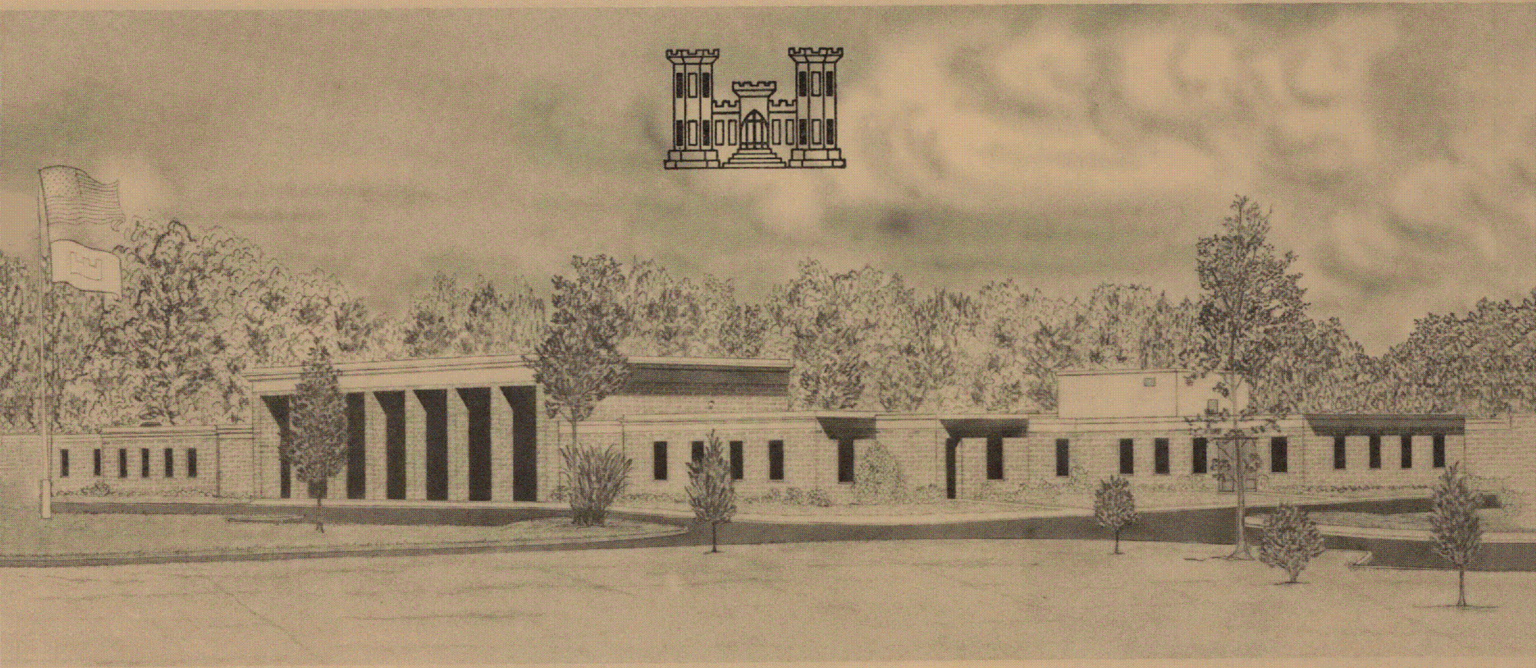
MISCELLANEOUS PAPER K-73-4

A PLANE AND AXISYMMETRIC FINITE ELEMENT PROGRAM FOR STEADY-STATE AND TRANSIENT SEEPAGE PROBLEMS

by

F. T. Tracy



May 1973

Sponsored by U. S. Army Engineer Division, Lower Mississippi Valley

Conducted by U. S. Army Engineer Waterways Experiment Station
Automatic Data Processing Center
Vicksburg, Mississippi

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FOREWORD

This report was written to document a two-dimensional finite element seepage program written by Mr. F. T. Tracy of the Computer Analysis Branch, Automatic Data Processing Center, U. S. Army Engineer Waterways Experiment Station (WES). The computer program is designed to solve a wide variety of problems that are encountered in groundwater flow.

This work was sponsored by the Lower Mississippi Valley Division of the Corps of Engineers; Mr. Robert Kaufman and Mr. Frank Weaver are thanked for providing very excellent engineering guidance and good practical test problems.

Special thanks go to Dr. N. Radhakrishnan whose ideas, suggestions, and overall knowledge of up-to-date finite element method technology were instrumental in the development of this computer program. The assistance given by others in the Computer Analysis Branch is also greatly appreciated.

This project was an offshoot from the development of a three-dimensional finite element seepage program documented in WES Miscellaneous Paper K-73-3. This program is a two-dimensional version of the three-dimensional program.

This work was done between May 1971 and June 1972, and was accomplished under the direct supervision of Mr. James B. Cheek, Jr., Chief, Computer Analysis Branch. Mr. Donald L. Neumann was Chief of the ADPC during this study. COL Ernest D. Peixotto, CE, was Director of the WES during the course of the study and the preparation and publication of this report. Mr. F. R. Brown was Technical Director.

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NOTATION

a_{ij}	Constant
$\vec{A}$	Outward area vector (L^2)
A_H	Effective area projected on a horizontal plane
$\underline{\underline{B}}$	Matrix used in computing element stiffness matrices
h	Head; sometimes height and head simultaneously (L)
$\bar{h}$	Average head
H_i^e	Head at ith node of element
$\underline{H}^G$	Set of heads at the nodes
$H_H(t)$	Height of headwater
$H_T(t)$	Height of tailwater
$\hat{i}$	Unit vector in the x direction
I	Infiltration rate (L/T); the quantity of water per unit area per unit time entering the flow region in unconfined flow problems due to percolation, evaporation, etc.
$\hat{j}$	Unit vector in the y direction
$\underline{\underline{J}}$	Jacobian matrix
k	Permeability (L/T)
$\underline{\underline{k}}$	Permeability matrix
$\underleftrightarrow{k}$	Permeability tensor
$\underline{\underline{K}}^e$	Element stiffness matrix

$\underline{\underline{K}}^G$	Global stiffness matrix
n	Porosity (unitless); volume of spaces between soil particles per unit volume of saturated soil
$\underline{N}$	Set of shape functions
$\underline{0}$	Five-component zero-filled vector
$\underline{\underline{P}}$	$\nabla' \underline{N}^T$
q	Flow; quantity of water per unit time per unit length (L^2/T) for plane flow or per unit radian (L^3/T) for axisymmetric flow
q_e	Exit flow
$\underline{q}^G$	Set of flows lumped at the nodes
q_k	Computed flow
q_s	Storage flow
R	Area of element (L^2)
$\underline{\underline{R}}^e$	$\left[\underline{X}^e \quad \underline{Y}^e\right]$
r,s	Parameters that form a right-handed coordinate system
s	Storage coefficient (unitless); the change in storage per unit horizontal area per unit change in head
S_s	Specific storage $(1/L)$; the change in storage per unit volume per unit change in head
t	Time (T)
$T_0, \ldots, T_4$	Time steps
u	Discharge velocity in the x direction (L/T)
v	Discharge velocity in the y direction (L/T)
$\vec{v}$	Discharge velocity (L/T); the quantity of water crossing a unit area perpendicular to the direction of flow per unit time
$\vec{v}_P$	Discharge velocity (L/T) at point P
x,y	Coordinate system (L)

$\underline{X}^e,\underline{Y}^e$	Coordinates for the nodes of an element
$\bar{X}^e,\bar{Y}^e$	Average coordinates for an element
$\alpha_1,\alpha_2,\alpha_3$	Constants
∇	Gradient operator in x-y-z (Cartesian) system
∇'	Gradient operator in r-s-t (Transformed) system
Δt	Time step (T)
$\Delta\eta$	Incremental adjustment of phreatic surface (L)
ρ	Mass density of fluid (M/L^3)

CONVERSION FACTORS, BRITISH TO METRIC UNITS OF MEASUREMENT

British units of measurement used in this report can be converted to metric units as follows:

Multiply	By	To Obtain
feet	0.3048	meters
feet per minute	0.3048	meters per minute
cubic feet per minute	0.02831685	cubic meters per minute

SUMMARY

A two-dimensional finite element seepage computer program for solving complicated seepage problems has been developed. Both confined and unconfined problems can be solved. Steady-state problems and transient problems that can be treated as a series of steady-state problems can be solved. The program offers some special advantages over other finite element seepage programs.

Complicated boundaries and inhomogeneous or anisotropic media are treated by dividing the porous media into small finite elements.

Five types of boundary conditions can be used in this program. They are (a) specified head, such as headwater and tailwater levels, (b) specified flow, such as the rate of pumping from a well, (c) specified discharge velocity, (d) pressure head equal to zero, such as on the surface of seepage, and (e) the phreatic surface type boundary condition.

Output consists of heads and flows for nodes and discharge velocities for elements at each time step. The position of the phreatic surface is also printed for unconfined flow problems.

This computer program can serve as a very useful aid to the practicing engineer in modeling flow through porous media.

A PLANE AND AXISYMMETRIC FINITE ELEMENT PROGRAM FOR STEADY-STATE AND TRANSIENT SEEPAGE PROBLEMS

PART I: INTRODUCTION

Purpose and Scope

1. Many two-dimensional seepage problems are too complicated to be solved by analytical or graphical means. In these situations, approximating numerical techniques used in conjunction with a high-speed digital computer provide an effective means for obtaining a solution. Of the many and varied numerical techniques available, the finite element method is the most versatile.

2. To apply this numerical technique, a two-dimensional finite element program for solving steady-state and transient seepage problems has been developed at the U. S. Army Engineer Waterways Experiment Station (WES). This report is essentially a user's guide for the two-dimensional seepage program and includes only simple example problems to demonstrate the usefulness of the program. Emphasis is placed on information for using the program; theoretical discussion is limited to a brief description. More complicated field flow problems are presently being attempted with guidance from LMVD engineers for check-out purposes and will be documented in a subsequent report.

Previous Work

3. Taylor and Brown[1] and Finn[2] developed a two-dimensional finite element seepage program for solving confined and unconfined steady-state problems. However, their procedures for finding the position of the phreatic surface did not always converge. Neuman and Witherspoon[3] corrected this problem by producing an improved version.

4. Desai[4] used the alternating direction explicit finite difference procedure[5] to solve two-dimensional unconfined transient seepage problems for initially dry Mississippi River banks. This method is not

easily extended to more complicated problems; however, France[6] developed a technique for solving transient unconfined problems by the finite element method by treating the problem as a series of steady-state problems. Isaacs and Mills[7] used France's basic procedure but modified the geometry of only those elements crossed by the phreatic surface. This avoided the recomputation of all the element stiffness* matrices at each time step.

Purpose for Development

5. The engineers at WES have been using for some time a finite element seepage program (developed by Taylor and Brown[1]). This use has disclosed several disadvantages of the program:

  a. Pressures instead of heads are presented in the output.
  b. The iterative procedure for finding the phreatic surface in unconfined problems does not always converge.
  c. The boundary conditions used for the exit point of the phreatic surface are incorrect.
  d. The phreatic surface cannot pass through material zones of different permeabilities.

