.20
23	GAINZA	29	BAAO-1	31.20	1.60	2.20	27.40
23	GAINZA	30	NABUA-1	59.30	1.60	30.30	27.40
23	GAINZA	121	NAGA CITY-2	11.00	1.60	5.00	4.40
23	GAINZA	122	CAMALIGAN-2	13.60	1.60	11.90	.10
23	GAINZA	123	GAINZA-2	5.10	1.60	3.50	.00
23	GAINZA	124	CANAMAN-2	8.60	1.60	7.00	.00
23	GAINZA	125	MAGARAO-2	22.40	1.60	.00	20.80
23	GAINZA	126	PILI-2	34.00	1.60	-14.30	46.70
23	GAINZA	127	OCAMPO-2	35.40	1.60	6.60	27.20
23	GAINZA	128	BULA-2	32.90	1.60	.00	31.30
23	GAINZA	129	BAAO-2	36.00	1.60	7.40	27.00
23	GAINZA	130	NAUBA-2	64.70	1.60	35.70	27.40
23	GAINZA	99999	NOT SHIPPED	.00	1.60	-19.20	17.60

24	CANAMAN	21	NAGA CITY-1	7.00	-1.80	.00	8.80
24	CANAMAN	22	CAMALIGAN-1	9.80	-1.80	7.10	4.50
24	CANAMAN	23	GAINZA-1	3.30	-1.80	.00	5.10
24	CANAMAN	24	CANAMAN-1	.00	-1.80	.00	1.80
24	CANAMAN	25	MAGARAO-1	18.20	-1.80	-11.30	31.30
24	CANAMAN	26	PILI-1	30.50	-1.80	-19.20	51.50
24	CANAMAN	27	OCAMPO-1	31.40	-1.80	1.90	31.30
24	CANAMAN	28	BULA-1	28.90	-1.80	.00	30.70
24	CANAMAN	29	BAAO-1	32.30	-1.80	2.20	31.90
24	CANAMAN	30	NABUA-1	60.40	-1.80	30.30	31.90
24	CANAMAN	121	NAGA CITY-2	12.20	-1.80	5.00	9.00
24	CANAMAN	122	CAMALIGAN-2	14.90	-1.80	11.90	4.80
24	CANAMAN	123	GAINZA-2	8.60	-1.80	3.50	6.90
24	CANAMAN	124	CANAMAN-2	5.20	-1.80	7.00	.00
24	CANAMAN	125	MAGARAO-2	23.00	-1.80	.00	24.80
24	CANAMAN	126	PILI-2	35.60	-1.80	-14.30	51.70
24	CANAMAN	127	OCAMPO-2	36.70	-1.80	6.60	31.90
24	CANAMAN	128	BULA-2	33.40	-1.80	.00	35.20
24	CANAMAN	129	BAAO-2	37.30	-1.80	7.40	31.70
24	CANAMAN	130	NAUBA-2	65.10	-1.80	35.70	31.20
24	CANAMAN	99999	NOT SHIPPED	.00	-1.80	-19.20	21.00
25	MACARAO	21	NAGA CITY-1	15.60	11.30	.00	4.30
25	MAGARAO	22	CAMALIGAN-1	18.40	11.30	7.10	.00
25	MAGARAO	23	GAINZA-1	17.10	11.30	.00	5.80
25	MAGARAO	24	CANAMAN-1	18.20	11.30	.00	6.90
25	MAGARAO	25	MAGARAO-1	.00	11.30	-11.30	.00
25	MAGARAO	26	PILI-1	12.30	11.30	-19.20	20.20
25	MAGARAO	27	OCAMPO-1	13.20	11.30	1.90	.00
25	MAGARAO	28	BULA-1	10.70	11.30	.00	-.60
25	MAGARAO	29	BAAO-1	14.10	11.30	2.20	.60
25	MAGARAO	30	NABUA-1	42.20	11.30	30.30	.60
25	MAGARAO	121	NAGA CITY-2	21.40	11.30	5.00	5.10
25	MAGARAO	122	CAMALIGAN-2	23.90	11.30	11.90	.70
25	MAGARAO	123	GAINZA-2	22.40	11.30	3.50	7.60
25	MAGARAO	124	CANAMAN-2	23.00	11.30	7.00	4.70
25	MAGARAO	125	MAGARAO-2	5.10	11.30	.00	-6.20
25	MAGARAO	126	PILI-2	17.60	11.30	-14.30	20.60
25	MAGARAO	127	OCAMPO-2	18.80	11.30	6.60	.90
25	MAGARAO	128	BULA-2	15.60	11.30	.00	4.30
25	MAGARAO	129	BAAO-2	19.70	11.30	7.40	1.00
25	MAGARAO	130	NAUBA-2	47.00	11.30	35.70	.00
25	MAGARAO	99999	NOT SHIPPED	.00	11.30	-19.20	7.90
26	PILI	21	NAGA CITY-1	27.90	19.20	.00	8.70
26	PILI	22	CAMALIGAN-1	30.70	19.20	7.10	4.40
26	PILI	23	GAINZA-1	29.40	19.20	.00	10.20
26	PILI	24	CANAMAN-1	30.50	19.20	.00	11.30
26	PILI	25	MAGARAO-1	12.30	19.20	-11.30	4.40
26	PILI	26	PILI-1	.00	19.20	-19.20	.00
26	PILI	27	OCAMPO-1	22.80	19.20	1.90	1.70
26	PILI	28	BULA-1	20.70	19.20	.00	1.50
26	PILI	29	BAAO-1	21.40	19.20	2.20	.00
26	PILI	30	NABUA-1	52.20	19.20	30.30	2.70

26	PILI	121	NAGA CITY-2	32.90	19.20	5.00	8.70
26	PILI	122	CAMALIGAN-2	35.20	19.20	11.90	4.10
26	PILI	123	GAINZA-2	34.00	19.20	3.50	11.30
26	PILI	124	CANAMAN-2	35.60	19.20	7.00	9.40
26	PILI	125	MAGARAO-2	17.60	19.20	.00	-1.60
26	PILI	126	PILI-2	4.90	19.20	-14.30	.00
26	PILI	127	OCAMPO-2	27.80	19.20	6.60	2.00
26	PILI	128	BULA-2	25.40	19.20	.00	6.20
26	PILI	129	BAAO-2	29.00	19.20	7.40	2.40
26	PILI	130	NAUBA-2	57.30	19.20	35.70	2.40
26	PILI	99999	NOT SHIPPED	.00	19.20	-19.20	.00
27	OCAMPO	21	NAGA CITY-1	28.80	-1.90	.00	30.70
27	OCAMPO	22	CAMALIGAN-1	31.60	-1.90	7.10	26.40
27	OCAMPO	23	GAINZA-1	30.30	-1.90	.00	32.20
27	OCAMPO	24	CANAMAN-1	31.40	-1.90	.00	33.30
27	OCAMPO	25	MAGARAO-1	13.20	-1.90	-11.30	26.40
27	OCAMPO	26	PILI-1	22.80	-1.90	-19.20	43.90
27	OCAMPO	27	OCAMPO-1	.00	-1.90	1.90	.00
27	OCAMPO	28	BULA-1	16.50	-1.90	.00	18.40
27	OCAMPO	29	BAAO-1	19.90	-1.90	2.20	19.60
27	OCAMPO	30	NABUA-1	48.00	-1.90	30.30	19.60
27	OCAMPO	121	NAGA CITY-2	33.90	-1.90	5.00	30.80
27	OCAMPO	122	CAMALIGAN-2	36.50	-1.90	11.90	26.50
27	OCAMPO	123	GAINZA-2	35.40	-1.90	3.50	33.80
27	OCAMPO	124	CANAMAN-2	36.70	-1.90	7.00	31.60
27	OCAMPO	125	MAGARAO-2	18.80	-1.90	.00	20.70
27	OCAMPO	126	PILI-2	27.80	-1.90	-14.30	44.00
27	OCAMPO	127	OCAMPO-2	4.70	-1.90	6.60	.00
27	OCAMPO	128	BULA-2	21.40	-1.90	.00	23.30
27	OCAMPO	129	BAAO-2	25.00	-1.90	7.40	19.50
27	OCAMPO	130	NAUBA-2	52.60	-1.90	35.70	18.80
27	OCAMPO	99999	NOT SHIPPED	.00	-1.90	-19.20	21.10
28	BULA	21	NAGA CITY-1	26.30	1.20	.00	25.10
28	BULA	22	CAMALIGAN-1	29.10	1.20	7.10	20.80
28	BULA	23	GAINZA-1	27.80	1.20	.00	26.60
28	BULA	24	CANAMAN-1	28.90	1.20	.00	27.70
28	BULA	25	MAGARAO-1	10.70	1.20	-11.30	20.80
28	BULA	26	PILI-1	20.70	1.20	-19.20	38.70
28	BULA	27	OCAMPO-1	16.50	1.20	1.90	13.40
28	BULA	28	BULA-1	.00	1.20	.00	-1.20
28	BULA	29	BAAO-1	3.40	1.20	2.20	.00
28	BULA	30	NABUA-1	31.50	1.20	30.30	.00
28	BULA	121	NAGA CITY-2	31.00	1.20	5.00	24.80
28	BULA	122	CAMALIGAN-2	34.00	1.20	11.90	20.90
28	BULA	123	GAINZA-2	32.90	1.20	3.50	28.20
28	BULA	124	CANAMAN-2	33.40	1.20	7.00	25.20
28	BULA	125	MAGARAO-2	15.60	1.20	.00	14.40
28	BULA	126	PILI-2	25.40	1.20	-14.30	38.50
28	BULA	127	OCAMPO-2	21.40	1.20	6.60	13.60
28	BULA	128	BULA-2	5.00	1.20	.00	3.80
28	BULA	129	BAAO-2	8.60	1.20	7.40	.00
28	BULA	130	NAUBA-2	36.90	1.20	35.70	.00

28	BULA	99999	NOT SHIPPED	.00	1.20	-19.20	18.00
29	BAAO	21	NAGA CITY-1	29.70	-2.20	.00	31.90
29	BAAO	22	CAMALIGAN-1	32.50	-2.20	7.10	27.60
29	BAAO	23	GAINZA-1	31.20	-2.20	.00	33.40
29	BAAO	24	CANAMAN-1	32.30	-2.20	.00	34.50
29	BAAO	25	MAGARAO-1	14.10	-2.20	-11.30	27.60
29	BAAO	26	PILI-1	21.40	-2.20	-19.20	42.80
29	BAAO	27	OCAMPO-1	19.90	-2.20	1.90	20.20
29	BAAO	28	BULA-1	3.40	-2.20	.00	5.60
29	BAAO	29	BAAO-1	.00	-2.20	2.20	.00
29	BAAO	30	NABUA-1	28.10	-2.20	30.30	.00
29	BAAO	121	NAGA CITY-2	34.50	-2.20	5.00	31.70
29	BAAO	122	CAMALIGAN-2	37.60	-2.20	11.90	27.90
29	BAAO	123	GAINZA-2	36.00	-2.20	3.50	34.70
29	BAAO	124	CANAMAN-2	37.30	-2.20	7.00	32.50
29	BAAO	125	MAGARAO-2	19.70	-2.20	.00	21.90
29	BAAO	126	PILI-2	29.00	-2.20	-14.30	45.50
29	BAAO	127	OCAMPO-2	25.00	-2.20	6.60	20.60
29	BAAO	128	BULA-2	8.60	-2.20	.00	10.80
29	BAAO	129	BAAO-2	5.40	-2.20	7.40	.20
29	BAAO	130	NAUBA-2	33.60	-2.20	35.70	.10
29	BAAO	99999	NOT SHIPPED	.00	-2.20	-19.20	21.40
30	NABUA	21	NAGA CITY-1	57.80	-30.40	.00	88.20
30	NABUA	22	CAMALIGAN-1	60.60	-30.40	7.10	83.90
30	NABUA	23	GAINZA-1	59.30	-30.40	.00	89.70
30	NABUA	24	CANAMAN-1	60.40	-30.40	.00	90.80
30	NABUA	25	MAGARAO-1	42.20	-30.40	-11.30	83.90
30	NABUA	26	PILI-1	52.20	-30.40	-19.20	101.80
30	NABUA	27	OCAMPO-1	48.00	-30.40	1.90	76.50
30	NABUA	28	BULA-1	31.50	-30.40	.00	61.90
30	NABUA	29	BAAO-1	28.10	-30.40	2.20	56.30
30	NABUA	30	NABUA-1	.00	-30.40	30.30	.10
30	NABUA	121	NAGA CITY-2	61.50	-30.40	5.00	86.90
30	NABUA	122	CAMALIGAN-2	65.80	-30.40	11.90	84.30
30	NABUA	123	GAINZA-2	64.70	-30.40	3.50	91.60
30	NABUA	124	CANAMAN-2	65.10	-30.40	7.00	88.50
30	NABUA	125	MAGARAO-2	47.00	-30.40	.00	77.40
30	NABUA	126	PILI-2	57.30	-30.40	-14.30	102.00
30	NABUA	127	OCAMPO-2	52.60	-30.40	6.60	76.40
30	NABUA	128	BULA-2	36.90	-30.40	.00	67.30
30	NABUA	129	BAAO-2	38.60	-30.40	7.40	61.60
30	NABUA	130	NAUBA-2	5.30	-30.40	35.70	.00
30	NABUA	99999	NOT SHIPPED	.00	-30.40	-19.20	49.60

SECTION VIII

OPTIMUM MARKETING AND STORAGE PATTERNS FOR RICE

Concept of Multi-Channel Recursive Distribution Analysis

Multi-channel considerations come into play for many real world marketing and distribution problems which involve choices among alternative ways to get from origin M to destination N. In the simplest case, alternative transport modes may be available, such as highway, railroad and waterway. In more complex cases there may be alternative routes and marketing channels as well. Movement from origin M to destination N may involve movement through time (storage) and change in form (processing) as well as movement through space.

The TRLP programs address problems with these kinds of dimensions as multi-modal, requiring that the mode be identified for each link and its associated rate in the network. The final value used as cost in each link for the optimum distribution solution is taken to be the least costly alternative. The RATES program is designed to search the alternative modes and select the best for each link. The TRLP program keeps track of the selected mode associated with individual links, and displays the mode or market channel in the program output. Given these modifications in concept and problem formulation, the linear programming solution is determined in the same way and subject to the same interpretation as the pure spatial equilibrium case.

The recursive option of TRLP permits consideration of the time dimension and certain kinds of form change (processing). For example, the annual distribution of a crop from production point to final utilization point can be treated as twelve sequential runs with the recursive feature. Equilibrium distribution for the first harvest month is allocated between current utilization and storage for later utilization. Supply quantities in storage from the first month are added to current production the second month to obtain totals for allocation among current utilization and storage the second month, and so on.

In the formulation of recursive problems the quantities by point of origin need to be identified in terms of time (and form) as well as place. The demand quantities by destination need to be identified in the same way. Each link and its associated cost needs to include spatial transfer, storage (say for one month), and processing (say from rough rice to brown rice or to polished rice). The mode identification needs to include the market channel or route for going from source M to destination N. This might include such descriptions as DIRECT USE, TRANSPORT ONLY, STORAGE ONLY, or TRANSPORT & STORAGE. Or to also reflect three-stage processing, it might involve a set of modes such as STOR-PROC-SHIP, STOR-SHIP-PROC, PROC-SHIP-STOR, PROC-STOR-SHIP, SHIP-STOR-PROC, SHIP-PROC-STOR, STOR-SHIP, SHIP-STOR, PROC-SHIP, SHIP-PROC, STOR-PROC, PROC-STOR, STOR ONLY, PROC ONLY, SHIP ONLY, DIRECT USE.

It is convenient to structure recursive problems such that the transfer costs for a given link remain constant from one month to the next. Then the monthly supply quantities and monthly demand quantities can be supplied for each month in

succession at the outset in the TRLPDATA.RUN file, and the twelve monthly solutions will appear in sequence without further input or interaction by the user.

Description of the Case

The TRLPDATA.TWO Bicol Rice Storage and Marketing Case illustrates the power of the Transportation LP Program in applying the recursive feature plus the multi-modal feature to gain additional information from the linear programming solution. The case is the same as TRLPCASE.ONE except that four transfer modes are identified and a recursive solution for Period 0285 (second harvest month) is ordered following the Period 0185 solution. The four transfer modes are distinguished not by method of transport but by kind of transfer, i.e., by storage, by transport, by neither, or by both. Of course, as is true of mode selection generally, only one transfer mode is applied between any pair of points for input to the optimum solution. The mode feature keeps track of which mode is used for every transfer and provides solution output which is sorted accordingly.

The request for mode identification is indicated by a code of 1 for MOD at input Step 1 of the separate front program for entering command codes for the problem, TRANS (see Section V). The total number of modes is indicated as 4 at NM in Step 2 of that program. Mode identification numbers and names are supplied for each of the four modes at Step 4 of the TRANS program. In addition, mode identification numbers are added to the transfer cost matrix in the TRLPDATA input file for the problem. The desired output tables by mode are indicated by codes of 0 for MOORIG and MODEST (and entries of 1 for the other options) at Step 3 of the TRANS program input.

The recursive solution for the case is activated by inserting another set of input data (for Period 0285) in the data input file, TRLPDATA.RUN, immediately following the last data entry for Period 0185, and indicating that IRECUR is 1 at Step 2 of the commands through TRANS. The demand points are numbered in the case so that quantities allocated to storage points from Period 0185 can be added to the current supply quantities at these points to form the total supply quantity by location for 0285. Because the transfer costs in this case are the same in Period 0285 as those in Period 0185 (ISAME is entered as 1 at Step 2 of TRANS), the transfer cost data input is omitted for the recursive solution. Of course, the output options requested for the first period will also be executed for the recursive runs, as this case illustrates.

For realistic application of the recursive feature of the TRLP to grain storage and marketing over an entire crop year, one would repeat the subsequent recursive runs with the program for each succeeding harvest month in the same fashion. Once the storage capacity at a location becomes filled, the "storage" demand at that location for that month would be set at zero. Any recursive runs after the harvest is completed would contain zero current supply quantities (no new harvest) for all supply locations; in this case the recursive feature would find the minimum cost pattern for supplying current demand from storage stocks at the beginning of that period.

With respect to the transportation linear programming analysis, a few additional characteristics of the case need to be kept in mind. These are outlined under points 1 - 7 for TRLPCASE.ONE in Section VII.

Program Commands and Data Input for the Case

The program commands and data input for TRLP solution of the optimum marketing and storage pattern for rice in the Bicol Region of the Philippines are contained in two files, INPUT.TWO and TRLPDATA.TWO. The first is created with the separate program TRANS in the manner described in Section V. The second is created manually in the manner and format described in Section IV of the manual. The TRLPDATA file contains the data for the first period, including supply quantities, demand quantities, and transfer rates, and then the data for the second period, including supply quantities and demand quantities, but not transfer rates (since ISAME is indicated as 1). The two files as used to determine the optimum rice marketing and storage pattern are reproduced below.

Input.Two File

```
 10  20 100   0   1
  2 185   0   0   0   0   4   0   0   1   1   1   0   0   1   0   0
      1     LOCAL USE
      2     DIRECT HAUL
      3     STORAGE ONLY
      4     DIRECT & STORAGE
```

TRLPData.Two File

0185	21	650	NAGA CITY
0185	22	350	CAMALIGAN
0185	23	490	GAINZA
0185	24	615	CANAMAN
0185	25	870	MAGARAO
0185	26	530	PILI
0185	27	690	OCAMPO
0185	28	715	BULA
0185	29	820	BAAO
0185	30	400	NABUA
0185	21	150	NAGA CITY-1
0185	22	500	CAMALIGAN-1
0185	23	0	GAINZA-1
0185	24	0	CANAMAN-1
0185	25	320	MAGARAO-1
0185	26	240	PILI-1
0185	27	300	OCAMPO-1
0185	28	0	BULA-1
0185	29	250	BAAO-1
0185	30	600	NABUA-1
0185	121	300	NAGA CITY-2
0185	122	400	CAMALIGAN-2
0185	123	350	GAINZA-2
0185	124	750	CANAMAN-2
0185	125	0	MAGARAO-2
0185	126	150	PILI-2
0185	127	470	OCAMPO-2
0185	128	0	BULA-2

0185	129	490	BAAO-2
0185	130	750	NAUBA-2
21	21	0.00	1
21	22	7.20	2
21	23	5.90	2
21	24	7.00	2
21	25	15.60	2
21	26	27.90	2
21	27	28.80	2
21	28	26.30	2
21	29	29.70	2
21	30	57.80	2
21	121	5.00	3
21	122	11.90	4
21	123	11.00	4
21	124	12.20	4
21	125	21.40	4
21	126	32.90	4
21	127	33.90	4
21	128	31.00	4
21	129	34.50	4
21	130	61.50	4
22	21	7.20	2
22	22	0.00	1
22	23	8.70	2
22	24	9.80	2
22	25	18.40	2
22	26	30.70	2
22	27	31.60	2
22	28	29.10	2
22	29	32.50	2
22	30	60.60	2
22	121	11.90	4
22	122	4.80	3
22	123	13.60	4
22	124	14.90	4
22	125	23.90	4
22	126	35.20	4
22	127	36.50	4
22	128	34.00	4
22	129	37.60	4
22	130	65.80	4
23	21	5.90	2
23	22	8.70	2
23	23	0.00	1
23	24	3.30	2
23	25	17.10	2
23	26	29.10	2
23	27	30.30	2
23	28	27.80	2
23	29	31.20	2
23	30	59.30	2

23	121	11.00	4
23	122	13.60	4
23	123	5.10	3
23	124	8.60	4
23	125	22.40	4
23	126	34.00	4
23	127	35.40	4
23	128	32.90	4
23	129	36.00	4
23	130	64.70	4
24	21	7.00	2
24	22	9.80	2
24	23	3.30	3
24	24	0.00	1
24	25	18.20	2
24	26	30.50	2
24	27	31.40	2
24	28	28.90	2
24	29	32.30	2
24	30	60.40	2
24	121	12.20	4
24	122	14.90	4
24	123	8.60	4
24	124	5.20	3
24	125	23.00	4
24	126	35.60	4
24	127	36.70	4
24	128	33.40	4
24	129	37.30	4
24	130	65.10	4
25	21	15.60	2
25	22	18.40	2
25	23	17.10	2
25	24	18.20	2
25	25	0.00	1
25	26	12.30	2
25	27	13.20	2
25	28	10.70	2
25	29	14.10	2
25	30	42.20	2
25	121	21.40	4
25	122	23.90	4
25	123	22.40	4
25	124	23.00	4
25	125	5.10	3
25	126	17.60	4
25	127	18.80	4
25	128	15.60	4
25	129	19.70	4
25	130	47.00	4
26	21	27.90	2
26	22	30.70	2

26	23	29.40	2
26	24	30.50	2
26	25	12.30	2
26	26	0.00	1
26	27	22.80	2
26	28	20.70	2
26	29	21.40	2
26	30	52.20	2
26	121	32.90	4
26	122	35.20	4
26	123	34.00	4
26	124	35.60	4
26	125	17.60	4
26	126	4.90	3
26	127	27.80	4
26	128	25.40	4
26	129	29.00	4
26	130	57.30	4
27	21	28.80	2
27	22	31.60	2
27	23	30.30	2
27	24	31.40	2
27	25	13.20	2
27	26	22.80	2
27	27	0.00	1
27	28	16.50	2
27	29	19.90	2
27	30	48.00	2
27	121	33.90	4
27	122	36.50	4
27	123	35.40	4
27	124	36.70	4
27	125	18.80	4
27	126	27.80	4
27	127	4.70	3
27	128	21.40	4
27	129	25.00	4
27	130	52.60	4
28	21	26.30	2
28	22	29.10	2
28	23	27.80	2
28	24	28.90	2
28	25	10.70	2
28	26	20.70	2
28	27	16.50	2
28	28	0.00	1
28	29	3.40	2
28	30	31.50	2
28	121	31.00	4
28	122	34.00	4
28	123	32.90	4
28	124	33.40	4