6. The finite element seepage code developed by Witherspoon has several improvements over the Taylor and Brown code. Principal among the improvements are:

  a. Heads instead of pressures are computed.
  b. Additional steps were added to the iteration process to ensure convergence.

However, Witherspoon's version still did not exactly specify boundary conditions at the exit point. Also, his program did not attempt to allow the phreatic surface to cross from one zone of permeability to another or solve transient problems. Thus, further improvement was needed.

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* "Stiffness" is a term originating from mechanics. It is used here because of the almost universal usage of the term "stiffness matrix" in finite element analysis. As stiffness in structural analysis represents the force resulting from a unit displacement, so stiffness in seepage analysis represents the quantity of flow resulting from the application of a unit head. One should therefore expect the stiffness matrices to be closely related to permeability.

Versatility of Program

7. The WES finite element computer program discussed herein is designed to solve a wide range of plane and axisymmetric groundwater and seepage problems.

Complicated geometrical shapes

8. Problems involving complicated geometrical shapes can be easily handled by utilizing various shapes and dimensions of the finite elements.

Inhomogeneous and anisotropic medium

9. An anisotropic medium is handled by allowing the two principal permeabilities to be different. Inhomogeneity is modeled by allowing each element to have different values of: (a) magnitude and direction of the principal permeabilities, and (b) storage coefficient.

Confined and unconfined flow

10. Many types of confined and unconfined flow problems can be solved. This program offers two unique features for unconfined flow problems:

- a. The phreatic surface can cross from one zone of permeability to another during the solution process.
- b. The proper boundary conditions of the exit point of the phreatic surface are maintained.

Steady-state and transient problems

11. This program can solve almost all steady-state problems. Transient problems which can be treated as a set of equivalent steady-state problems can also be solved. These include situations where (a) the compressibility of the soil-water complex is negligible, and (b) Darcy's law is valid.

Advantages over Traditional Finite Element Programs

Smaller number of elements

12. Fewer elements are needed for a given problem than in conventional finite element programs. This is made possible by implementing

a quadratic form of the isoparametric element (see paragraph 30).

Reduction of running time

13. The running time for solving time-dependent and/or unconfined flow problems has been drastically shortened. In most cases the element stiffness matrices must be recomputed for each time step. This program, however, computes them once and stores them on disc. Most of this data can be used repeatedly with only the elements immediately under the phreatic surface requiring a new computation for stiffness matrix.

PART II: THEORY

Introduction

14. There are basically two approaches in obtaining a governing partial differential equation for transient flow through a porous medium. The first is to consider a vertical column having an infinitesimal length dx and a height h as shown in fig. 1. If for the present we consider the medium to be homogeneous and isotropic, this approach leads to

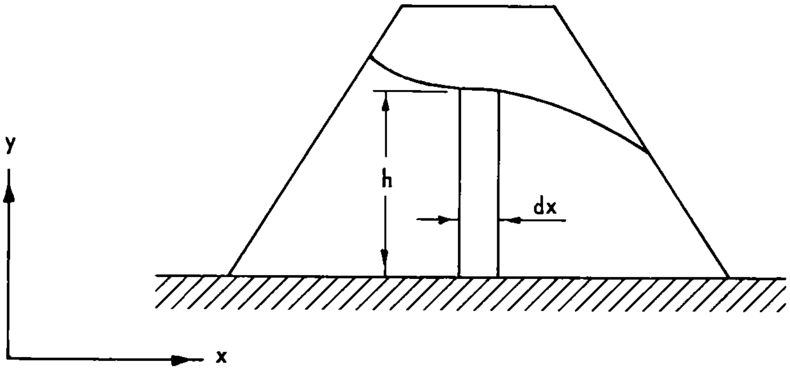

Fig. 1.

$$\nabla^2 h = \frac{\partial^2 h}{\partial x^2} + \frac{\partial^2 h}{\partial y^2} = \frac{n}{k\bar{h}} \frac{\partial h}{\partial t}$$

where k is the permeability, n is the porosity, and $\bar{h}$ is an average head. Four assumptions are made in deriving this equation:

a. The x component of discharge velocity is independent of y .

b. The y component of discharge velocity varies linearly with y .

c. The term $(\partial h/\partial x)^2$ is neglected.

d. The terms $h(\partial^2 h/\partial x^2)$ and $h(\partial^2 h/\partial y^2)$ are linearized to $\bar{h}(\partial^2 h/\partial x^2)$ and $\bar{h}(\partial^2 h/\partial y^2)$.

For some applications these assumptions are not valid. Also, $\bar{h}$ is sometimes difficult to determine.

15. The second approach is to consider an infinitesimal square of area dx dy as shown in fig. 2. This produces

$$\nabla^2 h = \frac{S_s}{k} \frac{\partial h}{\partial t}$$

where S_s is the specific storage. This expression does not contain any of the four assumptions of the first method and is therefore more general. For this reason the second approach has been adopted in this work.

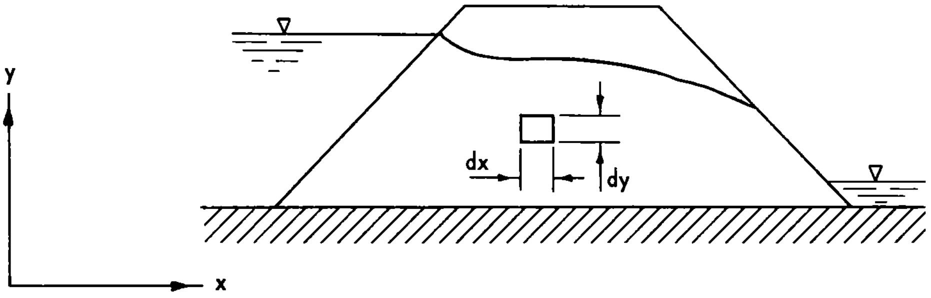

Fig. 2.

Basic Assumptions

16. Two basic assumptions are made:
   - a. The compressibility of the soil-water complex is zero ($S_s = 0$). Thus, in confined flow problems, a change of head does not result in a change in storage.
   - b. The flow is laminar. Hence, Darcy's law[8] is valid.

Governing Equations

Equation of continuity

17. The equation of continuity for unsteady flow of a compressible

fluid in a compressible medium[9] is given by

$$\frac{\partial}{\partial x}(\rho u) + \frac{\partial}{\partial y}(\rho v) + \frac{\partial}{\partial t}(\rho n) = 0 \tag{1}$$

where u and v are the discharge velocities in the x and y directions, respectively, ρ is the mass density of the fluid, n is the porosity of the medium, and t is the time. If the density of the fluid is considered a constant, equation 1 becomes

$$\frac{\partial u}{\partial x} + \frac{\partial v}{\partial y} + \frac{\partial n}{\partial t} = 0 \tag{2}$$

If the medium is considered incompressible, the porosity is independent of time and equation 2 reduces to

$$\frac{\partial u}{\partial x} + \frac{\partial v}{\partial y} = 0$$

or

$$\nabla \cdot \vec{v} = 0 \tag{3}$$

where $\vec{v} = u\hat{i} + v\hat{j}$.

Darcy's law

18. Darcy's law is stated as:

$$\vec{v} = -\underset{\leftrightarrow}{k} \cdot \nabla h \tag{4}$$

where $\underset{\leftrightarrow}{k}$ is the permeability tensor, and h is the head. Combining equations 3 and 4 gives:

$$\nabla \cdot \underset{\leftrightarrow}{k} \cdot \nabla h = 0 \tag{5}$$

Note that equation 5 does not explicitly contain time; nevertheless, time dependence is maintained through the boundary conditions.

Boundary Conditions

19. Three general types of boundary conditions are considered:

a. Specified head.

b. Specified flow.

c. Specified discharge velocity.

20. These three types of boundary conditions would permit handling other special boundary conditions such as specifying pressure equal to zero on the surface of seepage and phreatic surface type boundary condition. As an example consider the earth dam as shown in fig. 3.

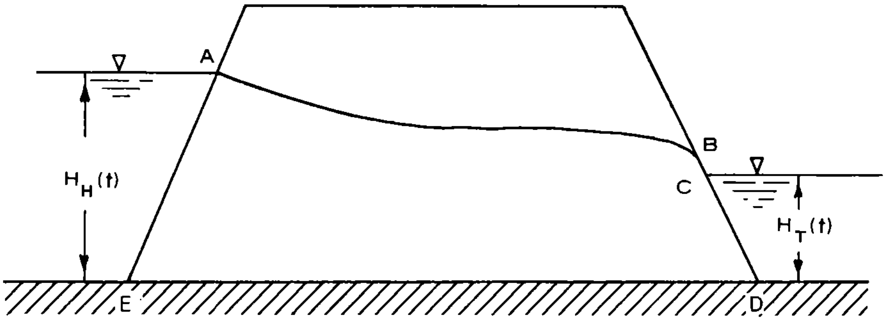

Fig. 3.

Along EA, $h = H_H(t)$.

Along AB, $h = y$ ($q = 0$ for steady-state conditions) .

Along BC, $h = y$.

Along CD, $h = H_T(t)$.

Along DE, $q = 0$.

21. Here q is the quantity of water per unit length per unit time entering the flow region ABCDE. A negative value of q indicates that water is leaving the flow region.

Solution Procedure

22. The solution procedure is a "time marching" type scheme. Time is first subdivided into small intervals called time steps as shown in fig. 4.

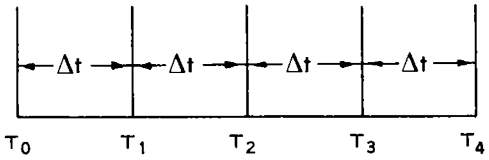

Fig. 4.

23. Δt is the size of each time step. A solution is then obtained for the times T_0, T_1, T_2, etc., starting with T_0 and "marching" in time. Time is kept current by summing time steps. For example, $T_4 = T_0 + 4\,\Delta t$.

24. At each instant of time (T_0, T_1, T_2, etc.), a boundary value problem must be solved. This requires that the boundary conditions be known at these instants of time. On all boundaries except the phreatic surface the boundary conditions must be specified for all times. For example, the height of the headwater, $H_H(t)$, and tailwater, $H_T(t)$, of the earth dam in fig. 3 must be provided at all time steps. The initial position of the phreatic surface must also be given, but its position at all future time steps is computed (see Appendix A for details). For unconfined flow problems the solution at $t = T_i$ depends upon the solution at $t = T_{i-1}$, and the problem is nonlinear with respect to time. If the time increment is chosen sufficiently small, the discrete solution will nevertheless closely approximate the continuous behavior of the problem being studied.

PART III: THE FINITE ELEMENT METHOD

Introduction

25. The finite element method is an exceptionally good numerical technique for solving many kinds of boundary value problems. The method for this application is summarized as follows:

- _a_. Approximate the geometrical shape of the flow region by subdividing it into small elements (hence the name "finite elements").
- _b_. Approximate the functional form that the head (h) will have within each element.
- _c_. Form the element stiffness matrices.
- _d_. Assemble global stiffness matrix and modify for boundary conditions.
- _e_. Solve for heads, flows, and discharge velocities.