28	125	15.60	4
28	126	25.40	4
28	127	21.40	4
28	128	5.00	3
28	129	8.60	4
28	130	36.90	4
29	21	29.70	2
29	22	32.50	2
29	23	31.20	2
29	24	32.30	2
29	25	14.10	2
29	26	21.40	2
29	27	19.90	2
29	28	3.40	2
29	29	0.00	1
29	30	28.10	2
29	121	34.50	4
29	122	37.60	4
29	123	36.00	4
29	124	37.30	4
29	125	19.70	4
29	126	29.00	4
29	127	25.00	4
29	128	8.60	4
29	129	5.40	3
29	130	33.60	4
30	21	57.80	2
30	22	60.60	2
30	23	59.30	2
30	24	60.40	2
30	25	42.20	2
30	26	52.20	2
30	27	48.00	2
30	28	31.50	2
30	29	28.10	2
30	30	0.00	1
30	121	61.50	4
30	122	65.80	4
30	123	64.70	4
30	124	65.10	4
30	125	47.00	4
30	126	57.30	4
30	127	52.60	4
30	128	36.90	4
30	129	38.60	4
30	130	5.30	3
0285	21	150	
0285	22	350	
0285	23	370	
0285	24	950	
0285	25	0	
0285	26	0	

0285	27	430
0285	28	250
0285	29	115
0285	30	220
0285	21	400
0285	22	200
0285	23	150
0285	24	0
0285	25	190
0285	26	450
0285	27	500
0285	28	0
0285	29	600
0285	30	300
0285	121	0
0285	122	250
0285	123	415
0285	124	250
0285	125	150
0285	126	0
0285	127	350
0285	128	100
0285	129	175
0285	130	500

Listing of Program Input for 0185

Supply Quantities

SUPPLY QUANTITIES BY ORIGIN FOR PROJECTED PERIOD 185

SUPPLY POINT		QUANTITY
21	NAGA CITY	650.00
22	CAMALIGAN	350.00
23	GAINZA	490.00
24	CANAMAN	615.00
25	MAGARAO	870.00
26	PILI	530.00
27	OCAMPO	690.00
28	BULA	715.00
29	BAAO	820.00
30	NABUA	400.00
	TOTAL	6130.00

Demand Quantities

DEMAND QUANTITIES BY DESTINATION FOR PROJECTED PERIOD 185

DEMAND POINT		QUANTITY
21	NAGA CITY-1	150.00
22	CAMALIGAN-1	500.00

23	GAINZA-1	.00	
24	CANAMAN-1	.00	
25	MAGARAO-1	320.00	
26	PILI-1	240.00	
27	OCAMPO-1	300.00	
28	BULA-1	.00	
29	BAAO-1	250.00	
30	NABUA-1	600.00	
121	NAGA CITY-2	300.00	
122	CAMALIGAN-2	400.00	
123	GAINZA-2	350.00	
124	CANAMAN-2	750.00	
125	MAGARAO-2	.00	
126	PILI-2	150.00	
127	OCAMPO-2	470.00	
128	BULA-2	.00	
129	BAAO-2	490.00	
130	NAUBA-2	750.00	
	TOTAL	6020.00	
99999	NOT SHIPPED	110.00	49 NOT AVAILABLE

Solution Storage and Marketing Patterns for 0185

Optimal Solution by Origin

OPTIMAL SOLUTION SORTED BY ORIGIN FOR PROJECTED PERIOD 185

ORIGIN	DESTINATION	MODE	QUANTITY	RATE	TOTAL COS'
21 NAGA CITY	21 NAGA CITY-1	1 LOCAL USE	150.	.00	.00
21 NAGA CITY	121 NAGA CITY-2	3 STORAGE ONLY	300.	5.00	1500.00
21 NAGA CITY	122 CAMALIGAN-2	4 DIRECT & STORAGE	200.	11.90	2380.00
22 CAMALIGAN	22 CAMALIGAN-1	1 LOCAL USE	150.	.00	.00
22 CAMALIGAN	122 CAMALIGAN-2	3 STORAGE ONLY	200.	4.80	960.00
23 GAINZA	22 CAMALIGAN-1	2 DIRECT HAUL	5.	8.70	43.50
23 GAINZA	123 GAINZA-2	3 STORAGE ONLY	350.	5.10	1785.00
23 GAINZA	124 CANAMAN-2	4 DIRECT & STORAGE	135.	8.60	1161.00
24 CANAMAN	124 CANAMAN-2	3 STORAGE ONLY	615.	5.20	3198.00
25 MAGARAO	22 CAMALIGAN-1	2 DIRECT HAUL	345.	18.40	6348.00
25 MAGARAO	25 MAGARAO-1	1 LOCAL USE	320.	.00	00
25 MAGARAO	27 OCAMPO-1	2 DIRECT HAUL	80.	13.20	1056.00
25 MAGARAO	130 NAUBA-2	4 DIRECT & STORAGE	125.	47.00	5875.00
26 PILI	26 PILI-1	1 LOCAL USE	240.	.00	.00
26 PILI	29 BAAO-1	2 DIRECT HAUL	30.	21.40	642.00
26 PILI	126 PILI-2	3 STORAGE ONLY	150.	4.90	735.00
26 PILI	99999 NOT SHIPPED	49 NOT AVAILABLE	110.	.00	.00
27 OCAMPO	27 OCAMPO-1	1 LOCAL USE	220.	.00	.00
27 OCAMPO	127 OCAMPO-2	3 STORAGE ONLY	470.	4.70	2209.00
28 BULA	129 BAAO-2	4 DIRECT & STORAGE	490.	8.60	4214.00
28 BULA	130 NAUBA-2	4 DIRECT & STORAGE	225.	36.90	8302.50
29 BAAO	29 BAAO-1	1 LOCAL USE	220.	.00	.00

29 BAAO	30 NABUA-1	2 DIRECT HAUL	600.	28.10	16860.0
30 NABUA	130 NAUBA-2	3 STORAGE ONLY	400.	5.30	2120.0
		TOTAL	6130.		59389.0

Optimal Solution by Destination

OPTIMAL SOLUTION SORTED BY DESTINATION FOR PROJECTED PERIOD 185

ORIGIN	DESTINATION	MODE	QUANTITY	RATE	TOTAL CO
21 NAGA CITY	21 NAGA CITY-1	1 LOCAL USE	150.	.00	.0
22 CAMALIGAN	22 CAMALIGAN-1	1 LOCAL USE	150.	.00	.0
23 GAINZA	22 CAMALIGAN-1	2 DIRECT HAUL	5.	8.70	43.5
25 MAGARAO	22 CAMALIGAN-1	2 DIRECT HAUL	345.	18.40	6348.0
25 MAGARAO	25 MAGARAO-1	1 LOCAL USE	320.	.00	.0
26 PILI	26 PILI-1	1 LOCAL USE	240.	.00	.0
25 MAGARAO	27 OCAMPO-1	2 DIRECT HAUL	80.	13.20	1056.0
27 OCAMPO	27 OCAMPO-1	1 LOCAL USE	220.	.00	.0
26 PILI	29 BAAO-1	2 DIRECT HAUL	30.	21.40	642.0
29 BAAO	29 BAAO-1	1 LOCAL USE	220.	.00	.0
29 BAAO	30 NABUA-1	2 DIRECT HAUL	600.	28.10	16860.0
21 NAGA CITY	121 NAGA CITY-2	3 STORAGE ONLY	300.	5.00	1500.0
21 NAGA CITY	122 CAMALIGAN-2	4 DIRECT & STORAGE	200.	11.90	2380.0
22 CAMALIGAN	122 CAMALIGAN-2	3 STORAGE ONLY	200.	4.80	960.0
23 GAINZA	123 GAINZA-2	3 STORAGE ONLY	350.	5.10	1785.0
23 GAINZA	124 CANAMAN-2	4 DIRECT & STORAGE	135.	8.60	1161.0
24 CANAMAN	124 CANAMAN-2	3 STORAGE ONLY	615.	5.20	3198.0
26 PILI	126 PILI-2	3 STORAGE ONLY	150.	4.90	735.0
27 OCAMPO	127 OCAMPO-2	3 STORAGE ONLY	470.	4.70	2209.0
28 BULA	129 BAAO-2	4 DIRECT & STORAGE	490.	8.60	4214.0
25 MAGARAO	130 NAUBA-2	4 DIRECT & STORAGE	125.	47.00	5875.0
28 BULA	130 NAUBA-2	4 DIRECT & STORAGE	225.	36.90	8302.5
30 NABUA	130 NAUBA-2	3 STORAGE ONLY	400.	5.30	2120.0
26 PILI	99999 NOT SHIPPED	49 NOT AVAILABLE	110.	.00	.0
		TOTAL	6130.		59389.0

Optimal Solution by Mode

OPTIMAL SOLUTION SORTED BY MODE FOR PROJECTED PERIOD 185

ORIGIN	DESTINATION	MODE	QUANTITY	RATE	TOTAL CO
21 NAGA CITY	21 NAGA CITY-1	1 LOCAL USE	150.	.00	.0
22 CAMALIGAN	22 CAMALIGAN-1	1 LOCAL USE	150.	.00	.0
25 MAGARAO	25 MAGARAO-1	1 LOCAL USE	320.	.00	.0
26 PILI	26 PILI-1	1 LOCAL USE	240.	.00	.0
27 OCAMPO	27 OCAMPO-1	1 LOCAL USE	220.	.00	.0
29 BAAO	29 BAAO-1	1 LOCAL USE	220.	.00	.0
		SUBTOTAL	1300.		.0
23 GAINZA	22 CAMALIGAN-1	2 DIRECT HAUL	5.	8.70	43.5
25 MAGARAO	22 CAMALIGAN-1	2 DIRECT HAUL	345.	18.40	6348.0
25 MAGARAO	27 OCAMPO-1	2 DIRECT HAUL	80.	13.20	1056.0

26 PILI	29 BAAO-1	2 DIRECT HAUL	30.	21.40	642.00
29 BAAO	30 NABUA-1	2 DIRECT HAUL	600.	28.10	16860.00
		SUBTOTAL	1060.		24949.50
21 NAGA CITY	121 NAGA CITY-2	3 STORAGE ONLY	300.	5.00	1500.00
22 CAMALIGAN	122 CAMALIGAN-2	3 STORAGE ONLY	200.	4.80	960.00
23 GAINZA	123 GAINZA-2	3 STORAGE ONLY	350.	5.10	1785.00
24 CANAMAN	124 CANAMAN-2	3 STORAGE ONLY	615.	5.20	3198.00
26 PILI	126 PILI-2	3 STORAGE ONLY	150.	4.90	735.00
27 OCAMPO	127 OCAMPO-2	3 STORAGE ONLY	470.	4.70	2209.00
30 NABUA	130 NAUBA-2	3 STORAGE ONLY	400.	5.30	2120.00
		SUBTOTAL	2485.		12507.00
21 NAGA CITY	122 CAMALIGAN-2	4 DIRECT & STORAGE	200.	11.90	2380.00
23 GAINZA	124 CANAMAN-2	4 DIRECT & STORAGE	135.	8.60	1161.00
25 MAGARAO	130 NAUBA-2	4 DIRECT & STORAGE	125.	47.00	5875.00
28 BULA	129 BAAO-2	4 DIRECT & STORAGE	490.	8.60	4214.00
28 BULA	130 NAUBA-2	4 DIRECT & STORAGE	225.	36.90	8302.50
		SUBTOTAL	1175.		21932.50
26 PILI	99999 NOT SHIPPED	49 NOT AVAILABLE	110.	.00	.00
		SUBTOTAL	110.		.00
		TOTAL	6130.		59389.00

ITERATION = 7

Listing of Program Input for 0285

Supply Quantities

SUPPLY QUANTITIES BY ORIGIN FOR PROJECTED PERIOD 285

SUPPLY POINT		QUANTITY
21	NAGA CITY	450.00
22	CAMALIGAN	750.00
23	GAINZA	720.00
24	CANAMAN	1700.00
25	MAGARAO	.00
26	PILI	150.00
27	OCAMPO	900.00
28	BULA	250.00
29	BAAO	605.00
30	NABUA	970.00
	TOTAL	6495.00

Demand Quantities

DEMAND QUANTITIES BY DESTINATION FOR PROJECTED PERIOD 285

DEMAND POINT		QUANTITY
21	NAGA CITY-1	400.00
22	CAMALIGAN-1	200.00
23	GAINZA-1	150.00
24	CANAMAN-1	.00
25	MAGARAO-1	190.00
26	PILI-1	450.00
27	OCAMPO-1	500.00
28	BULA-1	.00
29	BAAO-1	600.00
30	NABUA-1	300.00
121	NAGA CITY-2	.00
122	CAMALIGAN-2	250.00
123	GAINZA-2	415.00
124	CANAMAN-2	250.00
125	MAGARAO-2	150.00
126	PILI-2	.00
127	OCAMPO-2	350.00
128	BULA-2	100.00
129	BAAO-2	175.00
130	NAUBA-2	500.00
	TOTAL	4980.00
99999	NOT SHIPPED	1515.00 49 NOT AVAILABLE

Solution Storage and Marketing Patterns for 0285

Optimal Solution by Origin

OPTIMAL SOLUTION SORTED BY ORIGIN FOR PROJECTED PERIOD 285

ORIGIN	DESTINATION	MODE	QUANTITY	RATE	TOTAL COS
21 NAGA CITY	21 NAGA CITY-1	1 LOCAL USE	400.	.00	.0
21 NAGA CITY	26 PILI-1	2 DIRECT HAUL	50.	27.90	1395.0
22 CAMALIGAN	22 CAMALIGAN-1	1 LOCAL USE	200.	.00	.0
22 CAMALIGAN	122 CAMALIGAN-2	3 STORAGE ONLY	250.	4.80	1200.0
22 CAMALIGAN	99999 NOT SHIPPED	49 NOT AVAILABLE	300.	.00	.0
23 GAINZA	23 GAINZA-1	1 LOCAL USE	150.	.00	.0
23 GAINZA	26 PILI-1	2 DIRECT HAUL	155.	29.10	4510.5
23 GAINZA	123 GAINZA-2	3 STORAGE ONLY	415.	5.10	2116.5
24 CANAMAN	25 MAGARAO-1	2 DIRECT HAUL	190.	18.20	3458.0
24 CANAMAN	26 PILI-1	2 DIRECT HAUL	65.	30.50	1982.5
24 CANAMAN	124 CANAMAN-2	3 STORAGE ONLY	250.	5.20	1300.0
24 CANAMAN	125 MAGARAO-2	4 DIRECT & STORAGE	150.	23.00	3450.0
24 CANAMAN	99999 NOT SHIPPED	49 NOT AVAILABLE	1045.	.00	.0
26 PILI	26 PILI-1	1 LOCAL USE	150.	.00	.0
27 OCAMPO	26 PILI-1	2 DIRECT HAUL	30.	22.80	684.0

27 OCAMPO	27 OCAMPO-1	1 LOCAL USE	500.	.00	.00
27 OCAMPO	127 OCAMPO-2	3 STORAGE ONLY	350.	4.70	1645.00
27 OCAMPO	128 BULA-2	4 DIRECT & STORAGE	20.	21.40	428.00
28 BULA	128 BULA-2	3 STORAGE ONLY	80.	5.00	400.00
28 BULA	129 BAAO-2	4 DIRECT & STORAGE	170.	8.60	1462.00
29 BAAO	29 BAAO-1	1 LOCAL USE	600.	.00	.00
29 BAAO	129 BAAO-2	3 STORAGE ONLY	5.	5.40	27.00
30 NABUA	30 NABUA-1	1 LOCAL USE	300.	.00	.00
30 NABUA	130 NAUBA-2	3 STORAGE ONLY	500.	5.30	2650.00
30 NABUA	99999 NOT SHIPPED	49 NOT AVAILABLE	170.	.00	.00
		TOTAL	6495.		26708.50

Optimal Solution by Destination

OPTIMAL SOLUTION SORTED BY DESTINATION FOR PROJECTED PERIOD 285

ORIGIN	DESTINATION	MODE	QUANTITY	RATE	TOTAL COST
21 NAGA CITY	21 NAGA CITY-1	1 LOCAL USE	400.	.00	.00
22 CAMALIGAN	22 CAMALIGAN-1	1 LOCAL USE	200.	.00	.00
23 GAINZA	23 GAINZA-1	1 LOCAL USE	150.	.00	.00
24 CANAMAN	25 MAGARAO-1	2 DIRECT HAUL	190.	18.20	3458.00
21 NAGA CITY	26 PILI-1	2 DIRECT HAUL	50.	27.90	1395.00
23 GAINZA	26 PILI-1	2 DIRECT HAUL	155.	29.10	4510.50
24 CANAMAN	26 PILI-1	2 DIRECT HAUL	65.	30.50	1982.50
26 PILI	26 PILI-1	1 LOCAL USE	150.	.00	.00
27 OCAMPO	26 PILI-1	2 DIRECT HAUL	30.	22.80	684.00
27 OCAMPO	27 OCAMPO-1	1 LOCAL USE	500.	.00	.00
29 BAAO	29 BAAO-1	1 LOCAL USE	600.	.00	.00
30 NABUA	30 NABUA-1	1 LOCAL USE	300.	.00	.00
22 CAMALIGAN	122 CAMALIGAN-2	3 STORAGE ONLY	250.	4.80	1200.00
23 GAINZA	123 GAINZA-2	3 STORAGE ONLY	415.	5.10	2116.50
24 CANAMAN	124 CANAMAN-2	3 STORAGE ONLY	250.	5.20	1300.00
24 CANAMAN	125 MAGARAO-2	4 DIRECT & STORAGE	150.	23.00	3450.00
27 OCAMPO	127 OCAMPO-2	3 STORAGE ONLY	350.	4.70	1645.00
27 OCAMPO	128 BULA-2	4 DIRECT & STORAGE	20.	21.40	428.00
28 BULA	128 BULA-2	3 STORAGE ONLY	80.	5.00	400.00
28 BULA	129 BAAO-2	4 DIRECT & STORAGE	170.	8.60	1462.00
29 BAAO	129 BAAO-2	3 STORAGE ONLY	5.	5.40	27.00
30 NABUA	130 NAUBA-2	3 STORAGE ONLY	500.	5.30	2650.00
22 CAMALIGAN	99999 NOT SHIPPED	49 NOT AVAILABLE	300.	.00	.00
24 CANAMAN	99999 NOT SHIPPED	49 NOT AVAILABLE	1045.	.00	.00
30 NABUA	99999 NOT SHIPPED	49 NOT AVAILABLE	170.	.00	.00
		TOTAL	6495.		26708.50

Optimal Solution by Mode

OPTIMAL SOLUTION SORTED BY MODE FOR PROJECTED PERIOD 285

ORIGIN	DESTINATION	MODE	QUANTITY	RATE	TOTAL COS
21 NAGA CITY	21 NAGA CITY-1	1 LOCAL USE	400.	.00	.0
22 CAMALIGAN	22 CAMALIGAN-1	1 LOCAL USE	200.	.00	.0
23 GAINZA	23 GAINZA-1	1 LOCAL USE	150.	.00	.0
26 PILI	26 PILI-1	1 LOCAL USE	150.	.00	.0
27 OCAMPO	27 OCAMPO-1	1 LOCAL USE	500.	.00	.0
29 BAAO	29 BAAO-1	1 LOCAL USE	600.	.00	.0
30 NABUA	30 NABUA-1	1 LOCAL USE	300.	.00	.0
		SUBTOTAL	2300.		.0
21 NAGA CITY	26 PILI-1	2 DIRECT HAUL	50.	27.90	1395.0
23 GAINZA	26 PILI-1	2 DIRECT HAUL	155.	29.10	4510.5
24 CANAMAN	25 MAGARAO-1	2 DIRECT HAUL	190.	18.20	3458.0
24 CANAMAN	26 PILI-1	2 DIRECT HAUL	65.	30.50	1982.5
27 OCAMPO	26 PILI-1	2 DIRECT HAUL	30.	22.80	684.0
		SUBTOTAL	490.		12030.0
22 CAMALIGAN	122 CAMALIGAN-2	3 STORAGE ONLY	250.	4.80	1200.0
23 GAINZA	123 GAINZA-2	3 STORAGE ONLY	415.	5.10	2116.5
24 CANAMAN	124 CANAMAN-2	3 STORAGE ONLY	250.	5.20	1300.0
27 OCAMPO	127 OCAMPO-2	3 STORAGE ONLY	350.	4.70	1645.0
28 BULA	128 BULA-2	3 STORAGE ONLY	80.	5.00	400.0
29 BAAO	129 BAAO-2	3 STORAGE ONLY	5.	5.40	27.0
30 NABUA	130 NAUBA-2	3 STORAGE ONLY	500.	5.30	2650.0
		SUBTOTAL	1850.		9338.5
24 CANAMAN	125 MAGARAO-2	4 DIRECT & STORAGE	150.	23.00	3450.00
27 OCAMPO	128 BULA-2	4 DIRECT & STORAGE	20.	21.40	428.00
28 BULA	129 BAAO-2	4 DIRECT & STORAGE	170.	8.60	1462.00
		SUBTOTAL	340.		5340.00
22 CAMALIGAN	99999 NOT SHIPPED	49 NOT AVAILABLE	300.	.00	.00
24 CANAMAN	99999 NOT SHIPPED	49 NOT AVAILABLE	1045.	.00	.00
30 NABUA	99999 NOT SHIPPED	49 NOT AVAILABLE	170.	.00	.00
		SUBTOTAL	1515.		.00
		TOTAL	6495.		26708.5

ITERATION = 11

SECTION IX

OPTIMUM WHEAT AND FLOUR DISTRIBUTION FROM EGYPTIAN PORTS

Concept of Multi-Modal Distribution Analysis

The concept of linear programming solutions for spatial equilibrium needs to be modified only slightly for conceptualization of product distribution in multi-modal or multi-marketing-channel environments. Each transfer rate in the distribution network can be the lowest cost among several alternative "modes" of transferring the product from M to N. In a simplified case where three alternative shipment modes--truck, rail and barge--are available from all origins to all destinations, the rate in each cell can be the truck, rail or barge rate, which ever is lowest. The multi-modal linear programming model needs to be able to identify which mode is selected for use with each link, and to present solution distribution patterns sorted by mode, but otherwise the problem and model to solve it are the same as for the simple spatial equilibrium case.

In the more general multi-modal case, several alternative modes are available, but not all of the modes are applicable to all links in the network. Some links may be served by only one mode, say highway transport, some may be served by two, and others may be served by three or more of the alternative modes. Such complication does not change the basic concept of selection of the least-cost mode. The TRLP program and the accompanying RATES program for generating the least-cost network handle this "unbalanced" multi-modal situation without difficulty, as outlined in Section II of the Manual. For such problems the most convenient procedure with RATES is to list the rates for the major transfer mode first, and follow with those for modes which serve only selected links. The TRLP-Case.Egy illustrates the use of the two programs for this kind of multi-modal environment.

The alternative modes in multi-modal configurations need not be confined to different means of transport. They may be completely different marketing and distribution channels. The TRLPCase.Two in Section VIII illustrates transport and storage alternatives with the different modes being (1) Local Use, (2) Direct Haul, (3) Storage Only and (4) Direct & Storage. More complex configurations of alternative channels can include different combinations of first stage processing, storage, transport, and second stage processing, for example. Computationally, multi-channel optimization problems of this sort are handled in TRANS and TRLP in the same way as any other multi-modal configuration.

Restrictions of handling capacity often enter into multi-modal problems so that the least-cost mode for given links may not be able to handle unlimited volumes. Configurations to reflect such constraints may need to list more than one transfer cost for some links in the network, each with some capacity limits. Solutions can use the lowest cost rate for the link up to a specified volume, and thereafter the second lowest rate, and so on. Subject to the over-all capacity limits of the model, this is handled by showing the basic link as two or more links in the network, each with its own rate and its own supply quantity and/or demand quantity. One or more of such sublinks may be used in the optimum solution, depending on the

comparative advantage of the supply point served by the links in reaching alternative demand outlets.

Description of the Case

The TRLPDATA.EGY Case illustrates formulation of a multi-modal wheat and flour marketing problem and solving for the minimum-cost distribution pattern from point of import to Egypt's bakeries throughout the country. Projected consumer demand for bakery products by location for year 2000 is taken as base in order to provide time to construct the needed import and distribution capacity to serve as an optimum system.

Six alternative points of import (supply) are considered--Alexandria, Suez, Ismailiya, Port Said, Safaga and Damietta. The run illustrated is one with no restrictive assumptions so that each port can supply all of the wheat and flour that the least-cost solution may request of it (i.e., excess supply quantity at all ports). Likewise each port is assumed to be able to ship its solution volume of wheat and flour by the cheapest transport mode (truck, rail or inland waterway) to each destination. The least-cost mode for each transfer cost cell is selected with the separate program, RATES, and is identified by the TRLP program output for the problem.