Geometry of Elements

Element criteria

26. Key to the finite element method is the choice of the basic element form. The form used should be useful in modeling complex geometrical shapes, but it must not require excessively complicated numerical techniques and logic in the computational procedure.

The basic element

27. The quadrilateral, fig. 5, was chosen because it represents a good compromise of the above-mentioned criteria.

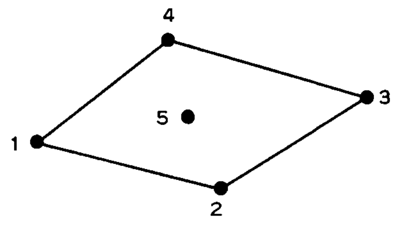

Fig. 5.

Element nodes

28. The corners of the element shown in fig. 5 are numbered from 1 through 4. It is common practice to apply the name of "nodes" to these corner points. Other points may also be specified as nodes, such

as the element's centroid (number 5, fig. 5).

Variations of the basic element

29. Triangles may be obtained by allowing two nodes to coincide. This is illustrated in fig. 6. This flexibility greatly enhances the ability of the element to model complex figures.

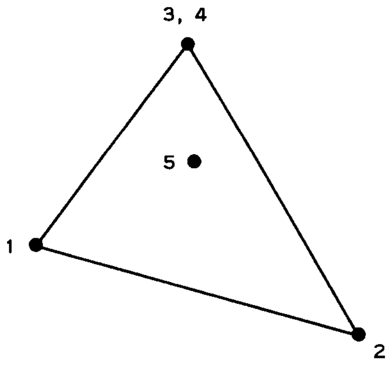

Fig. 6.

Approximation for Head Using the Isoparametric Element

Isoparametric element

30. The finite element method requires that a functional form be selected to approximate the head as a function of position within each element. The most common choice is

$$h(x,y) = \alpha_1 + \alpha_2 x + \alpha_3 y$$

where the α's are constants. Although this form is easy to implement and requires a small amount of computing, it is not very accurate. Hence, a large number of elements are usually required for a problem. The innovation of the isoparametric element[10,11,12] has made it possible to (a) implement more accurate expressions easily, (b) use less elements, (c) obtain a more accurate solution, and (d) spend less computation time. Elements with curved sides can also be easily produced.

Functional form

31. As the name implies, the functional form of the isoparametric element is a parametric expression. That is,

$$h = f(r,s)$$

r and s are two parameters that form a right-handed coordinate system such that a square of length 2 units in the r-s system is transformed into the shape of the element in the xy system. This is illustrated in fig. 7.

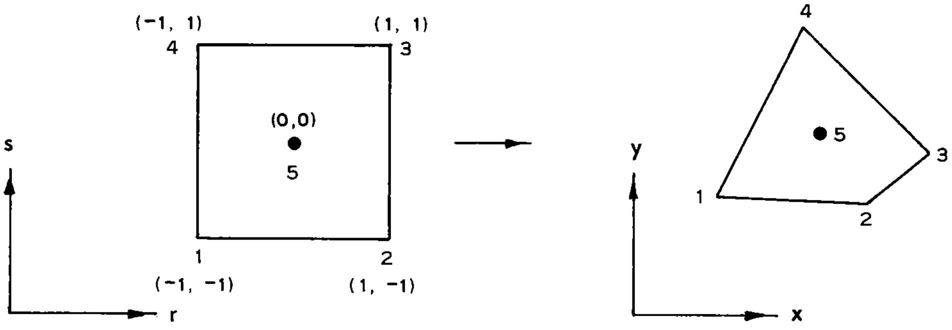

Fig. 7.

32. The expression for head is

$$h(r,s) = \underline{N}^T \, \underline{H}^e \tag{6}$$

where $\underline{N}$ is a set of shape functions of the form

$$N_i = \frac{1}{4}(1 + rr_i)(1 + ss_i) \; ; \quad i = 1, 2, 3, 4$$

$$N_5 = (1 - r^2)(1 - s^2)$$

where (r_i,s_i) is the value of (r,s) at node i. These values are either -1 , 0 , or 1 as shown in fig. 7.

$$\underline{H}^e = \begin{bmatrix} H_1^e \\ H_2^e \\ H_3^e \\ H_4^e \\ H_5^{e'} \end{bmatrix}$$

$$H_5^{e'} = H_5^e - \frac{1}{4} \sum_{j=1}^{4} H_j^e$$

where H_i^e is the head at the ith node of the element.

33. The shape functions are designed so that

$$h(r_i, s_i) = H_i^e$$

Also, the respective functions for h in two different elements give the same value for h at any point on a line common to both elements.

34. The transformation matrix between the r-s system and the x-y system is given by

$$\begin{bmatrix} x \\ y \end{bmatrix} = \begin{bmatrix} \underline{N}^T & \underline{O}^T \\ \underline{O}^T & \underline{N}^T \end{bmatrix} \begin{bmatrix} \underline{X}^e \\ \underline{Y}^e \end{bmatrix} \tag{7}$$

where $\underline{X}^e$ and $\underline{Y}^e$ are defined exactly like $\underline{H}^e$ and represent the coordinates of the nodes. $\underline{O}^T$ is a five-component zero-filled vector.

Element Stiffness Matrix

35. For unit thickness in plane flow and unit radian for axisymmetric flow, the stiffness matrix for each element is given by

$$\underline{\underline{K}}^e = \iint_R \underline{\underline{B}}^T \underline{\underline{k}} \, \underline{\underline{B}} \, a \; dx \, dy \tag{8}$$

where R is the area of the element, and $\underline{\underline{k}}$ is the permeability matrix. Also,

$$x = \begin{Bmatrix} \text{horizontal coordinate} \\ \text{radial distance from axis} \end{Bmatrix} \quad \text{for} \quad \begin{Bmatrix} \text{plane} \\ \text{axisymmetric} \end{Bmatrix} \quad \text{flow}$$

$$a = \begin{Bmatrix} 1 \\ x \end{Bmatrix} \quad \text{for} \quad \begin{Bmatrix} \text{plane} \\ \text{axisymmetric} \end{Bmatrix} \quad \text{flow}$$

$$\underline{\underline{B}} = \nabla \underline{N}^T$$

where ∇ is the gradient operator. If the integration is performed in terms of r and s, equation 8 becomes

$$\underline{\underline{K}}^e = \int_{-1}^{1} \int_{-1}^{1} \underline{\underline{B}}^T \, \underline{\underline{k}} \, \underline{\underline{B}} \, |\underline{\underline{J}}| \; a \; dr \; ds \tag{9}$$

where

$$\underline{\underline{J}} = \nabla' \underline{r}^T$$

$$\nabla' = \begin{bmatrix} \dfrac{\partial}{\partial r} \\ \dfrac{\partial}{\partial s} \end{bmatrix} \qquad \underline{r} = \begin{bmatrix} x \\ y \end{bmatrix}$$

and

$$a = \begin{Bmatrix} 1 \\ \underline{N}^T \underline{X}^e \end{Bmatrix} \quad \text{for} \quad \begin{Bmatrix} \text{plane} \\ \text{axisymmetric} \end{Bmatrix} \quad \text{flow}$$

From equation 7

$$\underline{\underline{J}} = \nabla' \underline{N}^T \begin{bmatrix} \underline{X}^e & \underline{Y}^e \end{bmatrix}$$

Let

$$\underline{\underline{P}} = \nabla' \underline{N}^T ; \; \underline{\underline{R}}^e = \begin{bmatrix} \underline{X}^e & \underline{Y}^e \end{bmatrix}$$

Then

$$\underline{\underline{J}} = \underline{\underline{P}} \, \underline{\underline{R}}^e \tag{10}$$

Note that $\underline{\underline{P}}$ is easily obtained since both ∇' and $\underline{\underline{N}}$ are functions only of r and s.

36. $\underline{\underline{B}}$ in its present form cannot be easily computed. This is overcome by finding an expression for ∇ in terms of ∇' and $\underline{\underline{J}}$. First,

$$\nabla' = \underline{\underline{J}}\ \nabla$$

or

$$\nabla = \underline{\underline{J}}^{-1}\ \nabla'$$

So,

$$\underline{\underline{B}} = \nabla\underline{N}^{T} = \underline{\underline{J}}^{-1}\ \nabla'\underline{N}^{T} = \underline{\underline{J}}^{-1}\ \underline{\underline{P}} \qquad (11)$$

Substituting equations 10 and 11 into equation 9 yields

$$\underline{\underline{K}}^{e} = \int_{-1}^{1}\int_{-1}^{1} \underline{\underline{P}}^{T}(\underline{\underline{PR}}^{e})^{-1T}\ \underline{\underline{k}}(\underline{\underline{PR}}^{e})^{-1}\ \underline{\underline{P}}\ \left|\underline{\underline{PR}}^{e}\right| \begin{Bmatrix} 1 \\ \underline{N}^{T}\ \underline{X}^{e} \end{Bmatrix} dr\ ds \qquad (12)$$

37. This expression cannot be integrated analytically. It is evaluated numerically by the 2 × 2 Gaussian scheme which integrates, exactly, a bicubic of the form

$$\sum_{i=1}^{3}\sum_{j=1}^{3} a_{ij}r^{i}s^{j}$$

where a_{ij} is a constant.

Set of Simultaneous Linear Equations

38. From these element stiffness matrices the global stiffness matrix can be formed. After modifying for boundary conditions, a system of simultaneous linear equations of the form

$$\underline{\underline{K}}^{G}\ \underline{H}^{G} = \underline{q}^{G} \qquad (13)$$

results. Here $\underline{\underline{K}}^{G}$ is the global stiffness matrix, $\underline{H}^{G}$ is the set of heads at the nodes, and $\underline{q}^{G}$ is the set of flows lumped at the nodes.

Solution for Heads, Flows, and Discharge Velocities

39. Equation 13 can now be solved for $\underline{H}^{G}$ by Gauss elimination. From $\underline{H}^{G}$ and the unmodified form of $\underline{\underline{K}}^{G}$ the unknown part of $\underline{q}^{G}$ is obtained. Discharge velocities at the centroids of the elements are

computed from the following equations:

$$\underline{v} = - \underline{\underline{k}} \, \nabla h \qquad \text{(4 bis)}$$

$$h = \underline{N}^T \, \underline{H}^e \qquad \text{(6 bis)}$$

$$\underline{v} = - \underline{\underline{k}} \, \nabla \underline{N}^T \, \underline{H}^e = - \underline{\underline{k}} \, \underline{\underline{B}} \, \underline{H}^e \qquad (14)$$

where $\underline{\underline{B}}$ is evaluated at $r = s = 0$.

PART IV: USER GUIDE

Computer Program Requirements

40. This program is written in FORTRAN IV for the Honeywell G-440 computer. It requires 28,672 words of core memory, two scratch magnetic tapes (logical units 2 and 4), and three discs (logical units 91, 92, and 93). Its WES program number is 704-G9R0-245.

Consistent Units

41. Before describing what actual data are to be provided it should be emphasized here that the input data should have consistent units. For example, if head is specified in feet and time in minutes, then the following units must be used:

- a. Permeability, ft/min.
- b. Discharge velocity, ft/min.
- c. Infiltration rate, ft/min.
- d. (x,y) node point data, ft.

In other words, if length (L) is given in feet or time (T) in minutes once, all subsequent input data (and output) must use these same units.

Description of Input Data

42. The following input data cards are required for each problem. Any number of problems can be solved by the same computer run by simply stacking problem data sets sequentially. In the section to follow, two items for each type of data are supplied to aid those who are familiar with FORTRAN language and FORMAT statements. The first item gives the format specifications (shown in brackets after the side heading) under which the data will be input. The second item states the names (variables) used in the program to retain the data.

Title card [10A8]

43. This card is an identification card for the problem.

Column	Variable	Description
1-80	HED	Alphanumeric identification.

Any legal FORTRAN character is permissible. The title will appear on the printed output of this program.

Control card [6I5, 2(1X,A4), 3F10.0]

44. This card controls the size and type of problem.

Column	Variable	Description
1-5	NUMNP	Number of node points. NUMNP cannot be greater than 350.
6-10	NUMEL	Number of elements. NUMEL cannot be greater than 250.
11-15	NUMMAT	Number of soil types. NUMMAT cannot be greater than 12.
16-20	NFLCD	Number of discharge velocity cards (see paragraph 54).
21-25	NØTIME	Number of time increments. NØTIME = 0 for steady-state confined problems.
26-30	IPRNT	Print interval. If this number is five, for example, output for every fifth time step is provided.
32-35	LTYP	Type of problem. Put CONF if flow is initially confined or UNCF if flow is initially unconfined.
37-40	LPLX	Type of problem. Put PLNE for plane flow or AXSY for axisymmetric flow.
41-50	DELTAT	Time increment (T). This variable is not used for confined flow problems.
51-60	RINFL	Rate of infiltration (L/T) for unconfined problems. Use a positive number for flow entering the region of saturated soil, and a negative number for flow leaving it. This variable is not used for confined flow problems.
61-70	DATUM	Elevation of datum (L).

Soil cards [I5, 3F10.0]

45. The soil cards describe the characteristics of the soil types in the problem. One card is required for each soil type.

Column	Variable	Description
1-5	I	Soil type number. Soil cards must be in ascending order with respect to soil type number.
6-15	XK1(I)	First principal permeability (L/T).
16-25	XK2(I)	Second principal permeability (L/T).
26-35	STØR(I)	Storage coefficient (unitless) for unconfined flow. This variable is not used for confined flow problems.

Nodal point cards [I5, I2, I3, 4F10.0]

46. These cards give required information for the nodes. One card per node is required unless a set of consecutively numbered nodes are located at equal intervals along a straight line segment (see fig. 8). In this case nodal point data for the interior nodes of the line segment (nodes 5-8) will be generated if node cards for these points are omitted. Thus for the example in fig. 8, the card for node 4 should be followed by a card for node 9. The coordinates of the generated nodes are found by linearly interpolating between the coordinates of the first node (4) and last node (9) of the line segment. The type and rate of change of boundary condition of generated nodes are set either to zero or to the respective values of the first node (see variable IN below). Boundary values for generated nodes are either determined by linearly interpolating between the first and last nodes of a line segment or are set to zero.

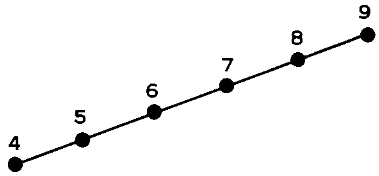

Fig. 8.

47. Node cards must be numbered consecutively with respect to node number, and the number of the first node must be 1. A data card for both the first and last nodes must always be supplied.

Column	Variable	Description
1-5	N	Nodal point number.
6-7	IN	Boundary condition flag for generated nodes of a line segment the first node of which is N . If IN = 0 , all boundary condition information is set to zero. If IN = 1 , type of boundary condition and rate of change of boundary value with respect to time for generated nodes are set to the respective values at node N . Boundary values for generated nodes are determined by linear interpolation if IN = 1 or set to zero if IN = 0 .
8-10	NBC(N)	Boundary condition flag. For confined flow problems, NBC = 0 for an internal node or an impervious boundary node, NBC = 1 for specified head on a boundary, and NBC = -1 for specified flow on a boundary. The following tabulation describes additional values provided for unconfined flow problems. Refer to fig. 9 to illustrate their use.

NBC	Description	Node No. in Fig. 9
2	In order to adjust the phreatic surface at each time step, either flows or discharge velocities are used as a basis for computation (see Appendix A). When a node with $\|NBC\| \le 1$ becomes a phreatic surface node, flows are used to compute the adjustment. A phreatic surface node is a node on or just above the phreatic surface whose (x,y) coordinates have been temporarily modified so that the node now lies on the phreatic surface. At some boundary nodes where head is specified, flows cannot be used, and thus discharge velocities must be used. Such a node requires NBC = 2 . This value will typically be used for nodes on the exit face that will possibly become a phreatic surface node at the exit point sometime during the solution (Continued)	13-14, 16-17

Column	Variable	Description		
8-10 (cont'd)	NBC(N) (cont'd)	NBC	Description	Node No. in Fig. 9
		2	process. A node which has not become a phreatic surface node with NBC = 2 will be treated exactly as if it had a value of NBC = 1 .	13-14, 16-17
		-2	This value is used for a boundary node which will possibly become a phreatic surface node sometime during the solution process for which the exit flow is known. NBC = -2 is typically used for nodes along the side of a well with unconfined flow where the rate of pumping is known. A node with NBC = -2 which is not a phreatic surface node will be treated like an NBC = -1 node.	
		3	This value is used for boundary nodes that will become phreatic surface nodes sometime during the solution process for which the position of the phreatic surface is known at all times. This value will typically be used for nodes at the headwater area. The values for head (FX) and rates of change of head with respect to time (ALP2) from this node data determine the position of the phreatic surface for an NBC = 3 type node. If such a node is not a phreatic surface node, it will be treated as if NBC = 1 .	52

Also, for unconfined flow problems where the phreatic surface will possibly touch the top or base of the aquifer, use NBC = -1 with FX = 0 for an impervious boundary node. The remaining nodes in fig. 9 have the following values. Nodes 5-8, 9-12, and 20-22 will have NBC = 0 . Nodes 51 and 53 will have NBC = 1 .

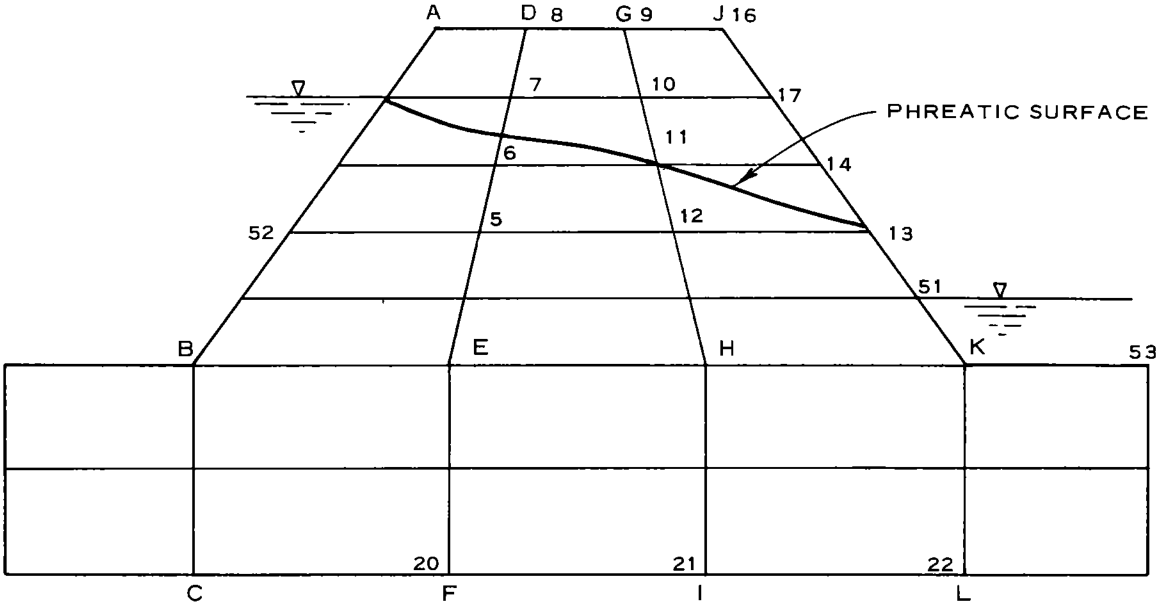

Fig. 9.

Column	Variable	Description
11-20	X(N)	x value (L) of node point.
21-30	Y(N)	y value (L) of node point.
31-40	FX(N)	Boundary value at t = 0 . FX represents head (L) for positive NBC and flow per unit length (L^2/T) for plane problems or flow per unit radian (L^3/T) for axisymmetric problems for negative NBC.
41-50	ALP2(N)	Rate of change of boundary value with respect to time (L/T for specified head, L^2/T^2 for specified flow in plane problems, and L^3/T^2 for specified flow in axisymmetric problems). FX for next time step = FX for this time step + ALP2 * DELTAT . If FX represents head, FX + DATUM will not be permitted a value less than y for an NBC value of 1 or 2.

Phreatic surface information cards [2I5, F10.0, I5]

48. For initially unconfined flow problems the position of the phreatic surface must be specified for t = 0 . This data set provides

that information. If the problem is initially confined, this data set is not needed and must not be included. The phreatic surface is adjusted after each time step along line segments such as ABC, DEF, GHI, and JKL in fig. 9. One card per line segment is needed if the nodes on or above the initial position of the phreatic surface of each line segment are numbered sequentially. Examples are nodes 7 and 8 on DEF and 9, 10, and 11 on GHI. Otherwise, one card for each set of sequentially numbered nodes on a given line segment is needed. Line segment JKL would therefore require two data cards.

Column	Variable	Description
1-5	M1	First node of a sequentially numbered set of nodes of a line segment on or above the initial position of the phreatic surface.
6-10	M2	Second node of sequentially numbered set of nodes ($M2 \geq M1$).
11-20	FR	Elevation (L) of phreatic surface at $t = 0$ on line segment.
21-25	NDD	Phreatic surface node. This is the node of the line segment closest to the phreatic surface yet on or above it.

49. This data set is terminated by a separate card with -1 in column 5. This termination card is not needed if the problem is initially confined.

Element cards [6I5, F10.0]

50. These cards contain the information for the elements. One card per element is needed unless a group of elements satisfy the following conditions:

a. The soil type and the two directions of the principal permeabilities are the same for all the elements of a group.

b. The element numbers of a group are in ascending order.

c. The node numbers for element N+1 of a group can be generated by incrementing the node numbers of element N by 1.

In this case element data for all but the first element of a group will be generated if cards for these elements are omitted. For example, elements 3-5 of the configuration in fig. 10 form a group. The data card for element 3 should therefore be followed by a data card for element 6. The soil type and directions of the principal permeabilities for generated elements are set to the respective values of the first element (element 3) of a group. Node numbers for generated elements are produced by successively incrementing the respective node numbers of the first element of a group by 1.