With respect to the transportation linear programming analysis, several characteristics of the case need to be recognized at the outset:

1. Estimates of supply and demand quantities are developed externally to the transportation linear program and supplied as input data.

2. The case is structured so that demand quantities at the supply points are represented by separate identification nodes (i.e., demand points). The points are numbered accordingly.

3. In addition to the demand for imported wheat to serve the domestic mills, demand exists for imported flour as such. These quantities are identified separately.

4. Transfer rates (unit costs) vary by type of transportation as well as by form (wheat or flour). The differences are reflected in the numbering of demand nodes and the alternate transfer costs from supply point M to demand point N.

5. The transportation linear programming algorithm is designed to minimize total distribution costs over the entire transport network. The solution must take supply quantities by location as given, and meet demand quantity requirements for both wheat and flour at each location.

6. In the problem as formulated, total supply quantity exceeds total demand quantity. The program assigns the excess quantities to the supply locations at the greatest comparative disadvantage for supplying demand locations in the network. A destination of 99999 NOT SHIPPED is assigned to such quantities by the program.

7. Two runs with TRLP are used to obtain the final solution in order to illustrate the automatic creation of computer file of intermediate results when final solution is not obtained within specified maximum iterations.

Use of RATES Program to Select Least-Cost Rate Network

The procedures for using the separate program, RATES.EXE, to generate the least-cost rate network from multi-modal alternatives are described in Section IV. Listings of the input files to that program and the output file generated by it for the TRLPCase.Egy are shown below.

Listing of the Default File, COMMANDS.TLP

```
6  76   3
      1    TRUCK TRANSPORT      456
      2    BARGE TRANSPORT       43
      3    RAIL TRANSPORT        23
```

Listing of the Data Input File, RATES.TLP

1	7	2.15	1
1	8	2.62	1
1	9	3.41	1
1	11	4.46	1
1	12	4.12	1
1	13	3.47	1
1	14	3.07	1
1	15	3.80	1
1	16	4.69	1
1	17	5.21	1
1	18	4.44	1
1	19	4.91	1
1	20	4.31	1
1	21	4.07	1
1	22	4.69	1
1	23	4.54	1
1	24	5.29	1
1	26	4.59	1
1	35	4.70	1
1	44	5.60	1
1	79	5.42	1
1	80	5.61	1
1	84	8.35	1
1	85	8.86	1
1	86	7.88	1
1	87	1.98	1
1	88	21.96	1
1	89	11.51	1
1	90	11.82	1
1	[illegible]	10.58	1
1	92	12.64	1
1	93	13.02	1

1	94	13.41	1
1	95	14.84	1
1	96	22.50	1
1	97	13.25	1
1	98	18.52	1
1	99	15.22	1
1	100	15.74	1
1	101	16.42	1
1	102	20.59	1
1	103	16.78	1
1	104	17.10	1
1	105	17.02	1
1	106	19.07	1
1	107	20.20	1
1	108	20.74	1
1	108	21.30	1
1	110	22.12	1
1	111	22.62	1
1	112	18.45	1
1	113	18.10	1
1	1007	2.55	1
1	1009	3.79	1
1	1011	4.81	1
1	1013	3.85	1
1	1016	5.04	1
1	1021	4.44	1
1	1023	4.90	1
1	1026	4.92	1
1	1035	5.00	1
1	1044	5.89	1
1	1079	5.73	1
1	1080	5.90	1
1	1084	8.60	1
1	1086	8.14	1
1	1092	12.83	1
1	1095	15.04	1
1	1011	1.78	1
1	1012	8.35	1
1	1013	6.94	1
1	1104	5.63	1
1	1105	18.83	1
1	1106	3.65	1
1	2101	2.19	1
1	2106	4.06	1
2	7	7.06	1
2	8	6.85	1
2	9	6.57	1
2	11	5.60	1
2	12	5.10	1
2	13	5.73	1
2	14	6.14	1
2	15	5.92	1

2	16	4.52	1
2	17	4.57	1
2	18	4.95	1
2	19	4.95	1
2	20	5.00	1
2	21	4.22	1
2	22	4.59	1
2	23	4.66	1
2	24	3.91	1
2	25	3.70	1
2	35	4.58	1
2	44	3.83	1
2	79	3.86	1
2	80	3.87	1
2	84	6.61	1
2	85	7.12	1
2	86	6.14	1
2	87	8.13	1
2	88	14.54	1
2	89	7.87	1
2	90	8.26	1
2	91	8.83	1
2	92	9.35	1
2	93	9.90	1
2	94	10.35	1
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2	97	11.51	1
2	98	16.08	1
2	99	12.48	1
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2	105	15.87	1
2	106	16.10	1
2	107	16.30	1
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2	109	18.22	1
2	110	18.76	1
2	111	19.83	1
2	112	16.02	1
2	113	15.72	1
2	1007	7.32	1
2	1009	6.85	1
2	1011	5.90	1
2	1013	6.03	1
2	1016	4.84	1
2	1021	4.60	1
2	1023	4.86	1
2	1026	4.07	1

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2	1079	4.23	1
2	1080	4.24	1
2	1084	6.93	1
2	1086	6.46	1
2	1092	9.61	1
2	1095	11.62	1
2	1101	8.35	1
2	1102	1.78	1
2	1103	2.81	1
2	1104	5.27	1
2	1105	11.63	1
2	1106	2.38	1
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2	2106	2.79	1
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3	9	4.70	1
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3	89	7.78	1
3	90	8.16	1
3	91	8.74	1
3	92	11.03	1
3	93	11.41	1
3	94	11.80	1
3	95	13.30	1
3	96	21.58	1
3	97	12.54	1

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3	101	15.84	1
3	102	17.39	1
3	103	15.28	1
3	104	15.52	1
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3	109	19.72	1
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3	113	16.52	1
3	1007	5.49	1
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3	1016	3.03	1
3	1021	4.35	1
3	1023	3.81	1
3	1026	3.94	1
3	1035	3.83	1
3	1044	4.07	1
3	1079	4.10	1
3	1080	4.14	1
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3	1086	6.37	1
3	1092	10.31	1
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3	1101	6.94	1
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3	1103	1.78	1
3	1104	3.39	1
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4	19	4.52	1

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4	96	25.51	1
4	97	14.26	1
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4	1007	5.65	1
4	1009	4.65	1
4	1011	3.41	1
4	1013	4.62	1
4	1016	4.46	1
4	1021	5.20	1
4	1023	5.12	1
4	1026	9.50	1
4	1035	9.46	1
4	1044	9.72	1
4	1079	9.68	1
4	1080	9.79	1

4	1084	11.90	1
4	1086	12.04	1
4	1092	14.33	1
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4	1103	2.85	1
4	1104	1.78	1
4	1105	12.24	1
4	1106	2.38	1
4	2101	6.04	1
4	2106	2.78	1
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5	8	17.01	1
5	9	16.73	1
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5	26	13.86	1
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5	44	13.99	1
5	79	14.02	1
5	80	14.04	1
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5	85	15.14	1
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5	96	19.29	1
5	97	10.04	1
5	98	5.91	1
5	99	9.10	1
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5	101	7.73	1

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5	103	7.33	1
5	104	6.71	1
5	105	5.70	1
5	106	5.94	1
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5	1021	15.43	1
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5	1102	11.41	1
5	1103	13.51	1
5	1104	15.43	1
5	1105	1.78	1
5	1106	16.89	1
5	2101	18.92	1
5	2106	17.30	1
6	7	4.08	1
6	8	3.61	1
6	9	2.82	1
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6	15	3.09	1
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6	17	4.01	1
6	18	4.59	1
6	19	3.92	1
6	20	4.46	1
6	21	4.23	1
6	22	4.85	1
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6	97	13.92	1
6	98	18.26	1
6	99	14.97	1
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6	101	16.01	1
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6	103	16.42	1
6	104	17.04	1
6	105	18.05	1
6	106	20.94	1
6	107	21.02	1
6	108	21.99	1
6	109	23.06	1
6	110	23.59	1
6	111	24.66	1
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6	113	18.20	1
6	1007	8.12	1
6	1009	5.99	1
6	1011	2.82	1
6	1013	5.20	1
6	1016	3.87	1
6	1021	5.59	1
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6	1026	7.70	1
6	1035	7.95	1
6	1044	8.21	1
6	1079	7.88	1
6	1080	8.00	1
6	1084	10.10	1
6	1086	10.24	1
6	1092	12.54	1
6	1095	14.04	1

6	1101	4.18	1
6	1102	6.72	1
6	1103	4.84	1
6	1104	2.92	1
6	1105	16.89	1
6	1106	1.78	1
6	2101	4.59	1
6	2106	2.19	1
1	88	19.96	2
1	89	9.51	2
1	90	9.82	2
1	92	10.64	2
1	93	11.02	2
1	94	11.41	2
1	95	12.84	2
1	101	14.42	2
1	103	14.78	2
1	104	15.10	2
1	105	15.02	2
1	106	17.07	2
1	107	18.20	2
1	108	18.74	2
1	109	19.30	2
1	110	20.12	2
1	111	20.62	2
1	113	16.10	2
1	1092	10.83	2
1	1095	13.04	2
2	101	14.53	2
3	88	15.38	2
3	92	9.03	2
3	93	9.41	2
3	94	9.80	2
3	95	11.30	2
3	101	13.84	2
3	103	13.28	2
3	104	13.52	2
3	105	14.44	2
3	106	16.39	2
3	107	16.62	2
3	108	17.16	2
3	109	17.72	2
3	110	18.54	2
3	111	19.04	2
3	113	14.52	2
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5	1084	14.22	2
5	1092	12.23	2
5	1095	10.02	2
4	1026	6.50	3

4	1035	6.46	3
4	1044	6.72	3
4	1079	6.68	3
4	1080	6.79	3
4	1084	8.90	3
4	1086	9.04	3
4	1092	11.33	3
4	1095	14.13	3
6	1007	5.12	3
6	1009	2.99	3
6	1013	3.20	3
6	1021	3.59	3
6	1023	4.10	3
6	1026	4.70	3
6	1035	4.95	3
6	1044	5.21	3
6	1079	4.88	3
6	1080	5.00	3
6	1084	7.10	3
6	1086	7.24	3
6	1092	9.54	3
6	1095	11.04	3

Listing of the RATES Output File, NINP3

1	7	2.15	1
1	8	2.62	1
1	9	3.41	1
1	11	4.46	1
1	12	4.12	1
1	13	3.47	1
1	14	3.07	1
1	15	3.80	1
1	16	4.69	1
1	17	5.21	1
1	18	4.44	1
1	19	4.91	1
1	20	4.31	1
1	21	4.07	1
1	22	4.69	1
1	23	4.54	1
1	24	5.29	1
1	26	4.59	1
1	35	4.70	1
1	44	5.60	1
1	79	5.42	1
1	80	5.61	1
1	84	8.35	1
1	85	8.86	1
1	86	7.88	1
1	87	1.98	1
1	88	19.96	2

1	89	9.51	2
1	90	9.82	2
1	91	10.58	1
1	92	10.64	2
1	93	11.02	2
1	94	11.41	2
1	95	12.84	2
1	96	22.50	1
1	97	13.25	1
1	98	18.52	1
1	99	15.22	1
1	100	15.74	1
1	101	14.42	2
1	102	20.59	1
1	103	14.78	2
1	104	15.10	2
1	105	15.02	2
1	106	17.07	2
1	107	18.20	2
1	108	18.74	2
1	109	19.30	2
1	110	20.12	2
1	111	20.62	2
1	112	18.45	1
1	113	16.10	2
1	1007	2.55	1
1	1009	3.79	1
1	1011	4.81	1
1	1013	3.85	1
1	1016	5.04	1
1	1021	4.44	1
1	1023	4.90	1
1	1026	4.92	1
1	1035	5.00	1
1	1044	5.89	1
1	1079	5.73	1
1	1080	5.90	1
1	1084	8.60	1
1	1086	8.14	1
1	1092	10.83	2
1	1095	13.04	2
1	1101	1.78	1
1	1102	8.35	1
1	1103	6.94	1
1	1104	5.63	1
1	1105	18.83	1
1	1106	3.65	1
1	2101	2.19	1
1	2106	4.06	1
2	7	7.06	1
2	8	6.85	1
2	9	6.57	1

2	11	5.60	1
2	12	5.10	1
2	13	5.73	1
2	14	6.14	1
2	15	5.92	1
2	16	4.52	1
2	17	4.57	1
2	18	4.95	1
2	19	4.95	1
2	20	5.00	1
2	21	4.22	1
2	22	4.59	1
2	23	4.66	1
2	24	3.91	1
2	26	3.70	1
2	35	4.58	1
2	44	3.83	1
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2	80	3.87	1
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2	97	11.51	1
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2	100	13.99	1
2	101	14.53	1
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2	103	14.93	1
2	104	15.55	1
2	105	15.87	1
2	106	16.10	1
2	107	16.30	1
2	108	17.15	1
2	109	18.22	1
2	110	18.76	1
2	111	19.83	1
2	112	16.02	1
2	113	15.72	1
2	1007	7.32	1
2	1009	6.85	1
2	1011	5.90	1

2	1013	6.03	1
2	1016	4.84	1
2	1021	4.60	1
2	1023	4.86	1
2	1026	4.07	1
2	1035	3.96	1
2	1044	4.20	1
2	1079	4.23	1
2	1080	4.24	1
2	1084	6.93	1
2	1086	6.46	1
2	1092	9.61	1
2	1095	11.62	1
2	1101	8.35	1
2	1102	1.78	1
2	1103	2.81	1
2	1104	5.27	1
2	1105	11.63	1
2	1106	2.38	1
2	2101	8.76	1
2	2106	2.79	1
3	7	5.19	1
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3	9	4.70	1
3	11	3.71	1
3	12	3.22	1
3	13	3.86	1
3	14	4.27	1
3	15	4.03	1
3	16	2.64	1
3	17	2.68	1
3	18	4.43	1
3	19	3.07	1
3	20	4.57	1
3	21	3.99	1
3	22	4.46	1
3	23	3.43	1
3	24	3.77	1
3	26	3.57	1
3	35	3.45	1
3	44	3.70	1
3	79	3.73	1
3	80	3.77	1
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3	86	6.04	1
3	87	6.26	1
3	88	15.38	2
3	89	7.78	1
3	90	8.16	1
3	91	8.74	1
3	92	9.03	2

3	93	9.41	2
3	94	9.80	2
3	95	11.30	2
3	96	21.58	1
3	97	12.54	1
3	98	16.68	1
3	99	13.38	1
3	100	13.90	1
3	101	13.84	2
3	102	17.39	1
3	103	13.28	2
3	104	13.52	2
3	105	14.44	2
3	106	16.39	2
3	107	16.62	2
3	108	17.16	2
3	109	17.72	2
3	110	18.54	2
3	111	19.04	2
3	112	16.62	1
3	113	14.52	2
3	1007	5.49	1
3	1009	5.00	1
3	1011	4.10	1
3	1013	4.23	1
3	1016	3.03	1
3	1021	4.35	1
3	1023	3.81	1
3	1026	3.94	1
3	1035	3.83	1
3	1044	4.07	1
3	1079	4.10	1
3	1080	4.14	1
3	1084	6.30	2
3	1086	6.37	1
3	1092	8.31	2
3	1095	9.10	2
3	1101	6.94	1
3	1102	3.34	1
3	1103	1.78	1
3	1104	3.39	1
3	1105	13.51	1
3	1106	4.84	1
3	2101	7.35	1
3	2106	5.23	1
4	7	5.34	1
4	8	4.87	1
4	9	4.28	1
4	11	3.03	1
4	12	3.92	1
4	13	4.23	1
4	14	4.63	1

4	15	3.69	1
4	16	4.10	1
4	17	4.61	1
4	18	5.19	1
4	19	4.52	1
4	20	5.06	1
4	21	4.82	1
4	22	5.45	1
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4	24	5.49	1
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4	35	5.38	1
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4	91	10.67	1
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4	103	16.77	1
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4	106	19.91	1
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4	108	20.96	1
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4	113	18.59	1
4	1007	5.65	1
4	1009	4.65	1
4	1011	3.41	1
4	1013	4.62	1
4	1016	4.46	1
4	1021	5.20	1
4	1023	5.12	1

4	1026	6.50	3
4	1035	6.46	3
4	1044	6.72	3
4	1079	6.68	3
4	1080	6.79	3
4	1084	8.90	3
4	1086	9.04	3
4	1092	11.33	3
4	1095	14.13	3
4	1101	5.63	1
4	1102	5.27	1
4	1103	2.85	1
4	1104	1.78	1
4	1105	12.24	1
4	1106	2.38	1
4	2101	6.04	1
4	2106	2.73	1
5	7	17.22	1
5	8	17.01	1
5	9	16.73	1
5	11	15.76	1
5	12	15.27	1
5	13	15.90	1
5	14	16.30	1
5	15	16.08	1
5	16	14.96	1
5	17	14.73	1
5	18	15.03	1
5	19	15.12	1
5	20	15.16	1
5	21	15.32	1
5	22	14.75	1
5	23	14.83	1
5	24	14.08	1
5	26	13.86	1
5	35	13.75	1
5	44	13.99	1
5	79	14.02	1
5	80	14.04	1
5	84	15.65	1
5	85	15.14	1
5	86	16.30	1
5	87	18.29	1
5	88	4.37	1
5	89	14.39	1
5	90	14.00	1
5	91	14.43	1
5	92	12.91	1
5	93	12.38	1
5	94	11.91	1
5	95	9.94	1
5	96	19.29	1

5	97	10.04	1
5	98	5.91	1
5	99	9.10	1
5	100	8.57	1
5	101	7.73	1
5	102	5.34	1
5	103	7.33	1
5	104	6.71	1
5	105	5.70	1
5	106	5.94	1
5	107	6.02	1
5	108	6.98	1
5	109	8.05	1
5	110	8.59	1
5	111	9.66	1
5	112	5.85	1
5	113	5.55	1
5	1007	17.44	1
5	1009	17.93	1
5	1011	15.97	1
5	1013	16.11	1
5	1016	15.17	1
5	1021	15.43	1
5	1023	15.04	1
5	1026	14.08	1
5	1035	13.97	1
5	1044	14.21	1
5	1079	14.24	1
5	1080	14.26	1
5	1084	14.22	2
5	1086	16.51	1
5	1092	12.23	2
5	1095	10.02	2
5	1101	18.51	1
5	1102	11.41	1
5	1103	13.51	1
5	1104	15.43	1
5	1105	1.78	1
5	1106	16.89	1
5	2101	18.92	1
5	2106	17.30	1
6	7	4.08	1
6	8	3.61	1
6	9	2.82	1
6	11	2.43	1
6	12	3.32	1
6	13	3.63	1
6	14	4.03	1
6	15	3.09	1
6	16	3.50	1
6	17	4.01	1
6	18	4.59	1

6	19	3.92	1
6	20	4.46	1
6	21	4.23	1
6	22	4.85	1
6	23	4.14	1
6	24	4.89	1
6	26	5.10	1
6	35	5.08	1
6	44	5.31	1
6	79	5.26	1
6	80	5.36	1
6	84	8.95	1
6	85	8.61	1
6	86	7.62	1
6	87	5.02	1
6	88	19.37	1
6	89	9.36	1
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6	94	11.84	1
6	95	13.81	1
6	96	23.16	1
6	97	13.92	1
6	98	18.26	1
6	99	14.97	1
6	100	15.48	1
6	101	16.01	1
6	102	20.34	1
6	103	16.42	1
6	104	17.04	1
6	105	18.05	1
6	106	20.94	1
6	107	21.02	1
6	108	21.99	1
6	109	23.06	1
6	110	23.59	1
6	111	24.66	1
6	112	18.20	1
6	113	18.20	1
6	1007	5.12	3
6	1009	2.99	3
6	1011	2.82	1
6	1013	3.20	3
6	1016	3.87	1
6	1021	3.59	3
6	1023	4.10	3
6	1026	4.70	3
6	1035	4.95	3
6	1044	5.21	3
6	1079	4.88	3

6	1080	5.00	3
6	1084	7.10	3
6	1086	7.24	3
6	1092	9.54	3
6	1095	11.04	3
6	1101	4.18	1
6	1102	6.72	1
6	1103	4.84	1
6	1104	2.92	1
6	1105	16.89	1
6	1106	1.78	1
6	2101	4.59	1
6	2106	2.19	1

Program Commands and Data Input for the Case

Listing of Phase One INPUT.TLP File with Restricted Iterations

```
6  76  15   0   1
12000   0   0   0   0   3   0   1   1   1   1   1   0   1   1   1
    1    TRUCK TRANSPORT
    2    BARGE TRANSPORT
    3    RAIL TRANSPORT
```

Listing of the TRLPDATA.RUN File

2000	1	2000000	ALEXANDRIA PORT
2000	2	200000	SUEZ PORT
2000	3	6000000	ISMAILIYA PORT
2000	4	200000	PORT SAID PORT
2000	5	2000000	SAFAGA PORT
2000	6	2000000	DAMIETTA PORT
2000	7	690000	DAMANHOUR
2000	8	54000	DESOUK
2000	9	217500	KAFR-EL SHEIKH
2000	11	568500	EL MANSOURA
2000	12	18000	MIT GHAMR
2000	13	274500	TANTA
2000	14	73500	KAFR-EL ZAYAT
2000	15	114000	MAHALA EL KOUBRA
2000	16	472500	ZAGAZIG
2000	17	45000	BELBIES
2000	18	36000	SIRS EL LAIYANA
2000	19	7500	MINIA EL KAMH
2000	20	21000	MENOUF
2000	21	303000	SHEBEIN EL KOMH
2000	22	28500	ASHMOUN
2000	23	625500	BENHA
2000	24	81000	KALYUB
2000	26	526200	SHUBRA
2000	35	380400	HELIOPOLIS
2000	44	426000	SOUTH CAIRO

2000	79	257100	IMBABA
2000	80	1002000	GIZA
2000	84	168600	BENI SUEF
2000	85	11100	BEBA
2000	86	285000	EL FAIYUM
2000	87	31500	RASHEID
2000	88	159150	QENA
2000	89	12600	MAGHAGHA
2000	90	9000	BENI MAZAR
2000	91	14100	SAMALOUT
2000	92	269100	MINYA
2000	93	23700	ABOU KORKAS
2000	94	17100	MALLAWI
2000	95	141300	ASYUT
2000	96	3000	EL WADI EL GEDID
2000	97	10800	DURUNKA
2000	98	5700	EL AUSIRNT
2000	99	21000	TEMA
2000	100	84000	TAHTA
2000	101	265000	SOHAG
2000	102	111000	KOUS
2000	103	38250	EL MENSHA
2000	104	22500	CERGA
2000	105	27000	NAG HAMADI
2000	106	30000	LUXOR
2000	107	37950	ARMANT
2000	108	30000	ISNA
2000	109	36000	IDFU
2000	110	57000	KOM OMBO
2000	111	66000	ASWAN
2000	112	9900	FARSHUT
2000	113	5400	HEW
2000	1007	48521	DAMANHOUR-Flour
2000	1009	14833	KAFR EL SHEIKH-F
2000	1011	1368	EL MANSOURA-Flr
2000	1013	13593	TANTA-Flour
2000	1016	24204	ZAGAZIG-Flour
2000	1021	11964	SHEBEIN EL K.-F
2000	1023	22507	BENHA-Flour
2000	1026	74724	SHUBRA-Flour
2000	1035	59878	HELIOPOLIS-Flour
2000	1044	102481	S. CAIRO-Flour
2000	1079	57984	IMBABA-Flour
2000	1080	157563	GIZA-Flour
2000	1084	19028	BENI SUEF-Flour
2000	1086	314	EL FAIYUM-Flour
2000	1092	19685	MINYA-Flour
2000	1095	44940	ASYUT-Flour
2000	1101	597600	ALEXANDRIA-Mills
2000	1102	90000	SUEZ-Mills
2000	1103	240000	ISMAILIYA-Mills
2000	1104	75000	PORT SAID-Mills

2000	1105	30000	SAFAGA-Mills
2000	1106	75000	DAMIETTA-Mills
2000	2101	111590	ALEXANDRIA-Flr
2000	2106	4615	DAMIETTA-Flour
1	7	2.15	1
1	8	2.62	1
1	9	3.41	1
1	11	4.46	1
1	12	4.12	1
1	13	3.47	1
1	14	3.07	1
1	15	3.80	1
1	16	4.69	1
1	17	5.21	1
1	18	4.44	1
1	19	4.91	1
1	20	4.31	1
1	21	4.07	1
1	22	4.69	1
1	23	4.54	1
1	24	5.29	1
1	26	4.59	1
1	35	4.70	1
1	44	5.60	1
1	79	5.42	1
1	80	5.61	1
1	84	8.35	1
1	85	8.86	1
1	86	7.88	1
1	87	1.98	1
1	88	19.96	2
1	89	9.51	2
1	90	9.82	2
1	91	10.58	1
1	92	10.64	2
1	93	11.02	2
1	94	11.41	2
1	95	12.84	2
.	.	.	.
.	.	.	.
.	.	.	.
6	1044	5.21	3
6	1079	4.88	3
6	1080	5.00	3
6	1084	7.10	3
6	1086	7.24	3
6	1092	9.54	3
6	1095	11.04	3
6	1101	4.18	1
6	1102	6.72	1
6	1103	4.84	1
6	1104	2.92	1

6	1105	16.89	1
6	1106	1.78	1
6	2101	4.59	1
6	2106	2.19	1

Listing of the Printed Output from Phase One

SUPPLY QUANTITIES BY ORIGIN FOR PROJECTED PERIOD 2000

SUPPLY POINT		QUANTITY
1	ALEXANDRIA PORT	2000000.00
2	SUEZ PORT	200000.00
3	ISMAILIYA PORT	6000000.00
4	PORT SAID PORT	200000.00
5	SAFAGA PORT	2000000.00
6	DAMIETTA PORT	2000000.00
	TOTAL	12400000.00

DEMAND QUANTITIES BY DESTINATION FOR PROJECTED PERIOD 2000

DEMAND POINT		QUANTITY
7	DAMANHOUR	690000.00
8	DESOUK	54000.00
9	KAFR-EL SHEIKH	217500.00
11	EL MANSOURA	568500.00
12	MIT GHAMR	18000.00
13	TANTA	274500.00
14	KAFR-EL ZAYAT	73500.00
15	MAHALA EL KOUBRA	114000.00
16	ZAGAZIG	472500.00
17	BELBIES	45000.00
18	SIRS EL LAIYANA	36000.00
19	MINIA EL KAMH	7500.00
20	MENOUF	21000.00
21	SHEBEIN EL KOMH	303000.00
22	ASHMOUN	28500.00
23	BENHA	625500.00
24	KALYUB	81000.00
26	SHUBRA	526200.00
35	HELIOPOLIS	380400.00
44	SOUTH CAIRO	426000.00
79	IMBABA	257100.00
80	GIZA	1002000.00
84	BENI SUEF	168600.00
85	BEBA	11100.00
86	EL FAIYUM	285000.00
87	RASHEID	31500.00
88	QENA	159150.00
89	MAGHAGHA	12600.00
90	BENI MAZAR	9000.00
91	SAMALOUT	14100.00

92	MINYA	269100.00	
93	ABOU KORKAS	23700.00	
94	MALLAWI	17100.00	
95	ASYUT	141300.00	
96	EL WADI EL GEDID	3000.00	
97	DURUNKA	10800.00	
98	EL AUSIRNT	5700.00	
99	TEMA	21000.00	
100	TAHTA	84000.00	
101	SOHAG	265000.00	
102	KOUS	111000.00	
103	EL MENSHA	38250.00	
104	CERGA	22500.00	
105	NAG HAMADI	27000.00	
106	LUXOR	30000.00	
107	ARMANT	37950.00	
108	ISNA	30000.00	
109	IDFU	36000.00	
110	KOM OMBO	57000.00	
111	ASWAN	66000.00	
112	FARSHUT	9900.00	
113	HEW	5400.00	
1007	DAMANHOUR-Flour	48521.00	
1009	KAFR EL SHEIKH-F	14833.00	
1011	EL MANSOURA-Flr	1368.00	
1013	TANTA-Flour	13593.00	
1016	ZAGAZIG-Flour	24204.00	
1021	SHEBEIN EL K.-F	11964.00	
1023	BENHA-Flour	22507.00	
1026	SHUBRA-Flour	74724.00	
1035	HELIOPOLIS-Flour	59878.00	
1044	S. CAIRO-Flour	102481.00	
1079	IMBABA-Flour	57984.00	
1080	GIZA-Flour	157563.00	
1084	BENI SUEF-Flour	19028.00	
1086	EL FAIYUM-Flour	314.00	
1092	MINYA-Flour	19685.00	
1095	ASYUT-Flour	44940.00	
1101	ALEXANDRIA-Mills	597600.00	
1102	SUEZ-Mills	90000.00	
1103	ISMAILIYA-Mills	240000.00	
1104	PORT SAID-Mills	75000.00	
1105	SAFAGA-Mills	30000.00	
1106	DAMIETTA-Mills	75000.00	
2101	ALEXANDRIA-Flr	111590.00	
2106	DAMIETTA-Flour	4615.00	
	TOTAL	10121842.00	
99999	NOT SHIPPED	2278158.00	49 NOT AVAILABLE

MAXIMUM ITERATIONS SPECIFIED = 15; ITERATIONS TOWARD SOLUTION = 15.

Stop - Program terminated.

Listing of the Intermediate Output File, NINP4

```
6  77   6  77  15   4
 2000      1       0   ALEXANDRIA PORT
 2000      2       0   SUEZ PORT
 2000      3       0   ISMAILIYA PORT
 2000      4       0   PORT SAID PORT
 2000      5       0   SAFAGA PORT
 2000      6       0   DAMIETTA PORT
 2000      7       0   DAMANHOUR
 2000      8       0   DESOUK
 2000      9       0   KAFR-EL SHEIKH
 2000     11       0   EL MANSOURA
 2000     12       0   MIT GHAMR
 2000     13       0   TANTA
 2000     14       0   KAFR-EL ZAYAT
 2000     15       0   MAHALA EL KOUBRA
 2000     16       0   ZAGAZIG
 2000     17       0   BELBIES
 2000     18       0   SIRS EL LAIYANA
 2000     19       0   MINIA EL KAMH
 2000     20       0   MENOUF
 2000     21       0   SHEBEIN EL KOMH
 2000     22       0   ASHMOUN
 2000     23       0   BENHA
 2000     24       0   KALYUB
 2000     26       0   SHUBRA
 2000     35       0   HELIOPOLIS
 2000     44       0   SOUTH CAIRO
 2000     79       0   IMBABA
 2000     80       0   GIZA
 2000     84       0   BENI SUEF
 2000     85       0   BEBA
 2000     86       0   EL FAIYUM
 2000     87       0   RASHEID
 2000     88       0   QENA
 2000     89       0   MAGHAGHA
 2000     90       0   BENI MAZAR
 2000     91       0   SAMALOUT
 2000     92       0   MINYA
 2000     93       0   ABOU KORKAS
 2000     94       0   MALLAWI
 2000     95       0   ASYUT
 2000     96       0   EL WADI EL GEDID
 2000     97       0   DURUNKA
 2000     98       0   EL AUSIRNT
 2000     99       0   TEMA
```

2000	100	0	TAHTA
2000	101	0	SOHAG
2000	102	0	KOUS
2000	103	0	EL MENSHA
2000	104	0	CERGA
2000	105	0	NAG HAMADI
2000	106	0	LUXOR
2000	107	0	ARMANT
2000	108	0	ISNA
2000	109	0	IDFU
2000	110	0	KOM OMBO
2000	111	0	ASWAN
2000	112	0	FARSHUT
2000	113	0	HEW
2000	1007	0	DAMANHOUR-Flour
2000	1009	0	KAFR EL SHEIKH-F
2000	1011	0	EL MANSOURA-Flr
2000	1013	0	TANTA-Flour
2000	1016	0	ZAGAZIG-Flour
2000	1021	0	SHEBEIN EL K.-F
2000	1023	0	BENHA-Flour
2000	1026	0	SHUBRA-Flour
2000	1035	0	HELIOPOLIS-Flour
2000	1044	0	S. CAIRO-Flour
2000	1079	0	IMBABA-Flour
2000	1080	0	GIZA-Flour
2000	1084	0	BENI SUEF-Flour
2000	1086	0	EL FAIYUM-Flour
2000	1092	0	MINYA-Flour
2000	1095	0	ASYUT-Flour
2000	1101	0	ALEXANDRIA-Mills
2000	1102	0	SUEZ-Mills
2000	1103	0	ISMAILIYA-Mills
2000	1104	0	PORT SAID-Mills
2000	1105	0	SAFAGA-Mills
2000	1106	0	DAMIETTA-Mills
2000	2101	0	ALEXANDRIA-Flr
2000	2106	0	DAMIETTA-Flour
2000	99999	0	NOT SHIPPED
1	TRUCK TRANSPORT		
2	BARGE TRANSPORT		
3	RAIL TRANSPORT		
49	NOT AVAILABLE		

690000.	2.15	1
54000.	2.62	1
0.	3.41	1
0.	4.46	1
0.	4.12	1
274500.	3.47	1
73500.	3.07	1
0.	3.80	1
0.	4.69	1

0.	5.21	1
0.	4.44	1
0.	4.91	1
0.	4.31	1
118789.	4.07	1
0.	4.69	1
0.	4.54	1
0.	5.29	1
0.	4.59	1
0.	4.70	1
0.	5.60	1
0.	5.42	1
0.	5.61	1
0.	8.35	1
0.	8.86	1
0.	7.88	1
31500.	1.98	1
0.	19.96	2
0.	9.51	2
0.	9.82	2
0.	10.58	1
0.	10.64	2
0.	11.02	2
0.	11.41	2
0.	12.84	2
0.	22.50	1
0.	13.25	1
0.	18.52	1
0.	15.22	1
0.	15.74	1
0.	14.42	2
0.	20.59	1
0.	14.78	2
0.	15.10	2
0.	15.02	2
0.	17.07	2
0.	18.20	2
0.	18.74	2
0.	19.30	2
0.	20.12	2
0.	20.62	2
0.	18.45	1
0.	16.10	2
48521.	2.55	1
0.	3.79	1
0.	4.81	1
0.	3.85	1
0.	5.04	1
0.	4.44	1
0.	4.90	1
0.	4.92	1
0.	5.00	1

0.	5.89	1
0.	5.73	1
0.	5.90	1
0.	8.60	1
0.	8.14	1
0.	10.83	2
0.	13.04	2
597600.	1.78	1
0.	8.35	1
0.	6.94	1
0.	5.63	1
0.	18.83	1
0.	3.65	1
111590.	2.19	1
0.	4.06	1
0.	.00	49
0.	7.06	1
0.	6.85	1
0.	6.57	1
0.	5.60	1
0.	5.10	1
0.	5.73	1
0.	6.14	1
0.	5.92	1
0.	4.52	1
0.	4.57	1
0.	4.95	1
0.	4.95	1
0.	5.00	1
0.	4.22	1
0.	4.59	1
0.	4.66	1
0.	3.91	1
0.	3.70	1
0.	4.58	1
0.	3.83	1
0.	3.86	1
0.	3.87	1
0.	6.61	1
0.	7.12	1
0.	6.14	1
0.	8.13	1
0.	14.54	1
0.	7.87	1
0.	8.26	1
0.	8.83	1
0.	9.35	1
0.	9.90	1
0.	10.35	1
0.	11.40	1
0.	20.75	1
0.	11.51	1

0.	16.08	1
0.	13.48	1
0.	13.99	1
0.	14.53	1
0.	15.50	1
0.	14.93	1
0.	15.55	1
0.	15.87	1
0.	16.10	1
0.	16.30	1
0.	17.15	1
0.	18.22	1
0.	18.76	1
0.	19.83	1
0.	16.02	1
0.	15.72	1
0.	7.32	1
0.	6.85	1
0.	5.90	1
0.	6.03	1
0.	4.84	1
0.	4.60	1
0.	4.86	1
0.	4.07	1
0.	3.96	1
0.	4.20	1
0.	4.23	1
0.	4.24	1
0.	6.93	1
0.	6.46	1
0.	9.61	1
0.	11.62	1
0.	8.35	1
90000.	1.78	1
0.	2.81	1
0.	5.27	1
0.	11.63	1
0.	2.38	1
0.	8.76	1
0.	2.79	1
110000.	.00	49
0.	5.19	1
0.	4.97	1
0.	4.70	1
0.	3.71	1
0.	3.22	1
0.	3.86	1
0.	4.27	1
0.	4.03	1
472500.	2.64	1
45000.	2.68	1
0.	4.43	1

7500.	3.07	1
0.	4.57	1
184211.	3.99	1
28500.	4.46	1
625500.	3.43	1
81000.	3.77	1
526200.	3.57	1
380400.	3.45	1
426000.	3.70	1
257100.	3.73	1
1002000.	3.77	1
168600.	6.15	1
11100.	7.03	1
285000.	6.04	1
0.	6.26	1
0.	15.38	2
12600.	7.78	1
9000.	8.16	1
14100.	8.74	1
269100.	9.03	2
23700.	9.41	2
17100.	9.80	2
0.	11.30	2
0.	21.58	1
0.	12.54	1
0.	16.68	1
0.	13.38	1
0.	13.90	1
0.	13.84	2
0.	17.39	1
0.	13.28	2
0.	13.52	2
0.	14.44	2
0.	16.39	2
0.	16.62	2
0.	17.16	2
0.	17.72	2
0.	18.54	2
0.	19.04	2
0.	16.62	1
0.	14.52	2
0.	5.49	1
0.	5.00	1
0.	4.10	1
0.	4.23	1
24204.	3.03	1
0.	4.35	1
22507.	3.81	1
74724.	3.94	1
59878.	3.83	1
102481.	4.07	1
57984.	4.10	1

157563.	4.14	1
19028.	6.30	2
314.	6.37	1
19685.	8.31	2
44940.	9.10	2
0.	6.94	1
0.	3.34	1
240000.	1.78	1
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0.	13.51	1
0.	4.84	1
0.	7.35	1
0.	5.23	1
330481.	.00	49
0.	5.34	1
0.	4.87	1
0.	4.28	1
0.	3.03	1
0.	3.52	1
0.	4.23	1
0.	4.63	1
0.	3.69	1
0.	4.10	1
0.	4.61	1
0.	5.19	1
0.	4.52	1
0.	5.06	1
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0.	5.50	1
0.	5.38	1
0.	5.63	1
0.	5.66	1
0.	5.70	1
0.	8.44	1
0.	8.96	1
0.	7.97	1
0.	6.15	1
0.	18.35	1
0.	9.70	1
0.	10.09	1
0.	10.67	1
0.	11.18	1
0.	10.47	1
0.	12.19	1
0.	14.16	1
0.	25.51	1
0.	14.26	1
0.	18.61	1
0.	15.31	1

0.	15.82	1
0.	16.36	1
0.	19.31	1
0.	16.77	1
0.	17.39	1
0.	18.37	1
0.	19.91	1
0.	20.00	1
0.	20.96	1
0.	22.03	1
0.	22.57	1
0.	23.64	1
0.	18.59	1
0.	18.59	1
0.	5.65	1
0.	4.65	1
0.	3.41	1
0.	4.62	1
0.	4.46	1
0.	5.20	1
0.	5.12	1
0.	6.50	3
0.	6.46	3
0.	6.72	3
0.	6.68	3
0.	6.79	3
0.	8.90	3
0.	9.04	3
0.	11.33	3
0.	14.13	3
0.	5.63	1
0.	5.27	1
0.	2.85	1
75000.	1.78	1
0.	12.24	1
0.	2.38	1
0.	6.04	1
0.	2.78	1
125000.	.00	49
0.	17.22	1
0.	17.01	1
0.	16.73	1
0.	15.76	1
0.	15.27	1
0.	15.90	1
0.	16.30	1
0.	16.08	1
0.	14.96	1
0.	14.73	1
0.	15.03	1
0.	15.12	1
0.	15.16	1

0.	15.32	1
0.	14.75	1
0.	14.83	1
0.	14.08	1
0.	13.86	1
0.	13.75	1
0.	13.99	1
0.	14.02	1
0.	14.04	1
0.	15.65	1
0.	15.14	1
0.	16.30	1
0.	18.29	1
159150.	4.37	1
0.	14.39	1
0.	14.00	1
0.	14.43	1
0.	12.91	1
0.	12.38	1
0.	11.91	1
141300.	9.94	1
3000.	19.29	1
10800.	10.04	1
5700.	5.91	1
21000.	9.10	1
84000.	8.57	1
265000.	7.73	1
111000.	5.34	1
38250.	7.33	1
22500.	6.71	1
27000.	5.70	1
30000.	5.94	1
37950.	6.02	1
30000.	6.98	1
36000.	8.05	1
57000.	8.59	1
66000.	9.66	1
9900.	5.85	1
5400.	5.55	1
0.	17.44	1
0.	17.93	1
0.	15.97	1
0.	16.11	1
0.	15.17	1
0.	15.43	1
0.	15.04	1
0.	14.08	1
0.	13.97	1
0.	14.21	1
0.	14.24	1
0.	14.26	1
0.	14.22	2

0.	16.51	1
0.	12.23	2
0.	10.02	2
0.	18.51	1
0.	11.41	1
0.	13.51	1
0.	15.43	1
30000.	1.78	1
0.	16.89	1
0.	18.92	1
0.	17.30	1
809050.	.00	49
0.	4.08	1
0.	3.61	1
217500.	2.82	1
568500.	2.43	1
18000.	3.32	1
0.	3.63	1
0.	4.03	1
114000.	3.09	1
0.	3.50	1
0.	4.01	1
36000.	4.59	1
0.	3.92	1
21000.	4.46	1
0.	4.23	1
0.	4.85	1
0.	4.14	1
0.	4.89	1
0.	5.10	1
0.	5.08	1
0.	5.31	1
0.	5.26	1
0.	5.36	1
0.	8.95	1
0.	8.61	1
0.	7.62	1
0.	5.02	1
0.	19.37	1
0.	9.36	1
0.	9.74	1
0.	10.32	1
0.	10.84	1
0.	11.39	1
0.	11.84	1
0.	13.81	1
0.	23.16	1
0.	13.92	1
0.	18.26	1
0.	14.97	1
0.	15.48	1
0.	16.01	1

0.	20.34	1
0.	16.42	1
0.	17.04	1
0.	18.05	1
0.	20.94	1
0.	21.02	1
0.	21.99	1
0.	23.06	1
0.	23.59	1
0.	24.66	1
0.	18.20	1
0.	18.20	1
0.	5.12	3
14833.	2.99	3
1368.	2.82	1
13593.	3.20	3
0.	3.87	1
11964.	3.59	3
0.	4.10	3
0.	4.70	3
0.	4.95	3
0.	5.21	3
0.	4.88	3
0.	5.00	3
0.	7.10	3
0.	7.24	3
0.	9.54	3
0.	11.04	3
0.	4.18	1
0.	6.72	1
0.	4.84	1
0.	2.92	1
0.	16.89	1
75000.	1.78	1
0.	4.59	1
4615.	2.19	1
903627.	.00	49

Listing of the Phase Two INPUT.TLP File for Completion of Run

```
 10  20 100   1   1
  2 185   0   0   0   0   4   0   0   1   1   1   0   0   1   0   0
      1    LOCAL USE
      2    DIRECT HAUL
      3    STORAGE ONLY
      4    DIRECT & STORAGE
```

Optimum Distribution Pattern for Year 2000

Optimal Solution by Origin

OPTIMAL SOLUTION SORTED BY ORIGIN FOR PROJECTED PERIOD 2000

ORIGIN	DESTINATION	MODE	QUANTITY	UNIT COST	TOTAL COS
1 ALEXANDRIA PORT	7 DAMANHOUR	1 TRUCK TRANSPORT	690000.	2.15	1483500.1
1 ALEXANDRIA PORT	8 DESOUK	1 TRUCK TRANSPORT	54000.	2.62	141480.0
1 ALEXANDRIA PORT	13 TANTA	1 TRUCK TRANSPORT	274500.	3.47	952515.0
1 ALEXANDRIA PORT	14 KAFR-EL ZAYAT	1 TRUCK TRANSPORT	73500.	3.07	225645.0
1 ALEXANDRIA PORT	20 MENOUF	1 TRUCK TRANSPORT	21000.	4.31	90510.0
1 ALEXANDRIA PORT	87 RASHEID	1 TRUCK TRANSPORT	31500.	1.98	62370.0
1 ALEXANDRIA PORT	1007 DAMANHOUR-Flour	1 TRUCK TRANSPORT	48521.	2.55	123728.5
1 ALEXANDRIA PORT	1101 ALEXANDRIA-Mills	1 TRUCK TRANSPORT	597600.	1.78	1063728.0
1 ALEXANDRIA PORT	2101 ALEXANDRIA-Flr	1 TRUCK TRANSPORT	111590.	2.19	244382.1
1 ALEXANDRIA PORT	99999 NOT SHIPPED	49 NOT AVAILABLE	97789.	.00	.0
2 SUEZ PORT	1102 SUEZ-Mills	1 TRUCK TRANSPORT	90000.	1.78	160200.0
2 SUEZ PORT	99999 NOT SHIPPED	49 NOT AVAILABLE	110000.	.00	.0
3 ISMAILIYA PORT	12 MIT GHAMR	1 TRUCK TRANSPORT	18000.	3.22	57960.0
3 ISMAILIYA PORT	16 ZAGAZIG	1 TRUCK TRANSPORT	472500.	2.64	1247400.0
3 ISMAILIYA PORT	17 BELBIES	1 TRUCK TRANSPORT	45000.	2.68	120600.0
3 ISMAILIYA PORT	18 SIRS EL LAIYANA	1 TRUCK TRANSPORT	36000.	4.43	159480.0
3 ISMAILIYA PORT	19 MINIA EL KAMH	1 TRUCK TRANSPORT	7500.	3.07	23025.0
3 ISMAILIYA PORT	21 SHEBEIN EL KOMH	1 TRUCK TRANSPORT	303000.	3.99	1208970.0
3 ISMAILIYA PORT	22 ASHMOUN	1 TRUCK TRANSPORT	28500.	4.46	127110.0
3 ISMAILIYA PORT	23 BENHA	1 TRUCK TRANSPORT	625500.	3.43	2145465.0
3 ISMAILIYA PORT	24 KALYUB	1 TRUCK TRANSPORT	81000.	3.77	305370.0
3 ISMAILIYA PORT	26 SHUBRA	1 TRUCK TRANSPORT	526200.	3.57	1878534.0
3 ISMAILIYA PORT	35 HELIOPOLIS	1 TRUCK TRANSPORT	380400.	3.45	1312380.0
3 ISMAILIYA PORT	44 SOUTH CAIRO	1 TRUCK TRANSPORT	426000.	3.70	1576200.0
3 ISMAILIYA PORT	79 IMBABA	1 TRUCK TRANSPORT	257100.	3.73	958983.0
3 ISMAILIYA PORT	80 GIZA	1 TRUCK TRANSPORT	1002000.	3.77	3777540.00
3 ISMAILIYA PORT	84 BENI SUEF	1 TRUCK TRANSPORT	168600.	6.15	1036890.0
3 ISMAILIYA PORT	85 BEBA	1 TRUCK TRANSPORT	11100.	7.03	78033.0
3 ISMAILIYA PORT	86 EL FAIYUM	1 TRUCK TRANSPORT	285000.	6.04	1721400.00
3 ISMAILIYA PORT	89 MAGHAGHA	1 TRUCK TRANSPORT	12600.	7.78	98028.0
3 ISMAILIYA PORT	90 BENI MAZAR	1 TRUCK TRANSPORT	9000.	8.16	73440.0
3 ISMAILIYA PORT	91 SAMALOUT	1 TRUCK TRANSPORT	14100.	8.74	123234.0
3 ISMAILIYA PORT	92 MINYA	2 BARGE TRANSPORT	269100.	9.03	2429973.00
3 ISMAILIYA PORT	93 ABOU KORKAS	2 BARGE TRANSPORT	23700.	9.41	223017.0
3 ISMAILIYA PORT	94 MALLAWI	2 BARGE TRANSPORT	17100.	9.80	167580.0
3 ISMAILIYA PORT	1016 ZAGAZIG-Flour	1 TRUCK TRANSPORT	24204.	3.03	73338.12
3 ISMAILIYA PORT	1023 BENHA-Flour	1 TRUCK TRANSPORT	22507.	3.81	85751.67
3 ISMAILIYA PORT	1026 SHUBRA-Flour	1 TRUCK TRANSPORT	74724.	3.94	294412.56
3 ISMAILIYA PORT	1035 HELIOPOLIS-Flour	1 TRUCK TRANSPORT	59878.	3.83	229332.73
3 ISMAILIYA PORT	1044 S. CAIRO-Flour	1 TRUCK TRANSPORT	102481.	4.07	417097.69
3 ISMAILIYA PORT	1079 IMBABA-Flour	1 TRUCK TRANSPORT	57984.	4.10	237734.39
3 ISMAILIYA PORT	1080 GIZA-Flour	1 TRUCK TRANSPORT	157563.	4.14	652310.81
3 ISMAILIYA PORT	1084 BENI SUEF-Flour	2 BARGE TRANSPORT	19028.	6.30	119876.41
3 ISMAILIYA PORT	1086 EL FAIYUM-Flour	1 TRUCK TRANSPORT	314.	6.37	2000.18
3 ISMAILIYA PORT	1092 MINYA-Flour	2 BARGE TRANSPORT	19685.	8.31	163582.36