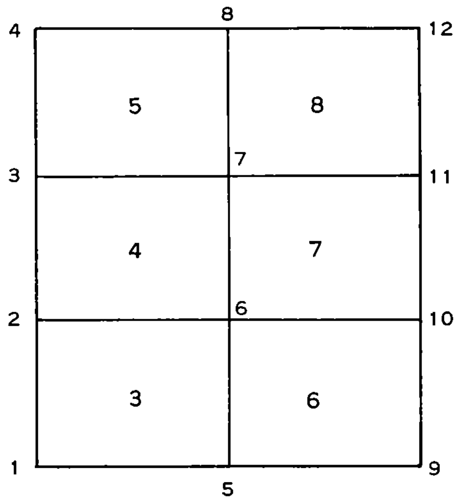

Fig. 10.

51. Element cards must be numbered consecutively with respect to element number, and the number of the first element must be 1. A data card for both the first and last elements must always be supplied.

52. During the initial setup of the problem, the user should attempt to assign node numbers to the elements in such a way as to minimize the difference between the largest and smallest node numbers of each element. This so-called greatest difference cannot be greater than 49.

Column	Variable	Description
1-5	J	Element number.
6-10	NP(1,J)	First node of element J . The nodes must be in counterclockwise order as shown in fig. 11. In this example the nodes could be rendered 5, 10, 11, 6.
11-15	NP(2,J)	Second node of element J .
16-20	NP(3,J)	Third node of element J .
21-25	NP(4,J)	Fourth node of element J .
26-30	NP(5,J)	Soil type number.
31-40	ANG(J)	Angle (degrees) between the first principal permeability and the x-axis as shown in fig. 12; k_1 and k_2 represent the two principal permeabilities.

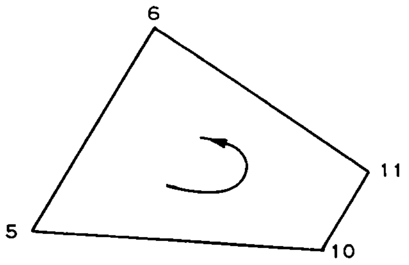

Fig. 11.

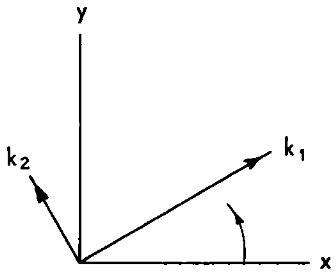

Fig. 12.

53. Elements that will be crossed by the phreatic surface have three additional restrictions:

- a. Each element must be a quadrilateral.
- b. The sides of each element must be at least as long as phreatic surface adjustments (see Appendix A) along the respective sides.
- c. The first node of each element must be the lower, left-hand one. For example, NP(1,N) of the element in fig. 11 must be 5.

Discharge velocity cards [2I5, F10.0]

54. The discharge velocity cards are used to specify discharge velocity along straight line segments connecting two nodes. One card for each line segment is required. The total number of discharge velocity cards must equal NFLCD. If NFLCD is zero, no cards are needed.

Column	Variable	Description
1-5	K	First node of line segment.
6-10	L	Second node of line segment.
11-20	FLRT	Normal component of discharge velocity (L/T) on line segment. A positive value for FLRT indicates that the flow is entering the system; a negative value indicates exit.

NBC(K) and NBC(L) must be set to a negative value in the nodal point data.

Description of Output

55. Output is in the form of printed information. Four groups of information are supplied:

- a. Input data.
- b. Heads and flows at nodes.
- c. Discharge velocities for the elements.
- d. Phreatic surface information.

For transient problems, b , c , and d are printed every IPRNT'th time step.

Input information

56. The problem identification, soil information, nodal point data, phreatic surface data, element information, and flow rate data are first printed. This includes all generated nodes and elements. This output is valuable for checking to be sure that the intended data were supplied.

Heads and flows

57. The head at every node is printed. Since seepage results from a head differential rather than from the magnitude of head, the percentage of net head is also printed for every node. Flow entering or leaving the flow region is provided for every boundary node. As shown in fig. 13, flow at a node is the quantity of water per unit time per unit length crossing the boundary through the effective area

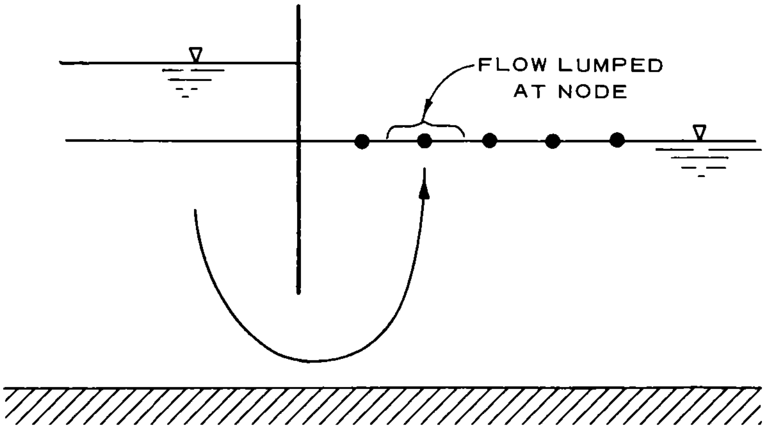

Fig. 13.

surrounding the node. A positive flow indicates flow entering the system, and a negative flow indicates exit.

Discharge velocity

58. The discharge velocities at $(\overline{X}^e, \overline{Y}^e)$ in the k_1 and k_2 directions, respectively, are printed for every element in the flow region. $(\overline{X}^e, \overline{Y}^e)$ is the average of the x's and y's , respectively, of the element's corner nodes. If the phreatic surface crosses a group of elements as shown in fig. 14, the coordinates of the nodes of these elements are temporarily changed to coincide with the phreatic surface. Elements outside the flow region are therefore eliminated, and $(\overline{X}^e, \overline{Y}^e)$ is altered for some elements.

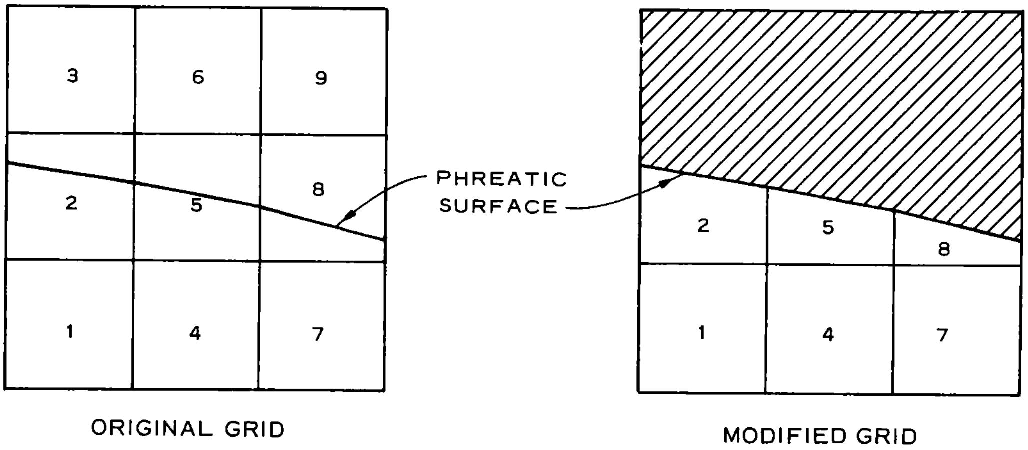

Fig. 14.

59. The magnitude and direction of the discharge velocity are also printed. The direction is specified by the counterclockwise angle between the x-axis and the discharge velocity.

Phreatic surface information

60. The status of every node with respect to the phreatic surface is printed. Two questions are answered by this output.

a. Is the node above, below, or part of the phreatic surface?

b. If the node is a phreatic surface node (a node just above or on the phreatic surface whose coordinates have been temporarily modified so that the node now rests on the phreatic surface), what are its temporary coordinates?

PART V: SAMPLE PROBLEMS

Introduction

61. The following problems are designed to illustrate how to use the program, some of the types of problems that can be solved, and the accuracy of the solutions. For each problem, five things are provided:

- *a*. A description of the problem.
- *b*. A view of the finite element grid.
- *c*. A listing of the input cards.
- *d*. A listing of the output.
- *e*. Analysis of the output.

Problems with simple geometries were deliberately picked so that the user could easily make the transition between the physical problem and the computer output.

Problem 1: Steady-State Axisymmetric Flow to a Fully Penetrating Artesian Well

Description of problem

62. The problem consists of a fully penetrating artesian well into a pervious aquifer as shown in fig. 15. The values of the variables are as follows:

$$r_w = 1\text{ ft}^*$$
$$R = 1000\text{ ft}$$
$$H - h_w = 10\text{ ft}$$
$$H = 0\text{ ft}$$
$$D = 100\text{ ft}$$
$$k = 0.1\text{ ft/min}$$

The quantity of flow (q_w) must be determined.

Finite element grid

63. Plate 1 shows a view of the finite element grid. Note that the grid is divided by 6 horizontal lines and 51 vertical lines. The vertical lines are arranged so that they are closer together as the

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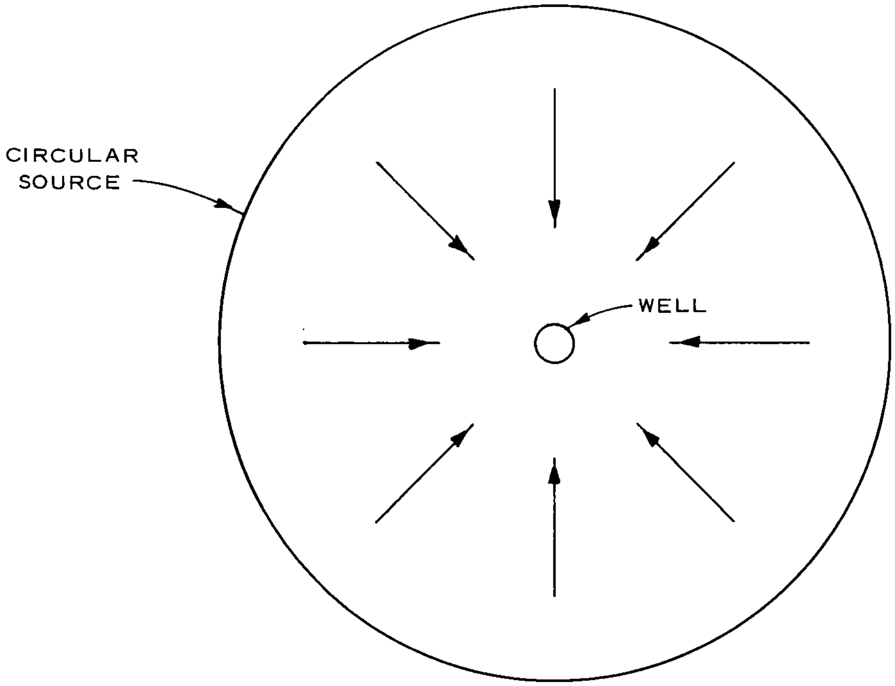
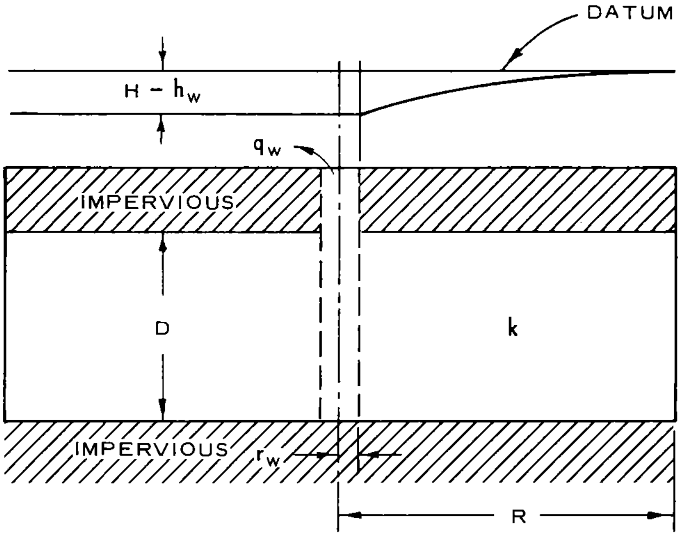
* A table of factors for converting British units of measurement to metric units is presented on page xiii.