OPTIMAL SOLUTION SORTED BY ORIGIN FOR PROJECTED PERIOD 2000

ORIGIN	DESTINATION	MODE	QUANTITY	UNIT COST	TOTAL COST
3 ISMAILIYA PORT	1095 ASYUT-Flour	2 BARGE TRANSPORT	44940.	9.10	408954.03
3 ISMAILIYA PORT	1103 ISMAILIYA-Mills	1 TRUCK TRANSPORT	240000.	1.78	427200.00
3 ISMAILIYA PORT	99999 NOT SHIPPED	49 NOT AVAILABLE	157692.	.00	.00
4 PORT SAID PORT	1104 PORT SAID-Mills	1 TRUCK TRANSPORT	75000.	1.78	133500.00
4 PORT SAID PORT	99999 NOT SHIPPED	49 NOT AVAILABLE	125000.	.00	.00
5 SAFAGA PORT	88 QENA	1 TRUCK TRANSPORT	159150.	4.37	695485.50
5 SAFAGA PORT	95 ASYUT	1 TRUCK TRANSPORT	141300.	9.94	1404522.00
5 SAFAGA PORT	96 EL WADI EL GEDID	1 TRUCK TRANSPORT	3000.	19.29	57870.00
5 SAFAGA PORT	97 DURUNKA	1 TRUCK TRANSPORT	10800.	10.04	108432.00
5 SAFAGA PORT	98 EL AUSIRNT	1 TRUCK TRANSPORT	5700.	5.91	33687.00
5 SAFAGA PORT	99 TEMA	1 TRUCK TRANSPORT	21000.	9.10	191100.02
5 SAFAGA PORT	100 TAHTA	1 TRUCK TRANSPORT	84000.	8.57	719880.00
5 SAFAGA PORT	101 SOHAG	1 TRUCK TRANSPORT	265000.	7.73	2048450.00
5 SAFAGA PORT	102 KOUS	1 TRUCK TRANSPORT	111000.	5.34	592740.00
5 SAFAGA PORT	103 EL MENSHA	1 TRUCK TRANSPORT	38250.	7.33	280372.50
5 SAFAGA PORT	104 CERGA	1 TRUCK TRANSPORT	22500.	6.71	150975.00
5 SAFAGA PORT	105 NAG HAMADI	1 TRUCK TRANSPORT	27000.	5.70	153900.00
5 SAFAGA PORT	106 LUXOR	1 TRUCK TRANSPORT	30000.	5.94	178200.00
5 SAFAGA PORT	107 ARMANT	1 TRUCK TRANSPORT	37950.	6.02	228459.00
5 SAFAGA PORT	108 ISNA	1 TRUCK TRANSPORT	30000.	6.98	209400.00
5 SAFAGA PORT	109 IDFU	1 TRUCK TRANSPORT	36000.	8.05	289800.00
5 SAFAGA PORT	110 KOM OMBO	1 TRUCK TRANSPORT	57000.	8.59	489630.00
5 SAFAGA PORT	111 ASWAN	1 TRUCK TRANSPORT	66000.	9.66	637560.00
5 SAFAGA PORT	112 FARSHUT	1 TRUCK TRANSPORT	9900.	5.85	57915.00
5 SAFAGA PORT	113 HEW	1 TRUCK TRANSPORT	5400.	5.55	29970.00
5 SAFAGA PORT	1105 SAFAGA-Mills	1 TRUCK TRANSPORT	30000.	1.78	53400.00
5 SAFAGA PORT	99999 NOT SHIPPED	49 NOT AVAILABLE	809050.	.00	.00
6 DAMIETTA PORT	9 KAFR-EL SHEIKH	1 TRUCK TRANSPORT	217500.	2.82	613350.00
6 DAMIETTA PORT	11 EL MANSOURA	1 TRUCK TRANSPORT	568500.	2.43	1381455.00
6 DAMIETTA PORT	15 MAHALA EL KOUBRA	1 TRUCK TRANSPORT	114000.	3.09	352260.00
6 DAMIETTA PORT	1009 KAFR EL SHEIKH-F	3 RAIL TRANSPORT	14833.	2.99	44350.67
6 DAMIETTA PORT	1011 EL MANSOURA-Flr	1 TRUCK TRANSPORT	1368.	2.82	3857.76
6 DAMIETTA PORT	1013 TANTA-Flour	3 RAIL TRANSPORT	13593.	3.20	43497.60
6 DAMIETTA PORT	1021 SHEBEIN EL K.-F	3 RAIL TRANSPORT	11964.	3.59	42950.76
6 DAMIETTA PORT	1106 DAMIETTA-Mills	1 TRUCK TRANSPORT	75000.	1.78	133500.00
6 DAMIETTA PORT	2106 DAMIETTA-Flour	1 TRUCK TRANSPORT	4615.	2.19	10106.85
6 DAMIETTA PORT	99999 NOT SHIPPED	49 NOT AVAILABLE	978627.	.00	.00
		TOTAL	12400000.		39880838.40

Optimal Solution by Destination

OPTIMAL SOLUTION SORTED BY DESTINATION FOR PROJECTED PERIOD 2000

ORIGIN	DESTINATION	MODE	QUANTITY	UNIT COST	TOTAL CO
1 ALEXANDRIA PORT	7 DAMANHOUR	1 TRUCK TRANSPORT	690000.	2.15	1483500.1
1 ALEXANDRIA PORT	8 DESOUK	1 TRUCK TRANSPORT	54000.	2.62	141480.0
6 DAMIETTA PORT	9 KAFR-EL SHEIKH	1 TRUCK TRANSPORT	217500.	2.82	613350.0
6 DAMIETTA PORT	11 EL MANSOURA	1 TRUCK TRANSPORT	568500.	2.43	1381455.0
3 ISMAILIYA PORT	12 MIT GHAMR	1 TRUCK TRANSPORT	18000.	3.22	57960.0
1 ALEXANDRIA PORT	13 TANTA	1 TRUCK TRANSPORT	274500.	3.47	952515.0
1 ALEXANDRIA PORT	14 KAFR-EL ZAYAT	1 TRUCK TRANSPORT	73500.	3.07	225645.0
6 DAMIETTA PORT	15 MAHALA EL KOUBRA	1 TRUCK TRANSPORT	114000.	3.09	352260.0
3 ISMAILIYA PORT	16 ZAGAZIG	1 TRUCK TRANSPORT	472500.	2.64	1247400.0
3 ISMAILIYA PORT	17 BELBIES	1 TRUCK TRANSPORT	45000.	2.68	120600.0
3 ISMAILIYA PORT	18 SIRS EL LAIYANA	1 TRUCK TRANSPORT	36000.	4.43	159480.0
3 ISMAILIYA PORT	19 MINIA EL KAMH	1 TRUCK TRANSPORT	7500.	3.07	23025.0
1 ALEXANDRIA PORT	20 MENOUF	1 TRUCK TRANSPORT	21000.	4.31	90510.0
3 ISMAILIYA PORT	21 SHEBEIN EL KOMH	1 TRUCK TRANSPORT	303000.	3.99	1208970.0
3 ISMAILIYA PORT	22 ASHMOUN	1 TRUCK TRANSPORT	28500.	4.46	127110.0
3 ISMAILIYA PORT	23 BENHA	1 TRUCK TRANSPORT	625500.	3.43	2145465.0
3 ISMAILIYA PORT	24 KALYUB	1 TRUCK TRANSPORT	81000.	3.77	305370.0
3 ISMAILIYA PORT	26 SHUBRA	1 TRUCK TRANSPORT	526200.	3.57	1878534.0
3 ISMAILIYA PORT	35 HELIOPOLIS	1 TRUCK TRANSPORT	380400.	3.45	1312380.0
3 ISMAILIYA PORT	44 SOUTH CAIRO	1 TRUCK TRANSPORT	426000.	3.70	1576200.0
3 ISMAILIYA PORT	79 IMBABA	1 TRUCK TRANSPORT	257100.	3.73	958983.0
3 ISMAILIYA PORT	80 GIZA	1 TRUCK TRANSPORT	1002000.	3.77	3777540.0
3 ISMAILIYA PORT	84 BENI SUEF	1 TRUCK TRANSPORT	168600.	6.15	1036890.0
3 ISMAILIYA PORT	85 BEBA	1 TRUCK TRANSPORT	11100.	7.03	78033.0
3 ISMAILIYA PORT	86 EL FAIYUM	1 TRUCK TRANSPORT	285000.	6.04	1721400.0
1 ALEXANDRIA PORT	87 RASHEID	1 TRUCK TRANSPORT	31500.	1.98	62370.0
5 SAFAGA PORT	88 QENA	1 TRUCK TRANSPORT	159150.	4.37	695485.5
3 ISMAILIYA PORT	89 MAGHAGHA	1 TRUCK TRANSPORT	12600.	7.78	98028.0
3 ISMAILIYA PORT	90 BENI MAZAR	1 TRUCK TRANSPORT	9000.	8.16	73440.0
3 ISMAILIYA PORT	91 SAMALOUT	1 TRUCK TRANSPORT	14100.	8.74	123234.0
3 ISMAILIYA PORT	92 MINYA	2 BARGE TRANSPORT	269100.	9.03	2429973.0
3 ISMAILIYA PORT	93 ABOU KORKAS	2 BARGE TRANSPORT	23700.	9.41	223017.0
3 ISMAILIYA PORT	94 MALLAWI	2 BARGE TRANSPORT	17100.	9.80	167580.0
5 SAFAGA PORT	95 ASYUT	1 TRUCK TRANSPORT	141300.	9.94	1404522.0
5 SAFAGA PORT	96 EL WADI EL GEDID	1 TRUCK TRANSPORT	3000.	19.29	57870.0
5 SAFAGA PORT	97 DURUNKA	1 TRUCK TRANSPORT	10800.	10.04	108432.0
5 SAFAGA PORT	98 EL AUSIRNT	1 TRUCK TRANSPORT	5700.	5.91	33687.0
5 SAFAGA PORT	99 TEMA	1 TRUCK TRANSPORT	21000.	9.10	191100.0
5 SAFAGA PORT	100 TAHTA	1 TRUCK TRANSPORT	84000.	8.57	719880.0
5 SAFAGA PORT	101 SOHAG	1 TRUCK TRANSPORT	265000.	7.73	2048450.0
5 SAFAGA PORT	102 KOUS	1 TRUCK TRANSPORT	111000.	5.34	592740.0
5 SAFAGA PORT	103 EL MENSHA	1 TRUCK TRANSPORT	38250.	7.33	280372.5
5 SAFAGA PORT	104 CERGA	1 TRUCK TRANSPORT	22500.	6.71	150975.0
5 SAFAGA PORT	105 NAG HAMADI	1 TRUCK TRANSPORT	27000.	5.70	153900.0
5 SAFAGA PORT	106 LUXOR	1 TRUCK TRANSPORT	30000.	5.94	178200.0
5 SAFAGA PORT	107 ARMANT	1 TRUCK TRANSPORT	37950.	6.02	228459.0
5 SAFAGA PORT	108 ISNA	1 TRUCK TRANSPORT	30000.	6.98	209400.0

OPTIMAL SOLUTION SORTED BY DESTINATION FOR PROJECTED PERIOD 2000

ORIGIN	DESTINATION	MODE	QUANTITY	UNIT COST	TOTAL COST
5 SAFAGA PORT	109 IDFU	1 TRUCK TRANSPORT	36000.	8.05	289800.00
5 SAFAGA PORT	110 KOM OMBO	1 TRUCK TRANSPORT	57000.	8.59	489630.00
5 SAFAGA PORT	111 ASWAN	1 TRUCK TRANSPORT	66000.	9.66	637560.00
5 SAFAGA PORT	112 FARSHUT	1 TRUCK TRANSPORT	9900.	5.85	57915.00
5 SAFAGA PORT	113 HEW	1 TRUCK TRANSPORT	5400.	5.55	29970.00
1 ALEXANDRIA PORT	1007 DAMANHOUR-Flour	1 TRUCK TRANSPORT	48521.	2.55	123728.55
6 DAMIETTA PORT	1009 KAFR EL SHEIKH-F	3 RAIL TRANSPORT	14833.	2.99	44350.67
6 DAMIETTA PORT	1011 EL MANSOURA-Flr	1 TRUCK TRANSPORT	1368.	2.82	3857.76
6 DAMIETTA PORT	1013 TANTA-Flour	3 RAIL TRANSPORT	13593.	3.20	43497.60
3 ISMAILIYA PORT	1016 ZAGAZIG-Flour	1 TRUCK TRANSPORT	24204.	3.03	73338.12
6 DAMIETTA PORT	1021 SHEBEIN EL K.-F	3 RAIL TRANSPORT	11964.	3.59	42950.76
3 ISMAILIYA PORT	1023 BENHA-Flour	1 TRUCK TRANSPORT	22507.	3.81	85751.67
3 ISMAILIYA PORT	1026 SHUBRA-Flour	1 TRUCK TRANSPORT	74724.	3.94	294412.56
3 ISMAILIYA PORT	1035 HELIOPOLIS-Flour	1 TRUCK TRANSPORT	59878.	3.83	229332.73
3 ISMAILIYA PORT	1044 S. CAIRO-Flour	1 TRUCK TRANSPORT	102481.	4.07	417097.69
3 ISMAILIYA PORT	1079 IMBABA-Flour	1 TRUCK TRANSPORT	57984.	4.10	237734.39
3 ISMAILIYA PORT	1080 GIZA-Flour	1 TRUCK TRANSPORT	157563.	4.14	652310.81
3 ISMAILIYA PORT	1084 BENI SUEF-Flour	2 BARGE TRANSPORT	19028.	6.30	119876.41
3 ISMAILIYA PORT	1086 EL FAIYUM-Flour	1 TRUCK TRANSPORT	314.	6.37	2000.18
3 ISMAILIYA PORT	1092 MINYA-Flour	2 BARGE TRANSPORT	19685.	8.31	163582.36
3 ISMAILIYA PORT	1095 ASYUT-Flour	2 BARGE TRANSPORT	44940.	9.10	408954.03
1 ALEXANDRIA PORT	1101 ALEXANDRIA-Mills	1 TRUCK TRANSPORT	597600.	1.78	1063728.00
2 SUEZ PORT	1102 SUEZ-Mills	1 TRUCK TRANSPORT	90000.	1.78	160200.00
3 ISMAILIYA PORT	1103 ISMAILIYA-Mills	1 TRUCK TRANSPORT	240000.	1.78	427200.00
4 PORT SAID PORT	1104 PORT SAID-Mills	1 TRUCK TRANSPORT	75000.	1.78	133500.00
5 SAFAGA PORT	1105 SAFAGA-Mills	1 TRUCK TRANSPORT	30000.	1.78	53400.00
6 DAMIETTA PORT	1106 DAMIETTA-Mills	1 TRUCK TRANSPORT	75000.	1.78	133500.00
1 ALEXANDRIA PORT	2101 ALEXANDRIA-Flr	1 TRUCK TRANSPORT	111590.	2.19	244382.11
6 DAMIETTA PORT	2106 DAMIETTA-Flour	1 TRUCK TRANSPORT	4615.	2.19	10106.85
1 ALEXANDRIA PORT	99999 NOT SHIPPED	49 NOT AVAILABLE	97789.	.00	.00
2 SUEZ PORT	99999 NOT SHIPPED	49 NOT AVAILABLE	110000.	.00	.00
3 ISMAILIYA PORT	99999 NOT SHIPPED	49 NOT AVAILABLE	157692.	.00	.00
4 PORT SAID PORT	99999 NOT SHIPPED	49 NOT AVAILABLE	125000.	.00	.00
5 SAFAGA PORT	99999 NOT SHIPPED	49 NOT AVAILABLE	809050.	.00	.00
6 DAMIETTA PORT	99999 NOT SHIPPED	49 NOT AVAILABLE	978627.	.00	.00
		TOTAL	12400000.		39880838.40

Optimal Solution by Mode

OPTIMAL SOLUTION SORTED BY MODE FOR PROJECTED PERIOD 2000

ORIGIN	DESTINATION	MODE	QUANTITY	UNIT COST	TOTAL COS
1 ALEXANDRIA PORT	7 DAMANHOUR	1 TRUCK TRANSPORT	690000.	2.15	1483500.1
1 ALEXANDRIA PORT	8 DESOUK	1 TRUCK TRANSPORT	54000.	2.62	141480.0
1 ALEXANDRIA PORT	13 TANTA	1 TRUCK TRANSPORT	274500.	3.47	952515.0
1 ALEXANDRIA PORT	14 KAFR-EL ZAYAT	1 TRUCK TRANSPORT	73500.	3.07	225645.0
1 ALEXANDRIA PORT	20 MENOUF	1 TRUCK TRANSPORT	21000.	4.31	90510.0
1 ALEXANDRIA PORT	87 RASHEID	1 TRUCK TRANSPORT	31500.	1.98	62370.0
1 ALEXANDRIA PORT	1007 DAMANHOUR-Flour	1 TRUCK TRANSPORT	48521.	2.55	123728.5
1 ALEXANDRIA PORT	1101 ALEXANDRIA-Mills	1 TRUCK TRANSPORT	597600.	1.78	1063728.0
1 ALEXANDRIA PORT	2101 ALEXANDRIA-Flr	1 TRUCK TRANSPORT	111590.	2.19	244382.1
2 SUEZ PORT	1102 SUEZ-Mills	1 TRUCK TRANSPORT	90000.	1.78	160200.0
3 ISMAILIYA PORT	12 MIT GHAMR	1 TRUCK TRANSPORT	18000.	3.22	57960.0
3 ISMAILIYA PORT	16 ZAGAZIG	1 TRUCK TRANSPORT	472500.	2.64	1247400.0
3 ISMAILIYA PORT	17 BELBIES	1 TRUCK TRANSPORT	45000.	2.68	120600.0
3 ISMAILIYA PORT	18 SIRS EL LAIYANA	1 TRUCK TRANSPORT	36000.	4.43	159480.0
3 ISMAILIYA PORT	19 MINIA EL KAMH	1 TRUCK TRANSPORT	7500.	3.07	23025.0
3 ISMAILIYA PORT	21 SHEBEIN EL KOMH	1 TRUCK TRANSPORT	303000.	3.99	1208970.0
3 ISMAILIYA PORT	22 ASHMOUN	1 TRUCK TRANSPORT	28500.	4.46	127110.0
3 ISMAILIYA PORT	23 BENHA	1 TRUCK TRANSPORT	625500.	3.43	2145465.0
3 ISMAILIYA PORT	24 KALYUB	1 TRUCK TRANSPORT	81000.	3.77	305370.0
3 ISMAILIYA PORT	26 SHUBRA	1 TRUCK TRANSPORT	526200.	3.57	1878534.0
3 ISMAILIYA PORT	35 HELIOPOLIS	1 TRUCK TRANSPORT	380400.	3.45	1312380.0
3 ISMAILIYA PORT	44 SOUTH CAIRO	1 TRUCK TRANSPORT	426000.	3.70	1576200.0
3 ISMAILIYA PORT	79 IMBABA	1 TRUCK TRANSPORT	257100.	3.73	958983.0
3 ISMAILIYA PORT	80 GIZA	1 TRUCK TRANSPORT	1002000.	3.77	3777540.0
3 ISMAILIYA PORT	84 BENI SUEF	1 TRUCK TRANSPORT	168600.	6.15	1036890.0
3 ISMAILIYA PORT	85 BEBA	1 TRUCK TRANSPORT	11100.	7.03	78033.0
3 ISMAILIYA PORT	86 EL FAIYUM	1 TRUCK TRANSPORT	285000.	6.04	1721400.0
3 ISMAILIYA PORT	89 MAGHAGHA	1 TRUCK TRANSPORT	12600.	7.78	98028.0
3 ISMAILIYA PORT	90 BENI MAZAR	1 TRUCK TRANSPORT	9000.	8.16	73440.0
3 ISMAILIYA PORT	91 SAMALOUT	1 TRUCK TRANSPORT	14100.	8.74	123234.0
3 ISMAILIYA PORT	1016 ZAGAZIG-Flour	1 TRUCK TRANSPORT	24204.	3.03	73338.12
3 ISMAILIYA PORT	1023 BENHA-Flour	1 TRUCK TRANSPORT	22507.	3.81	85751.67
3 ISMAILIYA PORT	1026 SHUBRA-Flour	1 TRUCK TRANSPORT	74724.	3.94	294412.56
3 ISMAILIYA PORT	1035 HELIOPOLIS-Flour	1 TRUCK TRANSPORT	59878.	3.83	229332.73
3 ISMAILIYA PORT	1044 S. CAIRO-Flour	1 TRUCK TRANSPORT	102481.	4.07	417097.69
3 ISMAILIYA PORT	1079 IMBABA-Flour	1 TRUCK TRANSPORT	57984.	4.10	237734.39
3 ISMAILIYA PORT	1080 GIZA-Flour	1 TRUCK TRANSPORT	157563.	4.14	652310.81
3 ISMAILIYA PORT	1086 EL FAIYUM-Flour	1 TRUCK TRANSPORT	314.	6.37	2000.18
3 ISMAILIYA PORT	1103 ISMAILIYA-Mills	1 TRUCK TRANSPORT	240000.	1.78	427200.00
4 PORT SAID PORT	1104 PORT SAID-Mills	1 TRUCK TRANSPORT	75000.	1.78	133500.00
5 SAFAGA PORT	88 QENA	1 TRUCK TRANSPORT	159150.	4.37	695485.50
5 SAFAGA PORT	95 ASYUT	1 TRUCK TRANSPORT	141300.	9.94	1404522.00
5 SAFAGA PORT	96 EL WADI EL GEDID	1 TRUCK TRANSPORT	3000.	19.29	57870.00
5 SAFAGA PORT	97 DURUNKA	1 TRUCK TRANSPORT	10800.	10.04	108432.00
5 SAFAGA PORT	98 EL AUSIRNT	1 TRUCK TRANSPORT	5700.	5.91	33687.00
5 SAFAGA PORT	99 TEMA	1 TRUCK TRANSPORT	21000.	9.10	191100.02
5 SAFAGA PORT	100 TAHTA	1 TRUCK TRANSPORT	84000.	8.57	719880.00