PLAN



SECTION

Fig. 15.

radius decreases. This is because the gradient changes rapidly in the vicinity of the well. The expression for the radii of the vertical lines is

$$r_i = 1000^{\left(\frac{i-1}{50}\right)} ; \; i = 1 , 2 , \ldots , 51 \qquad (15)$$

The reason for using this particular equation is given in paragraph 67.

Listing of input cards

64. A listing of the input cards is presented in table 1.

Listing of output

65. A listing of the output is presented in table 2.

Analysis of results

66. Symmetry. Note, first of all, that symmetry is preserved by the finite element method. The heads for all the nodes and the magnitude of the discharge velocities for all the elements, respectively, are the same for a given radius. Nodes 7-12, for instance, all have a head of -9.8 ft.

67. Heads. The theoretical expression for head for this problem is

$$H - h = \frac{H - h_w}{\ln\left(\frac{R}{r_w}\right)} \ln \frac{R}{r} \qquad (16)$$

Putting into equation 16 the respective values for the constants yields

$$h = - \frac{10 \text{ ft}}{\ln 1000} \ln \left(\frac{1000 \text{ ft}}{r}\right)$$

If now the heads along the 51 vertical lines are to be computed,

$$h_i = - \frac{10 \text{ ft}}{\ln 1000} \ln\left(\frac{1000 \text{ ft}}{r_i}\right) ; \; i = 1 , 2 , \ldots , 51$$

Substituting equation 15 for r_i gives the result

$$h_i = - \frac{1}{5}(51 - i)\text{ft} ; \; i = 1 , 2 , \ldots , 51 \qquad (17)$$

Therefore, the head goes from -10.0 ft to 0.0 ft in increments of 0.2 ft as one progresses from the innermost vertical line (r = 1 ft) to the outermost ring (r = 1000 ft).

68. A quick glance at the finite element results shows that indeed the heads do start at -10.0 ft and decrease approximately in steps of 0.2 ft from one vertical line (6 nodes) to the next until at r = 1000 ft the head is 0.0 ft. The percentage errors are in the range of 0.0-0.1%.

69. Flows. The theoretical expression for flow is

$$q_w = 2\pi kD \frac{H - h_w}{\ln\left(\frac{R}{r_w}\right)} \tag{18}$$

Substituting the values for the constants gives $q_w = 90.958$ cfm.

70. The flow from the finite element solution is obtained by summing the flows for the first six or the last six nodes and multiplying by 2π. The result in each case is 91.006 cfm. The percentage error is 0.05%.

Problem 2: Steady-State Flow to a Well Being Pumped

Description of problem

71. This problem is the same as problem 1 except that the well is being pumped at the rate of 90.958 cfm. All other aspects of the problem are the same. The finite element grid is shown in plate 1.

Listing of input cards

72. A listing of the input cards is presented in table 3.

Listing of output

73. A listing of the output is presented in table 4.

Analysis of results

74. Conservation of flow. The flow (90.958 cfm) was divided among the first six nodes and given a negative sign. Note that these flows are exactly matched by the flows of the last six nodes and that the sum of all flows is zero. Thus, conservation of water is maintained.

75. Heads. As expected from the previous problem, the heads are in error by 0.04-0.15%. Note also that they are on the lower side.

Problem 3: Transient Unconfined Flow in a Bank with Vertical Sides After Sudden Drawdown

Description of problem

76. The problem consists of a bank with vertical sides where the headwater and tailwater are initially the same until the tailwater level is suddenly lowered. The problem is illustrated in fig. 16.

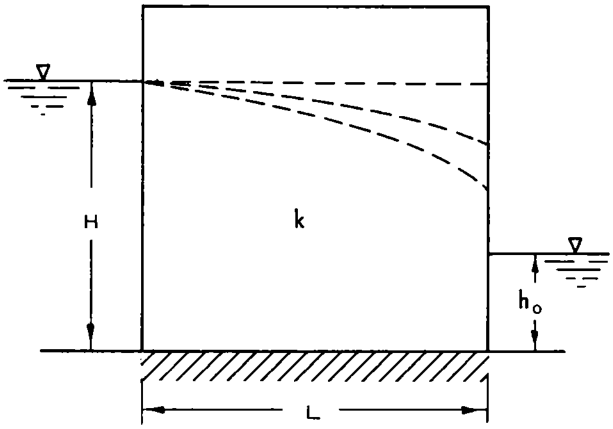


Fig. 16.

The values of the constants are

$$H = 100 \text{ ft}$$
$$h_o = 40 \text{ ft}$$
$$L = 100 \text{ ft}$$
$$k = 0.1 \text{ ft/min}$$
$$\Delta t = 5 \text{ min}$$

Finite element grid

77. Plate 2 shows a view of the finite element grid. Note that the elements are spaced so that the closer to the tailwater the finer the mesh.

Listing of input cards

78. A listing of the input cards is presented in table 5.

Listing of output

79. A listing of the output is presented in table 6.

Analysis of results

80. Convergence to steady-state. The output in table 6 was given for only two time steps for the sake of brevity. However, further computer runs were made in order to determine the steady-state solution. The resulting phreatic surface is shown in fig. 17.

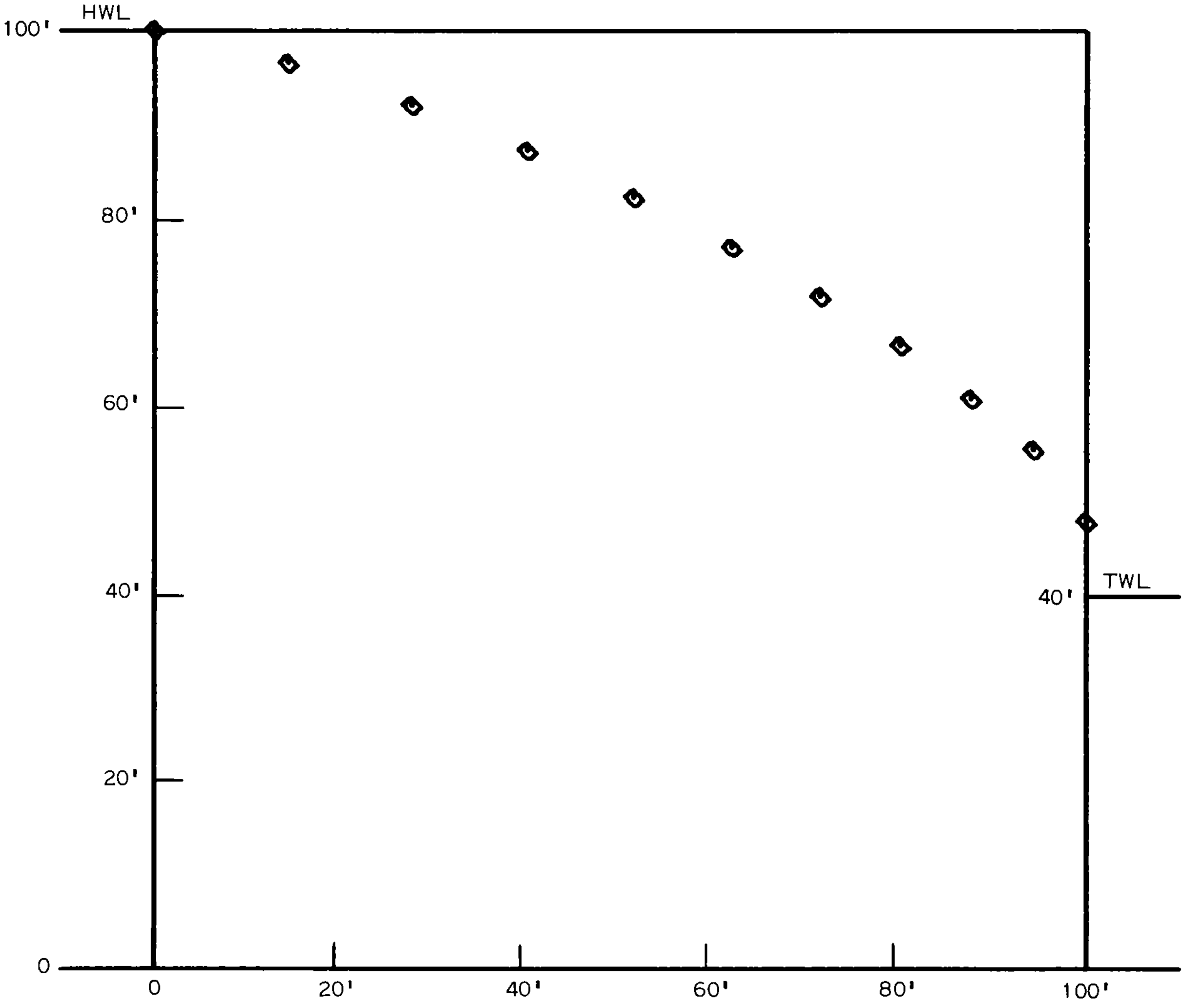


Fig. 17.

81. Comparison of exit point. The exit point from the FEM solution is 47.65 ft as compared with 48.00 ft from theoretical results presented by Mansur and Kaufman.[13] The percentage error is 0.73%.

82. Comparison of flows. The FEM result for flow is 4.23 cfm/ft. The flow from the Dupuit equation, which was found by Chapman[14] to be

accurate within 1%, is 4.20 cfm/ft. The percentage difference of the two results is 0.71%.

83. Comparison of heads. It is possible to compute the theoretical location of the phreatic surface by conformal mapping. However, this calculation is quite lengthy. Therefore, the alternate problem of

$$H = 200 \text{ ft} \qquad L = 100 \text{ ft}$$

$$h_o = 52 \text{ ft} \qquad k = 0.1 \text{ ft/min}$$

will be considered, since the theoretical results of this problem are presented by Chapman[14] (from work by Gunther). Chapman also developed a simplified equation for determining the position of the phreatic surface for this problem. Fig. 18 shows a comparison of the theoretical results (solid line), the FEM results (discrete points), and Chapman's formula (dotted line). Note that in each of these solutions the height of the exit line is, by assumption, identical. Chapman concluded that his equation is in error by as much as 6%. The percentage error of the FEM results is 0.00-0.89%. (This percentage error is only approximate, since the theoretical results were determined by taking points off a graph and fitting a spline through these points.)

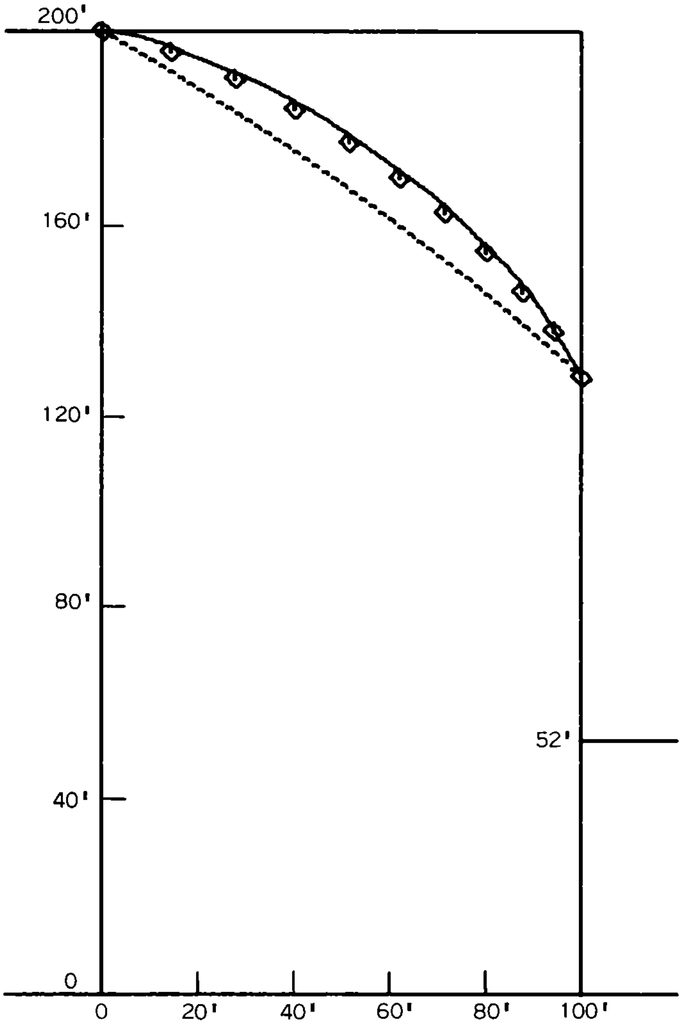


Fig. 18.

PART VI: LIMITATIONS OF PROGRAM AND FUTURE WORK

84. This program is designed to handle most two-dimensional seepage problems encountered by the practicing engineer. Certain problems, however, cannot yet be solved by this program. They are:

- a. Problems in which the density of saturated soil changes with time.
- b. Transient problems in which the boundary conditions cannot be approximated by a piecewise linear representation.
- c. Unconfined flow problems in which the infiltration rate cannot be assumed constant for the entire flow region.
- d. Transient problems in which the boundary conditions are changing too rapidly to permit treatment of the problem as a series of steady-state problems.

85. There are also computer-oriented limitations that must be considered. These determine what size of problem can be solved cost-effectively. These limitations vary from one computer system to another.

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Table 1

Input for Problem 1

Steady-State Axisymmetric Flow to a Fully Penetrating Artesian Well

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```
STEADY-STATE AXISYMMETRIC FLOW TO A FULLY PENETRATING ARTESIAN WELL
  306  250    1     0     0     1 CONF AXSY        5,00          0.        160,
    1        0,1         0,1          0,3
    1  1  1    1,0000     0,0000  -10,
    6     1    1,0000   100,0000  -10,
    7     0    1,1482     0,0000    0,0000
   12     0    1,1482   100,0000    0.0000
   13     0    1,3183     0,0000    0.0000
   18     0    1,3183   100,0000    0.0000
   19     0    1,5136     0,0000    0.0000
   24     0    1,5136   100,0000    0.0000
   25     0    1,7378     0,0000    0.0000
   30     0    1,7378   100,0000    0.0000
   31     0    1,9953     0,0000    0.0000
   36     0    1,9953   100,0000    0.0000
   37     0    2,2909     0,0000    0.0000
   42     0    2,2909   100,0000    0.0000
   43     0    2,6303     0,0000    0.0000
   48     0    2,6303   100,0000    0.0000
   49     0    3,0200     0,0000    0.0000
   54     0    3,0200   100,0000    0.0000
   55     0    3,4674     0,0000    0.0000
   60     0    3,4674   100,0000    0.0000
   61     0    3,9811     0,0000    0.0000
   66     0    3,9811   100,0000    0.0000
   67     0    4,5709     0,0000    0.0000
   72     0    4,5709   100,0000    0.0000
   73     0    5,2481     0,0000    0.0000
   78     0    5,2481   100,0000    0.0000
   79     0    6,0256     0,0000    0.0000
   84     0    6,0256   100,0000    0.0000
   85     0    6,9183     0,0000    0.0000
   90     0    6,9183   100,0000    0;0000
   91     0    7,9433     0,0000    0.0000
   96     0    7,9433   100,0000    0.0000
   97     0    9,1201     0,0000    0.0000
  102     0    9,1201   100,0000    0.0000
  103     0   10,4713     0,0000    0.0000
  108     0   10,4713   100,0000    0.0000
  109     0   12,0226     0,0000    0.0000
  114     0   12,0226   100,0000    0.0000
  115     0   13,8038     0,0000    0.0000
  120     0   13,8038   100,0000    0.0000
  121     0   15,8489     0,0000    0.0000
  126     0   15,8489   100,0000    0.0000
  127     0   18,1970     0,0000    0.0000
  132     0   18,1970   100,0000    0.0000
  133     0   20,8930     0,0000    0.0000
  138     0   20,8930   100,0000    0.0000
  139     0   23,9883     0,0000    0.0000
  144     0   23,9883   100,0000    0.0000
  145     0   27,5423     0,0000    0.0000
```

(Continued)

(1 of 3 sheets)

Table 1 (Continued)

150		0	27,5423	100,0000	0,0000
151		0	31,6228	0,0000	0,0000
156		0	31,6228	100,0000	0,0000
157		0	36,3078	0,0000	0,0000
162		0	36,3078	100,0000	0,0000
163		0	41,6869	0,0000	0,0000
168		0	41,6869	100,0000	0,0000
169		0	47,8630	0,0000	0,0000
174		0	47,8630	100,0000	0,0000
175		0	54,9541	0,0000	0,0000
180		0	54,9541	100,0000	0,0000
181		0	63,0957	0,0000	0,0000
186		0	63,0957	100,0000	0,0000
187		0	72,4436	0,0000	0,0000
192		0	72,4436	100,0000	0,0000
193		0	83,1764	0,0000	0,0000
198		0	83,1764	100,0000	0,0000
199		0	95,4993	0,0000	0,0000
204		0	95,4993	100,0000	0,0000
205		0	109,6478	0,0000	0,0000
210		0	109,6478	100,0000	0,0000
211		0	125,8925	0,0000	0,0000
216		0	125,8925	100,0000	0,0000
217		0	144,5440	0,0000	0,0000
222		0	144,5440	100,0000	0,0000
223		0	165,9587	0,0000	0,0000
228		0	165,9587	100,0000	0,0000
229		0	190,5461	0,0000	0,0000
234		0	190,5461	100,0000	0,0000
235		0	218,7762	0,0000	0,0000
240		0	218,7762	100,0000	0,0000
241		0	251,1886	0,0000	0,0000
246		0	251,1886	100,0000	0,0000
247		0	288,4032	0,0000	0,0000
252		0	288,4032	100,0000	0,0000
253		0	331,1311	0,0000	0,0000
258		0	331,1311	100,0000	0,0000
259		0	380,1894	0,0000	0,0000
264		0	380,1894	100,0000	0,0000
265		0	436,5158	0,0000	0,0000
270		0	436,5158	100,0000	0,0000
271		0	501,1872	0,0000	0,0000
276		0	501,1872	100,0000	0,0000
277		0	575,4399	0,0000	0,0000
282		0	575,4399	100,0000	0,0000
283		0	660,6934	0,0000	0,0000
288		0	660,6934	100,0000	0,0000
289		0	758,5776	0,0000	0,0000
294		0	758,5776	100,0000	0,0000
295		0	870,9636	0,0000	0,0000
300		0	870,9636	100,0000	0,0000
301	1	1	1000,0000	0,0000	0,0000

(Continued)

Table 1 (Concluded)

```
 306     1 1000.0000  100.0000     0.0000
   1     1     7     8     2     1
   6     7    13    14     8     1
  11    13    19    20    14     1
  16    19    25    26    20     1
  21    25    31    32    26     1
  26    31    37    38    32     1
  31    37    43    44    38     1
  36    43    49    50    44     1
  41    49    55    56    50     1
  46    55    61    62    56     1
  51    61    67    68    62     1
  56    67    73    74    68     1
  61    73    79    80    74     1
  66    79    85    86    80     1
  71    85    91    92    86     1
  76    91    97    98    92     1
  81    97   103   104    98     1
  86   103   109   110   104     1
  91   109   115   116   110     1
  96   115   121   122   116     1
 101   121   127   128   122     1
 106   127   133   134   128     1
 111   133   139   140   134     1
 116   139   145   146   140     1
 121   145   151   152   146     1
 126   151   157   158   152     1
 131   157   163   164   158     1
 136   163   169   170   164     1
 141   169   175   176   170     1
 146   175   181   182   176     1
 151   181   187   188   182     1
 156   187   193   194   188     1
 161   193   199   200   194     1
 166   199   205   206   200     1
 171   205   211   212   206     1
 176   211   217   218   212     1
 181   217   223   224   218     1
 186   223   229   230   224     1
 191   229   235   236   230     1
 196   235   241   242   236     1
 201   241   247   248   242     1
 206   247   253   254   248     1
 211   253   259   260   254     1
 216   259   265   266   260     1
 221   265   271   272   266     1
 226   271   277   278   272     1
 231   277   283   284   278     1
 236   283   289   290   284     1
 241   289   295   296   290     1
 246   295   301   302   296     1
 250   299   305   306   300     1
```

(3 of 3 sheets)

Table 2

Output for Problem 1

Steady-State Axisymmetric Flow to a Fully Penetrating Artesian Well

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STEADY-STATE AXISYMMETRIC FLOW TO A FULLY PENETRATING ARTESIAN WELL


  NUMBER OF NODAL POINTS------306

  NUMBER OF ELEMENTS----------250

  NUMBER OF DIFF, MATERIALS---  1

  NUMBER OF TIME STEPS--------  0

  PRINT INTERVAL--------------  1

  TIME INCREMENT------------        5.000

  INFILTRATION RATE-----------      0.000

  ELEVATION OF DATUM----------    160.000



                                   MATERIAL PROPERTIES

                     MAT          K1                K2            STOR

                      1       0.100E+00         0.100E+00         0.300
```

(Continued)