OPTIMAL SOLUTION SORTED BY MODE FOR PROJECTED PERIOD 2000

ORIGIN	DESTINATION	MODE	QUANTITY	UNIT COST	TOTAL COST
5 SAFAGA PORT	101 SOHAG	1 TRUCK TRANSPORT	265000.	7.73	2048450.00
5 SAFAGA PORT	102 KOUS	1 TRUCK TRANSPORT	111000.	5.34	592740.00
5 SAFAGA PORT	103 EL MENSHA	1 TRUCK TRANSPORT	38250.	7.33	280372.50
5 SAFAGA PORT	104 CERGA	1 TRUCK TRANSPORT	22500.	6.71	150975.00
5 SAFAGA PORT	105 NAG HAMADI	1 TRUCK TRANSPORT	27000.	5.70	153900.00
5 SAFAGA PORT	106 LUXOR	1 TRUCK TRANSPORT	30000.	5.94	178200.00
5 SAFAGA PORT	107 ARMANT	1 TRUCK TRANSPORT	37950.	6.02	228459.00
5 SAFAGA PORT	108 ISNA	1 TRUCK TRANSPORT	30000.	6.98	209400.00
5 SAFAGA PORT	109 IDFU	1 TRUCK TRANSPORT	36000.	8.05	289800.00
5 SAFAGA PORT	110 KOM OMBO	1 TRUCK TRANSPORT	57000.	8.59	489630.00
5 SAFAGA PORT	111 ASWAN	1 TRUCK TRANSPORT	66000.	9.66	637560.00
5 SAFAGA PORT	112 FARSHUT	1 TRUCK TRANSPORT	9900.	5.85	57915.00
5 SAFAGA PORT	113 HEW	1 TRUCK TRANSPORT	5400.	5.55	29970.00
5 SAFAGA PORT	1105 SAFAGA-Mills	1 TRUCK TRANSPORT	30000.	1.78	53400.00
6 DAMIETTA PORT	9 KAFR-EL SHEIKH	1 TRUCK TRANSPORT	217500.	2.82	613350.00
6 DAMIETTA PORT	11 EL MANSOURA	1 TRUCK TRANSPORT	568500.	2.43	1381455.00
6 DAMIETTA PORT	15 MAHALA EL KOUBRA	1 TRUCK TRANSPORT	114000.	3.09	352260.00
6 DAMIETTA PORT	1011 EL MANSOURA-Flr	1 TRUCK TRANSPORT	1368.	2.82	3857.76
6 DAMIETTA PORT	1106 DAMIETTA-Mills	1 TRUCK TRANSPORT	75000.	1.78	133500.00
6 DAMIETTA PORT	2106 DAMIETTA-Flour	1 TRUCK TRANSPORT	4615.	2.19	10106.85
		SUBTOTAL	9687899.		36237056.57
3 ISMAILIYA PORT	92 MINYA	2 BARGE TRANSPORT	269100.	9.03	2429973.00
3 ISMAILIYA PORT	93 ABOU KORKAS	2 BARGE TRANSPORT	23700.	9.41	223017.00
3 ISMAILIYA PORT	94 MALLAWI	2 BARGE TRANSPORT	17100.	9.80	167580.00
3 ISMAILIYA PORT	1084 BENI SUEF-Flour	2 BARGE TRANSPORT	19028.	6.30	119876.41
3 ISMAILIYA PORT	1092 MINYA-Flour	2 BARGE TRANSPORT	19685.	8.31	163582.36
3 ISMAILIYA PORT	1095 ASYUT-Flour	2 BARGE TRANSPORT	44940.	9.10	408954.03
		SUBTOTAL	393553.		3512982.80
6 DAMIETTA PORT	1009 KAFR EL SHEIKH-F	3 RAIL TRANSPORT	14833.	2.99	44350.67
6 DAMIETTA PORT	1013 TANTA-Flour	3 RAIL TRANSPORT	13593.	3.20	43497.60
6 DAMIETTA PORT	1021 SHEBEIN EL K.-F	3 RAIL TRANSPORT	11964.	3.59	42950.76
		SUBTOTAL	40390.		130799.03
1 ALEXANDRIA PORT	99999 NOT SHIPPED	49 NOT AVAILABLE	97789.	.00	.00
2 SUEZ PORT	99999 NOT SHIPPED	49 NOT AVAILABLE	110000.	.00	.00
3 ISMAILIYA PORT	99999 NOT SHIPPED	49 NOT AVAILABLE	157692.	.00	.00
4 PORT SAID PORT	99999 NOT SHIPPED	49 NOT AVAILABLE	125000.	.00	.00
5 SAFAGA PORT	99999 NOT SHIPPED	49 NOT AVAILABLE	809050.	.00	.00
6 DAMIETTA PORT	99999 NOT SHIPPED	49 NOT AVAILABLE	978627.	.00	.00
		SUBTOTAL	2278158.		.00
		TOTAL	12400000.		39880838.40

File of Optimum Distribution Output

1	ALEXANDRIA PORT	7	DAMANHOUR	1	TRUCK TRANSPORT	690000.	2.15
1	ALEXANDRIA PORT	8	DESOUK	1	TRUCK TRANSPORT	54000.	2.62
1	ALEXANDRIA PORT	13	TANTA	1	TRUCK TRANSPORT	274500.	3.47
1	ALEXANDRIA PORT	14	KAFR-EL ZAYAT	1	TRUCK TRANSPORT	73500.	3.07
1	ALEXANDRIA PORT	20	MENOUF	1	TRUCK TRANSPORT	21000.	4.31
1	ALEXANDRIA PORT	87	RASHEID	1	TRUCK TRANSPORT	31500.	1.98
1	ALEXANDRIA PORT	1007	DAMANHOUR-Flour	1	TRUCK TRANSPORT	48521.	2.55
1	ALEXANDRIA PORT	1101	ALEXANDRIA-Mills	1	TRUCK TRANSPORT	597600.	1.78
1	ALEXANDRIA PORT	2101	ALEXANDRIA-Flr	1	TRUCK TRANSPORT	111590.	2.19
1	ALEXANDRIA PORT	99999	NOT SHIPPED	49	NOT AVAILABLE	97789.	.00
2	SUEZ PORT	1102	SUEZ-Mills	1	TRUCK TRANSPORT	90000.	1.78
2	SUEZ PORT	99999	NOT SHIPPED	49	NOT AVAILABLE	110000.	.00
3	ISMAILIYA PORT	12	MIT GHAMR	1	TRUCK TRANSPORT	18000.	3.22
3	ISMAILIYA PORT	16	ZAGAZIG	1	TRUCK TRANSPORT	472500.	2.64
3	ISMAILIYA PORT	17	BELBIES	1	TRUCK TRANSPORT	45000.	2.68
3	ISMAILIYA PORT	18	SIRS EL LAIYANA	1	TRUCK TRANSPORT	36000.	4.43
3	ISMAILIYA PORT	19	MINIA EL KAMH	1	TRUCK TRANSPORT	7500.	3.07
3	ISMAILIYA PORT	21	SHEBEIN EL KOMH	1	TRUCK TRANSPORT	303000.	3.99
3	ISMAILIYA PORT	22	ASHMOUN	1	TRUCK TRANSPORT	28500.	4.46
3	ISMAILIYA PORT	23	BENHA	1	TRUCK TRANSPORT	625500.	3.43
3	ISMAILIYA PORT	24	KALYUB	1	TRUCK TRANSPORT	81000.	3.77
3	ISMAILIYA PORT	26	SHUBRA	1	TRUCK TRANSPORT	526200.	3.57
3	ISMAILIYA PORT	35	HELIOPOLIS	1	TRUCK TRANSPORT	380400.	3.45
3	ISMAILIYA PORT	44	SOUTH CAIRO	1	TRUCK TRANSPORT	426000.	3.70
3	ISMAILIYA PORT	79	IMBABA	1	TRUCK TRANSPORT	257100.	3.73
3	ISMAILIYA PORT	80	GIZA	1	TRUCK TRANSPORT	1002000.	3.77
3	ISMAILIYA PORT	84	BENI SUEF	1	TRUCK TRANSPORT	168600.	6.15
3	ISMAILIYA PORT	85	BEBA	1	TRUCK TRANSPORT	11100.	7.03
3	ISMAILIYA PORT	86	EL FAIYUM	1	TRUCK TRANSPORT	285000.	6.04
3	ISMAILIYA PORT	89	MAGHAGHA	1	TRUCK TRANSPORT	12600.	7.78
3	ISMAILIYA PORT	90	BENI MAZAR	1	TRUCK TRANSPORT	9000.	8.16
3	ISMAILIYA PORT	91	SAMALOUT	1	TRUCK TRANSPORT	14100.	8.74
3	ISMAILIYA PORT	92	MINYA	2	BARGE TRANSPORT	269100.	9.03
3	ISMAILIYA PORT	93	ABOU KORKAS	2	BARGE TRANSPORT	23700.	9.41
3	ISMAILIYA PORT	94	MALLAWI	2	BARGE TRANSPORT	17100.	9.80
3	ISMAILIYA PORT	1016	ZAGAZIG-Flour	1	TRUCK TRANSPORT	24204.	3.03
3	ISMAILIYA PORT	1023	BENHA-Flour	1	TRUCK TRANSPORT	22507.	3.81
3	ISMAILIYA PORT	1026	SHUBRA-Flour	1	TRUCK TRANSPORT	74724.	3.94
3	ISMAILIYA PORT	1035	HELIOPOLIS-Flour	1	TRUCK TRANSPORT	59878.	3.83
3	ISMAILIYA PORT	1044	S. CAIRO-Flour	1	TRUCK TRANSPORT	102481.	4.07
3	ISMAILIYA PORT	1079	IMBABA-Flour	1	TRUCK TRANSPORT	57984.	4.10
3	ISMAILIYA PORT	1080	GIZA-Flour	1	TRUCK TRANSPORT	157563.	4.14
3	ISMAILIYA PORT	1084	BENI SUEF-Flour	2	BARGE TRANSPORT	19028.	6.30
3	ISMAILIYA PORT	1086	EL FAIYUM-Flour	1	TRUCK TRANSPORT	314.	6.37
3	ISMAILIYA PORT	1092	MINYA-Flour	2	BARGE TRANSPORT	19685.	8.31
3	ISMAILIYA PORT	1095	ASYUT-Flour	2	BARGE TRANSPORT	44940.	9.10
3	ISMAILIYA PORT	1103	ISMAILIYA-Mills	1	TRUCK TRANSPORT	240000.	1.78
3	ISMAILIYA PORT	99999	NOT SHIPPED	49	NOT AVAILABLE	157692.	.00
4	PORT SAID PORT	1104	PORT SAID-Mills	1	TRUCK TRANSPORT	75000.	1.78
4	PORT SAID PORT	99999	NOT SHIPPED	49	NOT AVAILABLE	125000.	.00

5	SAFAGA PORT	88	QENA	1	TRUCK TRANSPORT	159150.	4.37
5	SAFAGA PORT	95	ASYUT	1	TRUCK TRANSPORT	141300.	9.94
5	SAFAGA PORT	96	EL WADI EL GEDID	1	TRUCK TRANSPORT	3000.	19.29
5	SAFAGA PORT	97	DURUNKA	1	TRUCK TRANSPORT	10800.	10.04
5	SAFAGA PORT	98	EL AUSIRNT	1	TRUCK TRANSPORT	5700.	5.91
5	SAFAGA PORT	99	TEMA	1	TRUCK TRANSPORT	21000.	9.10
5	SAFAGA PORT	100	TAHTA	1	TRUCK TRANSPORT	84000.	8.57
5	SAFAGA PORT	101	SOHAG	1	TRUCK TRANSPORT	265000.	7.73
5	SAFAGA PORT	102	KOUS	1	TRUCK TRANSPORT	111000.	5.34
5	SAFAGA PORT	103	EL MENSHA	1	TRUCK TRANSPORT	33250.	7.33
5	SAFAGA PORT	104	CERGA	1	TRUCK TRANSPORT	22500.	6.71
5	SAFAGA PORT	105	NAG HAMADI	1	TRUCK TRANSPORT	27000.	5.70
5	SAFAGA PORT	106	LUXOR	1	TRUCK TRANSPORT	30000.	5.94
5	SAFAGA PORT	107	ARMANT	1	TRUCK TRANSPORT	37950.	6.02
5	SAFAGA PORT	108	ISNA	1	TRUCK TRANSPORT	30000.	6.98
5	SAFAGA PORT	109	IDFU	1	TRUCK TRANSPORT	36000.	8.05
5	SAFAGA PORT	110	KOM OMBO	1	TRUCK TRANSPORT	57000.	8.59
5	SAFAGA PORT	111	ASWAN	1	TRUCK TRANSPORT	66000.	9.66
5	SAFAGA PORT	112	FARSHUT	1	TRUCK TRANSPORT	9900.	5.85
5	SAFAGA PORT	113	HEW	1	TRUCK TRANSPORT	5400.	5.55
5	SAFAGA PORT	1105	SAFAGA-Mills	1	TRUCK TRANSPORT	30000.	1.78
5	SAFAGA PORT	99999	NOT SHIPPED	49	NOT AVAILABLE	809050.	.00
6	DAMIETTA PORT	9	KAFR-EL SHEIKH	1	TRUCK TRANSPORT	217500.	2.82
6	DAMIETTA PORT	11	EL MANSOURA	1	TRUCK TRANSPORT	568500.	2.43
6	DAMIETTA PORT	15	MAHALA EL KOUBRA	1	TRUCK TRANSPORT	114000.	2.09
6	DAMIETTA PORT	1009	KAFR EL SHEIKH-F	3	RAIL TRANSPORT	14833.	2.99
6	DAMIETTA PORT	1011	EL MANSOURA-Flr	1	TRUCK TRANSPORT	1368.	2.82
6	DAMIETTA PORT	1013	TANTA-Flour	3	RAIL TRANSPORT	13593.	3.20
6	DAMIETTA PORT	1021	SHEBEIN EL K.-F	3	RAIL TRANSPORT	11964.	3.59
6	DAMIETTA PORT	1106	DAMIETTA-Mills	1	TRUCK TRANSPORT	75000.	1.78
6	DAMIETTA PORT	2106	DAMIETTA-Flour	1	TRUCK TRANSPORT	4615.	2.19
6	DAMIETTA PORT	99999	NOT SHIPPED	49	NOT AVAILABLE	978627.	.00

Normal End of TRLP Program Run

ITERATION = 21

Stop - Program terminated.

APPENDIX A

LISTING OF THE TRANS SOURCE PROGRAM

```
C
C     TRANSPORTATION LINEAR PROGRAM WITH RECURSIVE FEATURE, MODE,
C   SHADOW PRICES AND SECOND OPTIMAL SOLUTION INFORMATION (TRANS LP)
C
C                          A. READ PROGRAM
C     THIS READ PROGRAM FOR THE TRANSPORTATION LP HAS A MAIN PROGRAM
C       AND ONE SUB-PROGRAM.  MOST OF THE COMMANDS ARE READ BY THE
C       LATTER.
C
C                          RICHARD PHILLIPS
C                   DEPARTMENT OF AGRICULTURAL ECONOMICS
C                         KANSAS STATE UNIVERSITY
C
C     The number of supply points (M) multiplied by the number of
C       destination points (N) cannot exceed 3,000; also both M
C       and N must be 200 or less.
C
      DIMENSION T(3000),Q(3000),MODE(3000)
      COMMON/AREA1/ID,NCARD,NPRINT,NTEMP,JITER,NOITER,NN,MOD
      NCARD = 1
      NPRINT = 0
      NTEMP = 2
    9 FORMAT(5I4)
      OPEN (1,FILE='DEFAULT.TLP',STATUS='OLD')
C
C     I.  READ MASTER CONTROL COMMANDS
C
C     0. Read the number of supply and demand points, maximum
C        iterations and check for intermediate results
C        M  =  number of supply points
C        N  =  number of demand points
C        NOITER = maximum number of iterations to be executed toward
C                 solution of problem in order to avoid excessive
C                 processing time for solution.  If solution not found
C                 in specified NOITER, intermediate results will be
C                 stored on diskette.
C        ID = check the program runs from the intermediate result:
C             Yes = 1; No = 0
C        MOD = mode identified with transfer point input data:
C             Yes = 1; No = 0
C
C                        FORMAT IS (4I4)
C
    1 READ (NCARD,9,END=99) M,N,NOITER,ID,MOD
      M1=M+1
      N1=N+1
      MN=M1*N1
      IF((MN.GE.3000).OR.(MN.LE.0)) GOTO 88
```


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```
      JITER=NOITER
      CALL TRANS (M1,N1,T,Q,MODE)
      GOTO 1
   88 WRITE (NPRINT,100) MN
  100 FORMAT ('1',I9,'---','The total multiplier of supply',
     11X,'and demand points is over 3,000 or equal 0; the',
     21X,'program is terminated automatically')
   99 STOP
      END
C
      SUBROUTINE TRANS (M',N1,T,Q,MODE)
C
      COMMON/AREA1/ID,NCARD,NPRINT,NTEMP,JITER,NOITER,NN,MOD
      DIMENSION T(M1,N1),Q(M1,N1),MODE(M1,N1)
      DIMENSION NM(50),D(200),S(200),U(200),V(200),IP(200),JC(200),
     1ND(200),NS(200),IFAS(200),JFAS(200),KODED(200,4),KODEM(200,4),KODE
     2S(200,4)
    9 FORMAT (20I4)
      M = M1-1
      N = N1-1
C
C     II.  READ CONTROL COMMAND FOR DATA INPUT
C
C       1. Read logical units for supply and demand files, rate files,
C          data set ID, method of output storage, mode and recursive
C
C          NPASS = Total number of passes in the run, including
C                  recursive solutions
C          NYEAR = Identification number of data sets, 4 digits, month
C                  and year
C           LOAD = Disk storage of output, Yes = 1, No = 0
C         IRECUR = Add current supply quantities to those remaining
C                  from the previous period:  Yes = 1, No = 0
C          ISAME = Same rates to be used as in previous period:
C                  Yes = 1, No = 0
C         ISHADW = Print shadow price and marginal cost table:
C                  Yes = 1, No = 0
C             NN = Number of modes identified in the problem
C
C        NODIFF  = Skip printing difference in quantities; Yes=1, No=0
C        NOPREL  = Skip printing intermediate results; Yes = 1, No = 0
C        NORATE  = Skip printing transport rates; Yes = 1, No = 0
C        NOINIT  = Skip printing initial pattern; Yes = 1, No = 0
C        NOORIG  = Skip printing origin sort;     Yes = 1, No = 0
C        NODEST  = Skip printing destination sort;Yes = 1, No = 0
C        NOMODE  = Skip printing mode sort;       Yes = 1, No = 0
C        MORATE  = Skip printing rates by mode;   Yes = 1, No = 0
C        MOORIG  = Skip printing mode by origin;  Yes = 1, No = 0
C        MODEST  = Skip printing mode by destination; Yes = 1, No = 0
C                       FORMAT is 20 I 4
C
    3 READ (NCARD,9,END=33) NPASS,NYEAR,LOAD,IRECUR,
```

```
     1ISAME,ISHADW,NN,NODIFF,NOPREL,NORATE,NOINIT,NOORIG,NODEST,NOMODE,
     2MORATE,MOORIG,MODEST
  121 FORMAT (4X,I4,4X,4A4)
      IF (IRECUR.EQ.1) GOTO 202
      IF (MOD.EQ.0) GOTO 102
C
C      2. If MOD = 1, read transportation mode ID numbers and descriptions
C         NM     = Mode identification number
C         KODED = Description or name of this mode
C                     FORMAT is 4X, I4, 4X, 4A4
C           Omit this step if MOD = 0  (Step 1).
C
      DO 34 I=1,NN
      READ (NCARD,121,END=33) J,(KODEM(J,K),K=1,4)
      NM(I) = J
   34 CONTINUE
  102 CONTINUE
      WRITE (0,151)
  151 FORMAT (/11X,'TRANSPORTATION LINEAR PROGRAM WITH MODE AND SHADOW P
     1RICES'/23X,'Richard Phillips and Joe M. Tiao'/21X,'Department of A
     2gricultural Economics'/27X,'Kansas State University'//5X,'* This p
     3rogram reads default parameters and command instructions'/7X,'from
     4 the DEFAULT.TLP disk file for screen display to guide '/7X,
     5'the user in keyboard entry of corresponding information for his'/
     67X,'problem.'//5X,'* The program then reads the user-supplied info
     7rmation from the screen'/7X,'and creates the INPUT.TLP file of thi
     8s command information for'/7X,'use in the TRLP run.'//5X,'* The IN
     9PUT.TLP file created by the program follows the same format'/7X,
     A'as the DEFAULT.TLP file.  This enables the user who needs to make
     B'/7X,'no changes from the previous commands to simply rename the f
     Cile'/7X,'(with DOS) rather than using TRANS to build the INPUT.TLP
     D file'/7X,'for the TRLP run.'/)
      PAUSE
  141 WRITE (0,48)
   48 FORMAT (20(/))
      WRITE (0,156)
  156 FORMAT (/4X,'PARAMETERS AND COMMANDS TO BE SPECIFIED FOR THE LP RU
     1N'///'  Enter Code Number of Menu Selection and Key <return>.'//
     210X,'1  Size of Problem and Type of Run'//10X,'2  Command Codes fo
     3r the Problem'//10X,'3  Print Option Selections'//10X,'4  Mode Ide
     4ntification, If Used'//' SELECTION: ',I2/)
      READ (0,154) IVALUE
  154 FORMAT (I1)
      IF (IVALUE.EQ.0) GOTO 150
      GOTO (201,202,203,204) IVALUE
  201 WRITE (0,41) M,N,NOITER,ID,MOD
   41 FORMAT(//////5X,'DIMENSIONS OF PROBLEM AND TYPE OF ANALYSIS:'//5X,
     1'Enter three-digit value for each command in succession, with one'
     2/5X,'blank space between entries.'//' 1  NUMBER OF SUPPLY POINTS I
     3N PROBLEM:',5X,I4//' 2  NUMBER OF DEMAND POINTS IN PROBLEM:',5X,
     4I4//' 3  MAXIMUM NUMBER OF ITERATIONS IN RUN:',4X,I4//' 4  CHECK I
     5NCOMPLETE RESULTS FROM PRIOR RUN:'I4,3X,'(Yes = 001, No = 000)'
```

```
     6//' 5  MODE IDENTIFICATION INCLUDED IN DATA:',3X,I4,3X,'(Yes = 001
     7, No = 000)'///'  SELECTIONS:'/)
      READ (0,8) M,N,NOITER,ID,MOD
    8 FORMAT (5(I3,1X))
      GOTO 141
  202 WRITE (0,42) NPASS,NYEAR,LOAD,IRECUR,ISAME,ISHADW,NN
   42 FORMAT (////5X,' COMMANDS AND SPECIAL FEATURES FOR THE TRLP RUN:'/
     15X,'Enter required digits for each item with one space between ent
     2ries.'//' 1  Total number of passes included in the run:',2X,I4,2X
     3,'(Enter two-digit number)'/ ' 2  Month and/or year of data set:',
     415X,I4,2X,'(Enter four-digit number)'//' 3  Store output to disk f
     5ile:',19X,I4,2X,'(Put 1 for Yes, 0 for No)'/' 4  Add supply quanti
     6ties for recursive run:',5X,I4,2X,'(Enter as above)'//' 5  Use pre
     7vious rates for recursive run:',8X,I4,2X,'(Enter as above)'/' 6  P
     8rint shadow prices and marginal costs:',6X,I4,2X,'(Enter as above)
     9'//' 7  Number of modes identified in problem:',7X,I4,2X,'(Enter t
     Awo-digit number)'//' SELECTIONS: '/)
      READ (0,11) NPASS,NYEAR,LOAD,IRECUR,ISAME,ISHADW,NN
   11 FORMAT (I2,1X,I4,1X,4(I1,1X),I2)
      GOTO 141
  203 WRITE (0,43) NODIFF,NOPREL,NORATE,NOINIT,NOORIG,NODEST,NOMODE,
     1MORATE,MOORIG,MODEST
   43 FORMAT (/10X,'SELECTION OF OUTPUT OPTIONS TO PRINT:'//'  Enter one
     1-digit selection (Yes = 1, No = 0) for each option in'/
     2'  sequence, with one space between entries.'//' 1  Skip printing
     3difference in quantities',5X,I4/' 2  Skip printing intermediate re
     4sults',9X,I4//' 3  Skip printing transportation rates',9X,I4/
     5' 4  Skip printing initial solution',13X,I4//' 5  Skip printing so
     6lution by origin',11X,I4/' 6  Skip printing solution by destinatio
     7n',6X,I4//' 7  Skip printing solution sorted by mode',6X,I4/
     8' 8  Skip printing rates by mode',16X,I4//' 9  Skip printing origi
     9n solution by mode',6X,I4/' 10 Skip printing destination solution
     Aby mode',1X,I4//'  SELECTIONS: '/)
      READ (0,49) NODIFF,NOPREL,NORATE,NOINIT,NOORIG,NODEST,NOMODE,
     1MORATE,MOORIG,MODEST
   49 FORMAT (10(I1,1X))
      GOTO 141
  204 IF (MOD.EQ.0) GOTO 45
      DO 46 I = 1,NN
      WRITE (0,44) NM(I),(KODEM(I,K),K=1,4)
   44 FORMAT (/'  MODE Identification for No.',I4,' is ',4A4//
     1' New identification is: '/)
      READ (0,55) (KODEM(I,K),K=1,4)
   55 FORMAT (4A4)
   46 CONTINUE
      GOTO 141
   45 WRITE (0,56)
   56 FORMAT (/' Alternative modes not included in this problem.')
      PAUSE
      GOTO 141
  150 OPEN (2,FILE='INPUT.TLP',STATUS='NEW')
      WRITE (NTEMP,9) M,N,NOITER,ID,MOD
```

```
 18 WRITE (NTEMP,9) NPASS,NYEAR,LOAD,IRECUR,ISAME,
   1ISHADW,NN,NODIFF,NOPREL,NORATE,NOINIT,NOORIG,NODEST,NOMODE,
   2MORATE,MOORIG,MODEST
    IF (MOD.EQ.0) GOTO 341
    DO 340 I=1,NN
340 WRITE (NTEMP,121) NM(I),(KODEM(I,K),K=1,4)
341 CONTINUE
 33 CONTINUE
    WRITE (0,57)
 57 FORMAT (///'  The INPUT.TLP file now completed'//'  Call TRLP for
   1problem solution.'/)
    RETURN
    END
```

APPENDIX B

LISTING OF THE RATES SOURCE PROGRAM

```
C
C      TRANSPORTATION LINEAR PROGRAM WITH RECURSIVE FEATURE, MODE,
C    SHADOW PRICES AND SECOND OPTIMAL SOLUTION INFORMATION (TRANS LP)
C
C                    B. SELECTION OF LEAST COST MODE
C      THIS PROGRAM SELECTS THE LEAST COST MODE FOR EACH LINK AND ENTERS
C        THAT RATE TO THE MASTER TRANSPORT RATE FILE FOR RUNNING THE
C        TRANSPORTATION LINEAR PROGRAM.
C
C                          RICHARD PHILLIPS
C                   DEPARTMENT OF AGRICULTURAL ECONOMICS
C                         KANSAS STATE UNIVERSITY
C
C      The number of supply points (M) multiplied by the number of
C        destination points (N) cannot exceed 3,000; also both M
C        and N must be 200 or less.
C
      DIMENSION MODE(3000),T(3000)
      COMMON/AREA1/NCARD,NPRINT,NINP3,NN
      NCARD = 1
      NPRINT = 0
      NINP3 = 2
  999 FORMAT(3I4)
      OPEN (1,FILE='COMMANDS.TLP',STATUS='OLD')
C
C     1. Read the number of supply points, number of demand
C        points, and total number of transport modes
C        M  =  number of supply points
C        N  =  number of demand points
C        NN =  number of modes included
C
C                        FORMAT IS (3I4)
C
    1 READ (NCARD,999,END=99) M,N,NN
      M1=M+1
      N1=N+1
      MN=M1*N1
      IF((MN.GE.3000).OR.(MN.LE.0)) GOTO 88
      CALL RATES (M1,N1,T,MODE)
      GOTO 1
   88 WRITE (NPRINT,100) MN
  100 FORMAT ('1',I9,'---','The total multiplier of supply',
     11X,'and demand points is over 3,000 or equal 0; the',
     21X,'program is terminated automatically')
   99 STOP
      END
C
      SUBROUTINE RATES (M1,N1,T,MODE)
```


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```
C
      COMMON/AREA1/NCARD,NPRINT,NINP3,NN
      DIMENSION MODE(M1,N1),T(M1,N1)
      DIMENSION NM(50),NQ(50),ND(200),NS(200),NODE1(200),NODE2(200),
     1TA(500),KODEM(200,4)
  999 FORMAT (20I4)
 9992 FORMAT (' ',I8,4X,4A4,F16.2)
      M = M1-1
      N = N1-1
C
C      2. Read transportation mode ID, description and number of links
C         NM    = Mode identification number
C         KODED = Description or name of this mode
C         NQ    = Number of links for this mode
C                     FORMAT is 4X, I4, 4X, 4A4, 4X, I4
C
      DO 34 I=1,NN
      READ (NCARD,3684) J,(KODEM(J,K),K=1,4),L
      NM(I) = J
      NQ(I) = L
   34 CONTINUE
      WRITE (0,151)
  151 FORMAT (/11X,'TRANSPORTATION LINEAR PROGRAM WITH MODE AND SHADOW P
     1RICES'/23X,'Richard Phillips and Joe M. Tiao'/21X,'Department of A
     2gricultural Economics'/27X,'Kansas State University'//5X,'* This p
     3rogram reads default parameters and command instructions'/7X,'from
     4 the COMMANDS.TLP disk file for screen display to guide '/7X,
     5'the user in keyboard entry of corresponding information for his'/
     67X,'problem.'//5X,'* The program then reads the user-supplied info
     7rmation from the screen'/7X,'and proceeds to the ''highway'' rate
     8 file to begin selection of the'/7X,'least-cost mode.'    //5X,'*
     9The corresponding rate files for the remaining modes are read in'/
     A7X,'sequence, and a substitution made each time a lower rate is fo
     Bund.'//5X,'* The resulting least-cost rate file is prepared for us
     Ce with'/7X,'the TRLP Program in solving for the optimum shipment p
     Dattern.'/)
      PAUSE
  141 WRITE (0,48)
   48 FORMAT (20(/))
      WRITE (0,156) M,N,NN
  156 FORMAT (/4X,'PARAMETERS AND COMMANDS FOR THE RUN'
     1  ///'  Enter three-digit number followed by one space for each it
     2em, and then return.'//10X,'1  Number of supply points:',10X,I4//1
     30X,'2  Number of demand points:',10X,I4//10X,'3  Number of modes i
     4ncluded:',9X,I4///' SELECTIONS: '/)
      READ (0,154) M,N,NN
  154 FORMAT (3(I3,1X))
      DO 45 I = 1,NN
      WRITE (0,44) NM(I),NQ(I),(KODEM(I,K),K=1,4)
   44 FORMAT (/'  MODE Identification for No.',I4,' with',I4,' total lin
     1ks is ',4A4//' Correct to ____ links and mode name of ____________
     2__. '/)
```

```
      READ (0,55) NQ(I),(KODEM(I,K),K=1,4)
   55 FORMAT (I3,1X,4A4)
   45 CONTINUE
 3683 FORMAT (2(2X,I4),F10.2,I4)
 3684 FORMAT (4X,I4,4X,4A4,4X,I4)
C
C    3. Read Transfer Costs for Basic Transport Mode
C
      OPEN (1,FILE='RATES.TLP',STATUS='OLD')
      DO 46 I = 1,M
      DO 46 J = 1,N
      READ (1,3683) NS(I),ND(J),T(I,J),K
      MODE (I,J) = K
   46 CONTINUE
C
C    READ TRANSPORT RATES FOR OTHER MODES AND SELECT LOWEST
C
      IPASS = 2
  145 DO 146 L = 1,NQ(IPASS)
  146 READ (1,3683) NODE1(L),NODE2(L),TA(L),KA
      LL = 1
      DO 147 I = 1,M
      DO 147 J = 1,N
      IF (LL.GT.NQ(IPASS)) GOTO 147
      IF (NODE1(LL).EQ.NS(I).AND.NODE2(LL).EQ.ND(J)) GOTO 148
      GOTO 147
  148 IF (TA(LL).LE.0.0) TA(LL) = 99999999.
      IF (T(I,J).LE.TA(LL)) GOTO 149
      T(I,J) = TA(LL)
      MODE (I,J) = KA
  149 LL = LL + 1
  147 CONTINUE
      IPASS = IPASS + 1
      IF (IPASS.LE.NN) GOTO 145
      OPEN (2,FILE='NINP3',STATUS='NEW')
      DO 246 I = 1,M
      DO 246 J = 1,N
      WRITE (NINP3,3683) NS(I),ND(J),T(I,J),MODE(I,J)
  246 CONTINUE
  341 CONTINUE
      WRITE (0,57)
   57 FORMAT (///'  The Least-Cost Rate File is now completed'//'  Call
     1 TRANS for command input to the TRLP Program.'/)
      RETURN
      END
```

APPENDIX C

LISTING OF THE TRLP SOURCE PROGRAM

```
C
C     TRANSPORTATION LINEAR PROGRAM WITH RECURSIVE FEATURE, MODE,
C       SHADOW PRICES AND SECOND OPTIMAL SOLUTION INFORMATION
C
C     THIS TRANSPORTATION LINEAR PROGRAM HAS MAIN PROGRAM AND ONE
C       SUB-PROGRAM.  MOST OF THE PROBLEM IS CODED IN THE LATER.
C
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C
C     The core requirements to run this particular program under the
C       FORTRAN G Compiler are 256K.  The number of supply points (M)
C       multiplied by the number of destination points (N) cannot
C       exceed 3,000; also both M or N must be 200 or less.
      DIMENSION T(3000),Q(3000),MODE(3000)
      COMMON/AREA1/ID,NCARD,NPRINT,JITER,NOITER,NN,MOD
      NCARD = 2
      NPRINT = 0
      OPEN (2,FILE='INPUT.TLP',STATUS='OLD')
    9 FORMAT(5I4)
C
C     I.  READ MASTER CONTROL COMMANDS
C
C     0. Read the number of supply and demand points, time specif-
C        ication and identification number
C        M  =  number of supply points
C        N  =  number of demand points
C        NOITER = maximum number of iterations to be executed toward
C                 solution of problem in order to avoid excessive
C                 processing time for solution.  If solution not found
C                 in specified NOITER, intermediate results will be
C                 stored on diskette.
C        ID  = check the program runs from the intermediate result:
C              Yes = 1; No = 0
C        MOD = mode identified with transfer point input data;
C              Yes = 1; No = 0
C
C                        FORMAT IS (5I4)
C
    1 READ (NCARD,9,END=99) M,N,NOITER,ID,MOD
      M1=M+1
      N1=N+1
      MN=M1*N1
      IF((MN.GE.3000).OR.(MN.LE.0)) GOTO 88
      JITER=NOITER
      CALL TRLP (M1,N1,T,Q,MODE)
      IF (ID.EQ.1) GOTO 99
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      GOTO 1
   88 WRITE (NPRINT,100) MN
  100 FORMAT ('1',I9,'---','The total multiplier of supply',
     11X,'and demand points is over 3,000 or equal 0; the',
     21X,'program is terminated automatically')
   99 STOP
      END
C
      SUBROUTINE TRLP (M1,N1,T,Q,MODE)
C
C      MOST OF THE TRANSPORTATION LINEAR PROGRAM INSTRUCTIONS ARE
C        CODED IN THIS SUBPROGRAM.
C
      REAL*8 COST,SUM,SUMR,SUMS,SUMX,TOTAL,U,V,Z
      COMMON/AREA1/ID,NCARD,NPRINT,JITER,NOITER,NN,MOD
      DIMENSION T(M1,N1),Q(M1,N1),MODE(M1,N1)
      DIMENSION NM(50),D(200),S(200),U(200),V(200),IP(200),JC(200),
     1ND(200),NS(200),IFAS(200),JFAS(200),KODED(200,4),KODEM(200,4),KODE
     2S(200,4)
    2 FORMAT ('0',7X,'ORIGIN',13X,'DESTINATION',12X,'MODE',15X,
     1'QUANTITY',3X,'RATE',1X,'TOTAL COST'/'+',3(21('_'),1X),2X,
     28('_'),3X,4('_'),1X,10('_'))
    4 FORMAT (2(I6,2X,4A4),F7.2,3(F11.2))
    5 FORMAT (1H,2(I6,2X,4A4),F12.0,3X,F11.2,F16.2)
    7 FORMAT (2(I8,4A4),F11.2,F11.3)
   10 FORMAT ('0',I8,5X,4A4,4X,F11.2,1X,I4,1X,4A4)
   12 FORMAT (///,'OITERATION = ',I3///)
   37 FORMAT (' ',3(I5,1X,4A4),F8.0,F9.2,F11.2)
   38 FORMAT ('0',51X,'TOTAL',7X,F11.0,9X,F11.2/)
   40 FORMAT ('1',15X,'OPTIMAL SOLUTION SORTED BY MODE FOR PROJECTED PER
     1IOD ',I4)
   41 FORMAT (' ',48X,'SUBTOTAL',7X,F11.0,9X,F11.2/)
   43 FORMAT (' ',3(I5,1X,4A4),1X,F10.2)
   39 FORMAT (' ',2(I8,4X,4A4),4X,F18.3)
   49 FORMAT (20I4)
   51 FORMAT ('0',37X,'TOTAL',2X,F16.0,14X,F16.2/)
   86 FORMAT ('1',15X,'LISTING OF TRANSFER COST FROM ORIGIN TO DESTINATI
     1ON')
   87 FORMAT ('1',10X,'LISTING OF TRANSFER COST WITH MODE FROM ORIGIN TO
     1 DESTINATION')
   88 FORMAT ('1',15X,'OPTIMAL SOLUTION SORTED BY DESTINATION FOR PROJEC
     1TED PERIOD ',I4)
   89 FORMAT ('1',15X,'OPTIMAL SOLUTION SORTED BY ORIGIN FOR PROJECTED P
     1ERIOD ',I4)
   90 FORMAT ('1',15X,'INITIAL SOLUTION SORTED BY ORIGIN FOR PROJECTED P
     1ERIOD ',I4)
   91 FORMAT ('1',15X,'THE MARGINAL COST FROM ORIGIN TO DESTINATION PERI
     1OD ',I4)
   92 FORMAT (1H0,59X,'SUPPLY',5X,'DEMAND'/60X,'SHADOW',5X,'SHADOW',4X,
     1'MARGINAL'/10X,'ORIGIN',15X,'DESTINATION',8X,'RATE',7X,'PRICE',6X,
     2'PRICE',6X,'COST'/'+',4X,18('_'),4X,18('_'),4X,6('_'),5X,6('_'),
     35X,6('_'),5X,6('_')/)
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   93 FORMAT ('0',9X,'ORIGIN',24X,'DESTINATION',15X,'    UNIT COST'/'+',
     14X,18('_'),12X,18('_'),15X,13('_'))
   94 FORMAT ('0',4X,'ORIGIN',16X,'DESTINATION',13X,'MODE',14X,'UNIT COS
     1T',/'+',3(3X,18('_'),1X),2X,9('_'))
   95 FORMAT ('1',03X,'SUPPLY QUANTITIES BY ORIGIN FOR PROJECTED PERIOD
     1',I6)
   96 FORMAT ('1',03X,'DEMAND QUANTITIES BY DESTINATION FOR PROJECTED PE
     1RIOD ',I6)
   97 FORMAT ('0',16X,'TOTAL    ',4X,F16.2/)
   98 FORMAT ('0',8X,'ORIGIN',17X,'DESTINATION',10X,'QUANTITY',5X,
     1'UNIT COST',6X,'TOTAL COST'/'+',4X,14('_'),12X,14('_'), 8X,8('_')
     2,5X,9('_'),6X,10('_'))
   99 FORMAT ('0',10X,'SUPPLY POINT',12X,'QUANTITY'/'+',6X,18('_'),10X,
     18('_'))
  100 FORMAT ('0',10X,'DEMAND POINT',12X,'QUANTITY'/'+',6X,18('_'),10X,
     18('_'))
  112 FORMAT (' LINK',2I9,' IS OUT OF SEQUENCE',2I9)
  113 FORMAT ('1',6X,'MAXIMUM ITERATIONS SPECIFIED = ',I6,';',4X,'ITERAT
     1IONS TOWARD SOLUTION = ',I6,'.')
  114 FORMAT ('0',30X,'LISTING OF INTERMEDIATE RESULTS')
  115 FORMAT (50X,'POINT ',I8,' IS OUT OF SEQUENCE')
  116 FORMAT (' ',I8,4X,4A4,F16.2)
  117 FORMAT ('0',4X,'IN RECURSIVE FUNCTION SUPPLY INPUT DOES NOT MATCH
     1THE NUMBER'/4X,'SPECIFIED IN THE FUNCTION; IT IS ',I6)
      M = M1-1
      N = N1-1
      IPASS = 0
      NINP4 = 1
      NTEMP = 1
      OPEN (1,FILE='NTEMP',STATUS='NEW',ACCESS='SEQUENTIAL',
     1FORM='UNFORMATTED')
      IF (ID.EQ.1) GOTO 432
C
C     II.  READ CONTROL COMMAND FOR DATA INPUT
C
C       1. Read logical units for supply and demand files, rate files,
C          data set ID, method of output storage, mode and recursive
C
C          NPASS = Total number of passes in the run, including
C                  recursive solutions
C          NYEAR = Identification number of data sets, 4 digits, month
C                  and year
C           LOAD = Disk storage of output; Yes = 1, No = 0
C         IRECUR = Add current supply quantities to those remaining
C                  from the previous period:  Yes = 1, No = 0
C          ISAME = Same rates to be used as in previous period:
C                  Yes = 1, No = 0
C         ISHADW = Print shadow price and marginal cost table:
C                  Yes = 1, No = 0
C             NN = Number of modes identified in the problem
C
C         NODIFF = Skip printing difference in quantities; Yes=1, No=0
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C          NOPREL - Skip printing intermediate results; Yes = 1, No = 0
C          NORATE - Skip printing transport rates; Yes = 1, No = 0
C          NOINIT - Skip printing initial pattern; Yes = 1, No = 0
C          NOORIG - Skip printing origin sort;     Yes = 1, No = 0
C          NODEST - Skip printing destination sort; Yes = 1, No = 0
C          NOMODE - Skip printing mode sort;  Yes = 1, No = 0
C          MORATE - Skip printing rates by mode;   Yes = 1, No = 0
C          MOORIG - Skip printing mode by origin;  Yes = 1, No = 0
C          MODEST - Skip printing mode by destination; Yes = 1, No = 0
C                       FORMAT is 20 I 4
C
    3 READ (NCARD,49,END=33) NPASS,NYEAR,LOAD,IRECUR,ISAME,ISHADW,NN,
     1NODIFF,NOPREL,NORATE,NOINIT,NOORIG,NODEST,NOMODE,MORATE,MOORIG,
     2MODEST
  109 FORMAT (3(2X,I6),4X,4A4)
  118 FORMAT (2(4X,I4),F16.0,4X,4A4)
  119 FORMAT (2(4X,I4),F16.0)
  120 FORMAT (2(4X,I4),F16.2,4X,I4)
  121 FORMAT (4X,I4,4X,4A4)
  122 FORMAT (2(4X,I4),F16.2)
  123 FORMAT (2X,F16.0,F16.2)
  124 FORMAT (2X,F16.0,F16.2,4X,I4)
      IERR = 0
      ITER = 0
      NINP1 = 2
      IF (IRECUR.EQ.1) GOTO 18
      IF (MOD.EQ.0) GOTO 102
C
C      2. If MOD = 1, read transportation mode ID numbers and descriptions
C         NM    = Mode identification number
C         KODEM = Description or name of this mode
C                     FORMAT is 4X, I4, 4X, 4A4
C           Omit this step if MOD = 0  (Step 1).
C
      IF (NN.EQ.0) GOTO 33
      DO 34 I=1,NN
      READ (NCARD,121,END=33) J,(KODEM(J,K),K=1,4)
      NM(I)=J
   34 CONTINUE
  102 OPEN (2,FILE='TRLPDATA.RUN',STATUS='OLD')
   18 WRITE (NPRINT,95) NYEAR
      WRITE (NPRINT,99)
      IF (IRECUR.EQ.0) GOTO 42
C
C     This section is used for Recursive problems, where solutions
C       are made sequentially by time period, and where the supply
C       quantities for the next period include demand quantities
C       allocated to storage outlets in the solution for the previous
C       period.
C
      K = N-M
      IF (K.LE.0) GOTO 44
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      K = K+1
      LL = 0
      SUMS = 0.
      DO 542 J=K,N
      LL = LL+1
  543 READ (NINP1,119,END=548) IYEAR,NODE,S(LL)
      IF (IYEAR.NE.NYEAR) GOTO 543
      IF (NODE.EQ.NS(LL).OR.NODE.EQ.LL) GOTO 546
      WRITE (NPRINT,115) NODE
      IERR=1
      GOTO 542
  546 DO 547 I=1,M
      IF (Q(I,J).LE.1.0E-3) GOTO 547
      IF (ND(J).EQ.99999) GOTO 547
      S(LL) = S(LL)+Q(I,J)
  547 CONTINUE
      SUMS = SUMS+S(LL)
      WRITE (NPRINT,116) NS(LL),(KODES(LL,MM),MM=1,4),S(LL)
  542 CONTINUE
      GOTO 44
  548 K = K-1
      WRITE (NPRINT,117) K
      GOTO 541
C
C      3. Read supply point numbers and quantities
C         IYEAR = Identification number of data set, 4 digits, month
C                 and year
C         NS    = Supply point identification number
C         S     = Corresponding supply quantity
C         KODES = Supply location name
C                     FORMAT is 2(4X,I4), F16.0, 2X, 4A4
C            Note:  Invalid supply identifications or those out of
C                   sequence cause program termination; input lines
C                   whose ID does not equal specified NYEAR are ignored.
C
   42 SUMS = 0.
      DO 32 I=1,M
      READ (NINP1,118,END=33) IYEAR,NS(I),S(I),(KODES(I,J),J=1,4)
      IF (IYEAR.NE.NYEAR) IERR=1
      SUMS=SUMS+S(I)
   32 CONTINUE
   20 DO 21 I=1,M
   21 WRITE (NPRINT,116) NS(I) (KODES(I,J),J=1,4),S(I)
   44 WRITE (NPRINT,97) SUMS
      WRITE (NPRINT,96) NYEAR
      WRITE (NPRINT,100)
C
C      4. Read demand point numbers and quantities
C         IYEAR = Identification number of data set, 4 digits, month
C                 and year
C         ND    = Demand point identification number
C         D     = Corresponding demand quantity
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C         KODED = Demand location name
C                     FORMAT is 2(4X,I4), F16.0, 2X, 4A4
C            Note: Invalid supply identifications or those out of
C                  sequence cause program termination; input lines
C                  whose ID does not equal specified NYEAR are ignored.
C
      SUMR = 0.
      DO 45 J=1,N
      IF (IRECUR.EQ.1.AND.ISAME.EQ.1) GOTO 50
      READ (NINP1,118,END=33) IYEAR,ND(J),D(J),(KODED(J,K),K=1,4)
      GOTO 8
   50 READ (NINP1,119,END=33) IYEAR,ND(J),D(J)
    8 IF (IYEAR.NE.NYEAR) IERR=1
      SUMR = SUMR+D(J)
   45 CONTINUE
      DO 23 J=1,N
   23 WRITE (NPRINT,116) ND(J),(KODED(J,K),K=1,4),D(J)
      WRITE (NPRINT,97) SUMR
      IF (ISAME.EQ.1) GOTO 47
      IF (MOD.EQ.1) GOTO 22
      IF (NORATE.NE.1) WRITE (NPRINT,86)
      IF (NORATE.NE.1) WRITE (NPRINT,93)
C
C      5. Read transfer costs from M supply points to N demand points
C         NODE1 = Supply point identification number
C         NODE2 = Demand point identification number
C         T     = Transfer cost from M to N
C         MODE  = Mode identification number used for transfer (If
C                 specified in control command).  The number cannot be
C                 greater than 48.  Omit if MOD = 0 (Step 1).
C                    FORMAT is 2(4X,I4), F16.2, 4X, I4
C               Note: Identification numbers out of sequence or invalid
C                     ID causes program termination.  Omit this step if
C                     ISAME= 1 (Step 1).
C
      DO 36 I=1,M
      DO 36 J=1,N
      READ (NINP1,122,END=33) NODE1,NODE2,T(I,J)
      IF (NORATE.NE.1) WRITE (NPRINT,39) NODE1,(KODES(I,K),K=1,4),NODE2,
     1(KODED(J,K),K=1,4),T(I,J)
      IF (NODE1.EQ.NS(I).AND.NODE2.EQ.ND(J)) GOTO 36
      WRITE (NPRINT,112) NODE1,NODE2
      IERR=1
   36 CONTINUE
      GOTO 47
   22 IF (MORATE.NE.1) WRITE(NPRINT,87)
      IF (MORATE.NE.1) WRITE(NPRINT,94)
      DO 46 I=1,M
      DO 46 J=1,N
      READ (NINP1,120,END=33) NODE1,NODE2,T(I,J),K
      MODE(I,J) = K
      IF (MORATE.NE.1) WRITE (NPRINT,43) NODE1,(KODES(I,L),L=1,4),NODE2,
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     1(KODED(J,L),L=1,4),K,(KODEM(K,L),L=1,4),T(I,J)
      IF (NODE1.EQ.NS(I).AND.NODE2.EQ.ND(J)) GOTO 46
      WRITE (NPRINT,112) NODE1,NODE2,NS(I),ND(J)
      IERR=1
   46 CONTINUE
   47 IF (IERR.NE.0) GOTO 33
C
C   III. CHECK THE BALANCE OF SUPPLY AND DEMAND QUANTITIES.  IF THEY
C        ARE NOT EQUAL, THEN ASSIGN THE DIFFERENCE INTO DUMMY SUPPLY
C        OR DEMAND CELL.
C
      IF (SUMS-SUMR) 101,199,103
  103 N = N+1
      KODED(N,1) = 'NOT '
      KODED(N,2) = 'SHIP'
      KODED(N,3) = 'PED '
      KODED(N,4) = '    '
      ND(N) = 99999
      D(N) = SUMS-SUMR
      IF(MOD.NE.1) GOTO 106
      K = 49
      NN = NN+1
      NM(NN) = K
      KODEM(K,1) = 'NOT '
      KODEM(K,2) = 'AVAI'
      KODEM(K,3) = 'LABL'
      KODEM(K,4) = 'E   '
  106 DO 104 I=1,M
      IF (MOD.EQ.1) MODE(I,N)=49
  104 T(I,N) = 0.
      IF (NODIFF.NE.1) WRITE (NPRINT,10) ND(N),(KODED(N,L),L=1,4),D(N),
     1NM(NN),(KODEM(K,L),L=1,4)
      GOTO 199
  101 M=M+1
      NS(M) = 99999
      KODES(M,1) = 'NOT '
      KODES(M,2) = 'RECE'
      KODES(M,3) = 'IVED'
      KODES(M,4) = '    '
      S(M) = SUMR - SUMS
      IF (MOD.NE.1) GOTO 107
      K = 49
      NN = NN+1
      NM(NN) = K
      KODEM(K,1) = 'NOT '
      KODEM(K,2) = 'AVAI'
      KODEM(K,3) = 'LABL'
      KODEM(K,4) = 'E   '
  107 DO 105 J=1,N
      IF (MOD.EQ.1) MODE(M,J)=49
  105 T(M,J) = 0.
      IF (NODIFF.NE.1) WRITE (NPRINT,10) NS(M),(KODES(M,L),L=1,4),S(M),
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      1NM(NN),(KODEM(K,L),L=1,4)
  199 IF (IPASS.GT.0.OR.MOD.NE.1) GOTO 201
      REWIND NTEMP
      DO 200 I=1,M
      WRITE (NTEMP)(MODE(I,J),J=1,N)
  200 CONTINUE
  201 MDEX = M
      NDEX = N
      DO 428 I=1,M
      IFAS(I) = 0
      IF (S(I).NE.0.) GOTO 428
      IFAS(I) = 1
      MDEX = MDEX-1
  428 CONTINUE
      DO 430 J=1,N
      JFAS(J) = 0
      IF (D(J).NE.0.) GOTO 430
      JFAS(J) = 1
      NDEX = NDEX-1
  430 CONTINUE
      DO 48 I=1,M
      DO 48 J=1,N
      MODE(I,J) = 0
   48 Q(I,J) = 0.0
C
C      IV. THIS SECTION SERVES TO FIND AN INITIAL BASIC FEASIBLE SOLUTION.
C        The method is adapted from Russell, Edward J., "Extension of
C        Dantzig's Algorithm for Finding an Initial Near-Optimum Basis
C        for the Transportation Problem"
C
      ALPHA = 1.E-3
      OMEGA = 9.E+30
      DO 52 I=1,M
   52 U(I) = 0.
      DO 53 J=1,N
   53 V(J) = 0.
      ICOL = 0
      IROW = 0
      DO 54 I=1,M
      DO 55 J=1,N
      IF (T(I,J).LE.U(I)) GOTO 55
      U(I) = T(I,J)
   55 CONTINUE
   54 CONTINUE
      DO 56 J=1,N
      DO 57 I=1,M
      IF (T(I,J).LE.V(J)) GOTO 57
      V(J) = T(I,J)
   57 CONTINUE
   56 CONTINUE
      DO 58 I=1,M
      DO 59 J=1,N
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      MODE(I,J) = U(I)+V(J)-T(I,J)
   59 CONTINUE
   58 CONTINUE
   60 RMIN = 0.
      DO 61 I=1,M
      IF (U(I).LT.0.) GOTO 61
      DO 62 J=1,N
      IF (V(J).LT.0.) GOTO 62
      IF (MODE(I,J).LE.RMIN) GOTO 62
      RMIN = MODE(I,J)
      KI = I
      KJ = J
   62 CONTINUE
   61 CONTINUE
      IF (S(KI)-D(KJ)) 82,63,64
   82 Q(KI,KJ) = S(KI)
      D(KJ) = D(KJ)-S(KI)
      S(KI) = 0.
      U(KI) = -1.
      IROW = IROW+1
      GOTO 65
   64 Q(KI,KJ) = D(KJ)
      S(KI) = S(KI)-D(KJ)
      D(KJ) = 0.
      V(KJ) = -1.
      ICOL = ICOL+1
      GOTO 65
   63 Q(KI,KJ) = D(KJ)
      D(KJ) = 0.
      V(KJ) = -1.
      ICOL = ICOL+1
      S(KI) = ALPHA
      DO 66 J=1,N
      IF (V(J).LT.0.) GOTO 66
      D(J) = D(J)-ALPHA
      GOTO 65
   66 CONTINUE
   65 CONTINUE
      IF (IROW.EQ.(M-1)) GOTO 67
      IF (ICOL.EQ.(N-1)) GOTO 68
      GOTO 60
   67 DO 69 I=1,M
      IF (U(I).LT.0.) GOTO 69
      KI = I
      S(I) = 0.
      GOTO 70
   69 CONTINUE
   70 DO 71 J=1,N
      IF (V(J).LT.0.) GOTO 71
      Q(KI,J) = D(J)
      D(J) = 0.
   71 CONTINUE
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      GOTO 108
   68 DO 72 J=1,N
      IF (V(J).LT.0.) GOTO 72
      KJ = J
      D(J) = 0.
      GOTO 73
   72 CONTINUE
   73 DO 74 I=1,M
      IF (U(I).LT.0.) GOTO 74
      Q(I,KJ) = S(I)
      S(I) = 0.
   74 CONTINUE
  108 IF (NOINIT.EQ.1) GOTO 532
      SUM = 0.
      TOTAL = 0.
      WRITE (NPRINT,90) NYEAR
      WRITE (NPRINT,98)
      DO 125 I = 1,M
      DO 125 J = 1,N
      LL = 5
      IF (Q(I,J).LE.ALPHA) GOTO 125
      QANT = Q(I,J)
      RATE = T(I,J)
      COST = QANT*RATE
      TOTAL = TOTAL+QANT
      SUM=SUM+COST
      WRITE (NPRINT,5) NS(I),(KODES(I,L),L=1,4),ND(J),(KODED(J,L),L=1,4)
     1,Q(I,J),T(I,J),COST
      LL = LL+1
      IF (LL.LT.60) GOTO 125
      WRITE (NPRINT,98)
      LL = 5
  125 CONTINUE
      WRITE (NPRINT,51) TOTAL,SUM
      GOTO 532
C
C      V. READ INTERMEDIATE RESULTS IF ID = 1
C
  432 OPEN (1,FILE='NINP4',STATUS='OLD')
      READ (NINP4,49) M,N,MDEX,NDEX,ITER,NN
      DO 11 I=1,M
   11 READ (NINP4,109) IYEAR,NS(I),IFAS(I),(KODES(I,J),J=1,4)
      DO 19 J=1,N
   19 READ (NINP4,109) IYEAR,ND(J),JFAS(J),(KODED(J,K),K=1,4)
      IF (MOD.NE.1) GOTO 15
      DO 13 K=1,NN
      READ (NINP4,121) J,(KODEM(J,L),L=1,4)
      NM(K) = J
   13 CONTINUE
   15 DO 16 I=1,M
      DO 16 J=1,N
      IF (MOD.EQ.1) GOTO 17
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      READ (NINP4,123) Q(I,J),T(I,J)
      GOTO 16
   17 READ (NINP4,124) Q(I,J),T(I,J),MODE(I,J)
   16 CONTINUE
      REWIND NINP4
  532 DO 533 I=1,M
      IP(I) = 0
  533 U(I) = 0.
C
C       VI.  STORE INTERMEDIATE RESULTS ON DISK, IF ACTUAL EXECUTION
C            ITERATIONS OVER SPECIFIED MAXIMUM ITERATIONS (NOITER)
C
      IF (NOITER.EQ.0) GOTO 531
      JITER = NOITER-ITER
      IF (JITER.GT.0) GOTO 531
      WRITE (NPRINT,113) NOITER,ITER
      IF (NOPREL.NE.1) WRITE (NPRINT,114)
      IF (NOPREL.NE.1) WRITE (NPRINT,98)
      SUM = 0.
      TOTAL = 0.
      IF (MOD.NE.1) GOTO 500
      REWIND NTEMP
      DO 501 I=1,M
  501 READ (NTEMP,END=500)(MODE(I,J),J=1,N)
  500 OPEN (1,FILE='NINP4',STATUS='NEW')
      WRITE (NINP4,49) M,N,MDEX,NDEX,ITER,NN
      DO 1 I=1,M
    1 WRITE (NINP4,109) IYEAR,NS(I),IFAS(I),(KODES(I,J),J=1,4)
      DO 24 J=1,N
   24 WRITE (NINP4,109) IYEAR,ND(J),JFAS(J),(KODED(J,K),K=1,4)
      IF (MOD.NE.1) GOTO 26
      DO 25 K=1,NN
      J=NM(K)
   25 WRITE (NINP4,121) NM(K),(KODEM(J,L),L=1,4)
   26 TOTAL = 0.
      SUM = 0.
      DO 6 I=1,M
      DO 6 J=1,N
      IF (MOD.EQ.1) GOTO 9
      WRITE (NINP4,123) Q(I,J),T(I,J)
      GOTO 27
    9 WRITE (NINP4,124) Q(I,J),T(I,J),MODE(I,J)
   27 IF (Q(I,J).GE.OMEGA) GOTO 6
      QANT = Q(I,J)
      RATE = T(I,J)
      COST = QANT*RATE
      TOTAL = TOTAL+QANT
      SUM = SUM+COST
      IF (NOPREL.NE.1) WRITE (NPRINT,5) NS(I),(KODES(I,K),K=1,4),ND(J),(
     1KODED(J,K),K=1,4),Q(I,J),T(I,J),COST
    6 CONTINUE
      IF (NOPREL.NE.1) WRITE (NPRINT,51) TOTAL,SUM
```

```
      STOP
C
C      VII.  NOW THAT A BASIC FEASIBLE SOLUTION HAS BEEN DETERMINED, IT
C            IS NECESSARY TO CALCULATE SHADOW PRICES -- THAT IS THE
C            DIFFERENCES OF ROWS AND COLUMNS
C
  531 ITER = ITER+1
      DO 534 J=1,N
      JC(J) = 0
  534 V(J) = 0.0
      IDX = 1
      JDX = 0
      DO 654 I=1,M
      IF (IFAS(I).NE.0) GOTO 654
      IP(I) = 1
      GOTO 655
  654 CONTINUE
  655 DO 744 I=1,M
      IF (IFAS(I).EQ.0.AND.IP(I).GT.0) GOTO 536
      GOTO 744
  536 DO 644 J=1,N
      IF (JFAS(J).EQ.0.AND.JC(J).EQ.0.AND.Q(I,J).GT.0.) GOTO 539
      GOTO 644
  539 V(J) = T(I,J)-U(I)
      JC(J) = 1
      JDX = JDX+1
      DO 544 K=1,M
      IF (IFAS(K).EQ.0.AND.IP(K).EQ.0.AND.Q(K,J).GT.0.) GOTO 555
      GOTO 544
  555 U(K) = T(K,J)-V(J)
      IP(K) = 1
      IDX = IDX+1
  544 CONTINUE
  644 CONTINUE
  744 CONTINUE
      IF (IDX+JDX.LT.MDEX+NDEX) GOTO 655
C
C      VIII.  CALCULATE (Z-T(I,J)) AND FIND LARGEST POSITIVE NUMBER.
C             IT WILL BE CHOSEN AS AN ENTERING BASIC VARIABLE AND THAT
C             CELL ASSIGNED AS ONE UNIT
C             Z = COLUMN DIFFERENCE + ROW DIFFERENCE - TRANSFER COST
C             T = TRANSFER COST FROM M TO N
C
      IR = 0
      JCC = 0
      Z = 0.0
      DO 649 I=1,M
      IF (IFAS(I).NE.0) GOTO 649
      DO 549 J=1,N
      IF (JFAS(J).NE.0) GOTO 549
      SUMX=U(I)+V(J)-T(I,J)*1.0001
      IF(Z.LT.SUMX.AND.Q(I,J).LE.0.) GOTO 554
```

```
      GOTO 549
  554 IR = I
      JCC = J
      Z = SUMX
  549 CONTINUE
  649 CONTINUE
      IF (IR+JCC.LE.0) GOTO 595
      DO 551 I=1,M
  551 IP(I) = 0
      DO 552 J=1,N
  552 JC(J) = 0
      Q(IR,JCC) = 1.0
C
C       IX.  THIS SECTION SERVES TO FIND THE LEAVING BASIC VARIABLE.
C            IT IS CHOSEN ACCORDING TO THE SAME CRITERION AS FOR THE
C            GENERAL LP PROBLEM, NAMELY THE ONE THAT REACHES ZERO FIRST
C            AS THE ENTERING BASIC VARIABLE IS INCREASED.
C
  622 IDX = 0
      DO 560 I=1,M
      IF (IFAS(I).EQ.0.AND.IP(I).EQ.0) GOTO 455
      GOTO 560
  455 JDX = 0
      DO 558 J=1,N
      IF (JFAS(J).EQ.0.AND.JC(J).EQ.0) GOTO 557
      GOTO 558
  557 IF (Q(I,J).GT.0.) JDX = JDX + 1
  558 CONTINUE
      IF (JDX.NE.1) GOTO 560
      IP(I) = 1
      IDX = 1
  560 CONTINUE
      DO 570 J=1,N
      JDX = 0
      IF (JFAS(J).EQ.0.AND.JC(J).EQ.0) GOTO 562
      GOTO 570
  562 DO 566 I=1,M
      IF (IFAS(I).EQ.0.AND.IP(I).EQ.0) GOTO 565
      GOTO 566
  565 IF (Q(I,J).NE.0.) JDX = JDX+1
  566 CONTINUE
      IF (JDX.NE.1) GOTO 570
      JC(J) = 1
      IDX = 1
  570 CONTINUE
      IF (IDX.GT.0) GOTO 622
      KDEX = 0
      Z = 1.0E+30
  972 IIX = 0
      IDX = 0
      JDX = JCC
  572 J = JDX
```

```
      DO 581 I = 1,M
      IF (IFAS(I).EQ.0.AND.IP(I).EQ.0) GOTO 556
      GOTO 581
  556 IF (Q(I,J).EQ.0.) GOTO 581
      IF (IR.EQ.I.AND.JCC.EQ.J) GOTO 581
      IF (IIX.EQ.I) GOTO 581
      IF (Q(I,J).EQ.OMEGA) GOTO 578
      GOTO 679
  578 Z = 0.0
      IRX = I
      JCX = J
      GOTO 590
  679 IF (KDEX.LE.0) GOTO 682
      Q(I,J) = Q(I,J)-Z
      IF (Q(I,J).EQ.0.) Q(I,J) = OMEGA
      GOTO 580
  682 IF (Q(I,J).GE.Z) GOTO 580
      Z = Q(I,J)
      IRX = I
      JCX = J
  580 IDX = I
      JJX = J
      GOTO 781
  581 CONTINUE
  781 IF (IDX.EQ.IR) GOTO 590
      DO 589 J=1,N
      IF (JFAS(J).EQ.0.AND.JC(J).EQ.0) GOTO 582
      GOTO 589
  582 IF (JCC.EQ.J.OR.JJX.EQ.J.OR.Q(I,J).EQ.0.) GOTO 589
      IF (KDEX.EQ.0) GOTO 588
      IF (Q(I,J).EQ.OMEGA) GOTO 688
      Q(I,J) = Q(I,J)+Z
      GOTO 588
  688 Q(I,J) = Z
  588 JDX = J
      IIX = I
      GOTO 572
  589 CONTINUE
      GOTO 572
  590 IDX = 0
      JDX = JCC
      IF (Z.GT.0.) GOTO 592
      Q(IR,JCC) = OMEGA
      Q(IRX,JCX) = 0.0
      GOTO 532
  592 IF (KDEX.GT.0) GOTO 594
      KDEX = 1
      GOTO 972
  594 Q(IR,JCC) = Z
      Q(IRX,JCX) = 0.0
      GOTO 532
  595 DO 597 I=1,M
```

```
      DO 597 J=1,N
      IF (Q(I,J).EQ.OMEGA) Q(I,J) = 0.0
  597 CONTINUE
C
C       X.  PRINT THE LP OUTPUT
C
      TOTAL = 0.0
      SUM = 0.0
      NINP3 = 1
      REWIND NTEMP
      IF (MOD.NE.1.OR.ID.EQ.1) GOTO 76
      DO 75 I=1,M
      READ (NTEMP)(MODE(I,J),J=1,N)
   75 CONTINUE
   76 IF (LOAD.EQ.1) OPEN (1,FILE='OUTPUT.TLP',STATUS='NEW')
      IF (MOD.EQ.1.AND.MOORIG.NE.1) WRITE (NPRINT,89) NYEAR
      IF (MOD.EQ.0.AND.NOORIG.NE.1) WRITE (NPRINT,89) NYEAR
      IF (MOD.EQ.1.AND.MOORIG.NE.1) WRITE (NPRINT,2)
      IF (MOD.EQ.0.AND.NOORIG.NE.1) WRITE (NPRINT,98)
      LL = 5
      DO 77 I=1,M
      DO 77 J=1,N
      IF (Q(I,J).LE.ALPHA) GOTO 77
      QANT = Q(I,J)
      RATE = T(I,J)
      COST = QANT*RATE
      TOTAL = TOTAL+QANT
      SUM = SUM+COST
      IF (MOD.EQ.1) K = MODE(I,J)
      IF (MOD.EQ.1.AND.MOORIG.NE.1) WRITE (NPRINT,37) NS(I),(KODES(I,L),
     1L=1,4),ND(J),(KODED(J,L),L=1,4),K,(KODEM(K,L),L=1,4),Q(I,J),T(I,J)
     2,COST
      IF(MOD.EQ.1.AND.LOAD.EQ.1) WRITE(NINP3,37) NS(I),(KODES(I,KK),KK=
     11,4),ND(J),(KODED(J,KK),KK=1,4),K,(KODEM(K,KK),KK=1,4),Q(I,J),T(I,
     2J)
      IF (MOD.EQ.0.AND.NOORIG.NE.1) WRITE (NPRINT,5) NS(I),(KODES(I,L),
     1L=1,4),ND(J),(KODED(J,L),L=1,4),Q(I,J),T(I,J),COST
      IF(MOD.EQ.0.AND.LOAD.EQ.1) WRITE(NINP3,5) NS(I),(KODES(I,KK),KK =
     11,4),ND(J),(KODED(J,KK),KK=1,4),Q(I,J),T(I,J),COST
      LL = LL+1
      IF (LL.LT.60) GOTO 77
      IF (MOD.EQ.1.AND.MOORIG.NE.1) WRITE (NPRINT,89) NYEAR
      IF (MOD.EQ.0.AND.NOORIG.NE.1) WRITE (NPRINT,98)
      IF (MOD.EQ.1.AND.MOORIG.NE.1) WRITE (NPRINT,2)
      LL = 5
   77 CONTINUE
      IF (MOD.EQ.1.AND.MOORIG.NE.1) WRITE (NPRINT,38) TOTAL,SUM
      IF (MOD.EQ.0.AND.NOORIG.NE.1) WRITE (NPRINT,38) TOTAL,SUM
      LL = 5
      IF (MOD.EQ.1.AND.MODEST.EQ.1) GOTO 126
      IF (MOD.EQ.0.AND.NODEST.EQ.1) GOTO 126
      WRITE (NPRINT,88) NYEAR
```

```
      IF (MOD.EQ.1) WRITE (NPRINT,2)
      IF (MOD.EQ.0) WRITE (NPRINT,98)
      DO 78 J=1,N
      DO 78 I=1,M
      IF (Q(I,J).LE.ALPHA) GOTO 78
      QANT = Q(I,J)
      RATE = T(I,J)
      COST = QANT*RATE
      IF (MOD.EQ.1) K = MODE(I,J)
      IF (MOD.EQ.1) WRITE (NPRINT,37) NS(I),(KODES(I,KK),KK=1,4),ND(J),
     1(KODED(J,KK),KK=1,4),K,(KODEM(K,KK),KK=1,4),Q(I,J),T(I,J),COST
      IF (MOD.EQ.0) WRITE (NPRINT,5) NS(I),(KODES(I,KK),KK=1,4),ND(J),
     1(KODED(J,KK),KK=1,4),Q(I,J),T(I,J),COST
      LL = LL+1
      IF (LL.LT.60) GOTO 78
      IF (MOD.EQ.1) WRITE (NPRINT,88) NYEAR
      IF (MOD.EQ.0) WRITE (NPRINT,98)
      IF (MOD.EQ.1) WRITE (NPRINT,2)
      LL = 5
   78 CONTINUE
      IF (MOD.EQ.1) WRITE (NPRINT,38) TOTAL,SUM
      IF (MOD.EQ.0) WRITE (NPRINT,51) TOTAL,SUM
  126 IF (MOD.EQ.0.OR.NOMODE.EQ.1) GOTO 14
      LL = 5
      WRITE (NPRINT,40) NYEAR
      WRITE (NPRINT,2)
      DO 80 K = 1,NN
      SUMS = 0.
      SUMR = 0.
      DO 79 I = 1,M
      DO 79 J = 1,N
      MM = NM(K)
      IF (MM.NE.MODE(I,J)) GOTO 79
      IF (Q(I,J).LE.ALPHA) GOTO 79
      QANT = Q(I,J)
      RATE = T(I,J)
      COST = QANT*RATE
      SUMS = SUMS+COST
      SUMR = SUMR+QANT
      WRITE (NPRINT,37) NS(I),(KODES(I,L),L=1,4),ND(J),(KODED(J,L),L=1,
     14),MM,(KODEM(MM,L),L=1,4),Q(I,J),T(I,J),COST
      LL = LL+1
      IF (LL.LT.60) GOTO 79
      WRITE (NPRINT,40) NYEAR
      WRITE (NPRINT,2)
      LL = 5
   79 CONTINUE
      IF (SUMR.EQ.0.) GOTO 80
      WRITE (NPRINT,41) SUMR,SUMS
      LL = LL+2
      IF (LL.LT.60) GOTO 80
      WRITE (NPRINT,40) NYEAR
```

```
      WRITE (NPRINT,2)
      LL = 5
   80 CONTINUE
      WRITE (NPRINT,38) TOTAL,SUM
   14 WRITE (NPRINT,12) ITER
  111 IF (ISHADW.EQ.0) GOTO 28
C
C        XI. PRINT THE SHADOW PRICES AND MARGINAL COST
C
      WRITE (NPRINT,91) NYEAR
      WRITE (NPRINT,92)
      DO 29 I=1,M
      DO 29 J=1,N
      UC = T(I,J)-U(I)-V(J)
      WRITE (NPRINT,4) NS(I),(KODES(I,K),K=1,4),ND(J),(KODED(J,K),K=1,4)
     1,T(I,J),U(I),V(J),UC
   29 CONTINUE
   28 IPASS = IPASS + 1
      IF (IPASS.GE.NPASS) GOTO 300
      NYEAR = NYEAR + 100
      IRECUR = 1
      ISAME = 1
      M = M1-1
      N = N1-1
      IF (MOD.EQ.1) NN = NN-1
      IERR = 0
      ITER = 0
      GOTO 18
  300 RETURN
   33 WRITE (NPRINT,85)
   85 FORMAT ('0',5X,'POSSIBLE INTERRUPTION CASES:',/' ',7X,'(1) The num
     1ber of origins or destinations does not match M and N',/' ',7X,
     2'(2) Input data might not be in the specified read format',/
     3' ',7X,'(3) Invalid supply or demand identification or out of sequ
     4ence',/' ',7X,'(4) Mode identification number and name not listed
     5in the separate file'/)
  541 STOP
      END
```