Table 2 (Continued)

```
                 NODE POINT INFORMATION

NODE   BC           X            Y       FLOW-HEAD     BC RATE

  1     1         1,00         0.00       -10,00       0,0000
  2     1         1,00        20.00       -10,00       0,0000
  3     1         1,00        40.00       -10,00       0,0000
  4     1         1,00        60.00       -10,00       0,0000
  5     1         1,00        80.00       -10,00       0,0000
  6     1         1,00       100.00       -10,00       0,0000
  7     0         1,15         0.00         0,00       0,0000
  8     0         1,15        20.00         0,00       0,0000
  9     0         1,15        40.00         0,00       0,0000
 10     0         1,15        60.00         0,00       0,0000
 11     0         1,15        80.00         0,00       0,0000
 12     0         1,15       100.00         0,00       0,0000
 13     0         1,32         0.00         0,00       0,0000
 14     0         1,32        20.00         0,00       0,0000
 15     0         1,32        40.00         0,00       0,0000
 16     0         1,32        60.00         0,00       0,0000
 17     0         1,32        80.00         0,00       0,0000
 18     0         1,32       100.00         0,00       0,0000
 19     0         1,51         0.00         0,00       0,0000
 20     0         1,51        20.00         0,00       0,0000
 21     0         1,51        40.00         0,00       0,0000
 22     0         1,51        60.00         0,00       0,0000
 23     0         1,51        80.00         0,00       0,0000
 24     0         1,51       100.00         0,00       0,0000
 25     0         1,74         0.00         0,00       0,0000
 26     0         1,74        20.00         0,00       0,0000
 27     0         1,74        40.00         0,00       0,0000
 28     0         1,74        60.00         0,00       0,0000
 29     0         1,74        80.00         0,00       0,0000
 30     0         1,74       100.00         0,00       0,0000
 31     0         2,00         0.00         0,00       0,0000
 32     0         2,00        20.00         0,00       0,0000
 33     0         2,00        40.00         0,00       0,0000
 34     0         2,00        60.00         0,00       0,0000
 35     0         2,00        80.00         0,00       0,0000
 36     0         2,00       100.00         0,00       0,0000
 37     0         2,29         0.00         0,00       0,0000
 38     0         2,29        20.00         0,00       0,0000
 39     0         2,29        40.00         0,00       0,0000
 40     0         2,29        60.00         0,00       0,0000
 41     0         2,29        80.00         0,00       0,0000
 42     0         2,29       100.00         0,00       0,0000
 43     0         2,63         0.00         0,00       0,0000
 44     0         2,63        20.00         0,00       0,0000
 45     0         2,63        40.00         0,00       0,0000
 46     0         2,63        60.00         0,00       0,0000
 47     0         2,63        80.00         0,00       0,0000
 48     0         2,63       100.00         0,00       0,0000
 49     0         3,02         0.00         0,00       0,0000
 50     0         3,02        20.00         0,00       0,0000
 51     0         3,02        40.00         0,00       0,0000
 52     0         3,02        60.00         0,00       0,0000
```

(Continued)

Table 2 (Continued)

53	0	3,02	80.00	0,00	0,0000
54	0	3,02	100.00	0,00	0,0000
55	0	3,47	0.00	0,00	0,0000
56	0	3,47	20.00	0,00	0,0000
57	0	3,47	40.00	0,00	0,0000
58	0	3,47	60.00	0,00	0,0000
59	0	3,47	80.00	0,00	0,0000
60	0	3,47	100.00	0,00	0,0000
61	0	3,98	0.00	0,00	0,0000
62	0	3,98	20.00	0,00	0,0000
63	0	3,98	40.00	0,00	0,0000
64	0	3,98	60.00	0,00	0,0000
65	0	3,98	80.00	0,00	0,0000
66	0	3,98	100.00	0,00	0,0000
67	0	4,57	0.00	0,00	0,0000
68	0	4,57	20.00	0,00	0,0000
69	0	4,57	40.00	0,00	0,0000
70	0	4,57	60.00	0,00	0,0000
71	0	4,57	80.00	0,00	0,0000
72	0	4,57	100.00	0,00	0,0000
73	0	5,25	0.00	0,00	0,0000
74	0	5,25	20.00	0,00	0,0000
75	0	5,25	40.00	0,00	0,0000
76	0	5,25	60.00	0,00	0,0000
77	0	5,25	80.00	0,00	0,0000
78	0	5,25	100.00	0,00	0,0000
79	0	6,03	0.00	0,00	0,0000
80	0	6,03	20.00	0,00	0,0000
81	0	6,03	40.00	0,00	0,0000
82	0	6,03	60.00	0,00	0,0000
83	0	6,03	80.00	0,00	0,0000
84	0	6,03	100.00	0,00	0,0000
85	0	6,92	0.00	0,00	0,0000
86	0	6,92	20.00	0,00	0,0000
87	0	6,92	40.00	0,00	0,0000
88	0	6,92	60.00	0,00	0,0000
89	0	6,92	80.00	0,00	0,0000
90	0	6,92	100.00	0,00	0,0000
91	0	7,94	0.00	0,00	0,0000
92	0	7,94	20.00	0,00	0,0000
93	0	7,94	40.00	0,00	0,0000
94	0	7,94	60.00	0,00	0,0000
95	0	7,94	80.00	0,00	0,0000
96	0	7,94	100.00	0,00	0,0000
97	0	9,12	0.00	0,00	0,0000
98	0	9,12	20.00	0,00	0,0000
99	0	9,12	40.00	0,00	0,0000
100	0	9,12	60.00	0,00	0,0000
101	0	9,12	80.00	0,00	0,0000
102	0	9,12	100.00	0,00	0,0000
103	0	10,47	0.00	0,00	0,0000
104	0	10,47	20.00	0,00	0,0000
105	0	10,47	40.00	0,00	0,0000
106	0	10,47	60.00	0,00	0,0000
107	0	10,47	80.00	0,00	0,0000
108	0	10.47	100.00	0,00	0,0000
109	0	12,02	0.00	0,00	0,0000
110	0	12,02	20.00	0,00	0,0000
111	0	12,02	40.00	0,00	0,0000
112	0	12,02	60.00	0,00	0,0000
113	0	12,02	80,00	0,00	0,0000
114	0	12,02	100.00	0,00	0,0000
115	0	13,80	0.00	0,00	0,0000

(Continued)

Table 2 (Continued)

116	0	13,80	20.00	0,00	0,0000
117	0	13,80	40.00	0,00	0,0000
118	0	13,80	60.00	0,00	0,0000
119	0	13,80	80.00	0,00	0,0000
120	0	13,80	100.00	0,00	0,0000
121	0	15,85	0.00	0,00	0,0000
122	0	15,85	20.00	0,00	0,0000
123	0	15,85	40.00	0,00	0,0000
124	0	15,85	60.00	0,00	0,0000
125	0	15,85	80.00	0,00	0,0000
126	0	15,85	100.00	0,00	0,0000
127	0	18,20	0.00	0,00	0,0000
128	0	18,20	20.00	0,00	0,0000
129	0	18,20	40.00	0,00	0,0000
130	0	18,20	60.00	0,00	0,0000
131	0	18,20	80.00	0,00	0,0000
132	0	18,20	100.00	0,00	0,0000
133	0	20,89	0.00	0,00	0,0000
134	0	20,89	20.00	0,00	0,0000
135	0	20,89	40.00	0,00	0,0000
136	0	20,89	60.00	0,00	0,0000
137	0	20,89	80.00	0,00	0,0000
138	0	20,89	100.00	0,00	0,0000
139	0	23,99	0.00	0,00	0,0000
140	0	23,99	20.00	0,00	0,0000
141	0	23,99	40.00	0,00	0,0000
142	0	23,99	60.00	0,00	0,0000
143	0	23,99	80.00	0,00	0,0000
144	0	23,99	100.00	0,00	0,0000
145	0	27,54	0.00	0,00	0,0000
146	0	27,54	20.00	0,00	0,0000
147	0	27,54	40.00	0,00	0,0000
148	0	27,54	60.00	0,00	0,0000
149	0	27,54	80.00	0,00	0,0000
150	0	27,54	100.00	0,00	0,0000
151	0	31,62	0.00	0,00	0,0000
152	0	31,62	20.00	0,00	0,0000
153	0	31,62	40.00	0,00	0,0000
154	0	31,62	60.00	0,00	0,0000
155	0	31,62	80.00	0,00	0,0000
156	0	31,62	100.00	0,00	0,0000
157	0	36,31	0.00	0,00	0,0000
158	0	36,31	20.00	0,00	0,0000
159	0	36,31	40.00	0,00	0,0000
160	0	36,31	60.00	0,00	0,0000
161	0	36,31	80.00	0,00	0,0000
162	0	36,31	100.00	0,00	0,0000
163	0	41,69	0.00	0,00	0,0000
164	0	41,69	20.00	0,00	0,0000
165	0	41,69	40.00	0,00	0,0000
166	0	41,69	60.00	0,00	0,0000
167	0	41,69	80.00	0,00	0,0000
168	0	41,69	100.00	0,00	0,0000
169	0	47,86	0.00	0,00	0,0000
170	0	47,86	20.00	0,00	0,0000
171	0	47,86	40.00	0,00	0,0000
172	0	47,86	60.00	0,00	0,0000
173	0	47,86	80.00	0,00	0,0000
174	0	47,86	100.00	0,00	0,0000
175	0	54,95	0.00	0,00	0,0000
176	0	54,95	20.00	0,00	0,0000
177	0	54,95	40.00	0,00	0,0000
178	0	54,95	60.00	0,00	0,0000

(Continued)

Table 2 (Continued)

179	0	54,95	80.00	0,00	0,0000
180	0	54,95	100.00	0,00	0,0000
181	0	63,10	0.00	0,00	0,0000
182	0	63,10	20.00	0,00	0,0000
183	0	63,10	40.00	0,00	0,0000
184	0	63,10	60.00	0,00	0,0000
185	0	63,10	80.00	0,00	0,0000
186	0	63,10	100.00	0,00	0,0000
187	0	72,44	0.00	0,00	0,0000
188	0	72,44	20.00	0,00	0,0000
189	0	72,44	40.00	0,00	0,0000
190	0	72,44	60.00	0,00	0,0000
191	0	72,44	80.00	0,00	0,0000
192	0	72,44	100.00	0,00	0,0000
193	0	83,18	0.00	0,00	0,0000
194	0	83,18	20.00	0,00	0,0000
195	0	83,18	40.00	0,00	0,0000
196	0	83,18	60.00	0,00	0,0000
197	0	83,18	80.00	0,00	0,0000
198	0	83,18	100.00	0,00	0,0000
199	0	95,50	0.00	0,00	0,0000
200	0	95,50	20.00	0,00	0,0000
201	0	95,50	40.00	0,00	0,0000
202	0	95,50	60.00	0,00	0,0000
203	0	95,50	80.00	0,00	0,0000
204	0	95,50	100.00	0,00	0,0000
205	0	109,65	0.00	0,00	0,0000
206	0	109,65	20.00	0,00	0,0000
207	0	109,65	40.00	0,00	0,0000
208	0	109,65	60.00	0,00	0,0000
209	0	109,65	80.00	0,00	0,0000
210	0	109,65	100.00	0,00	0,0000
211	0	125,89	0.00	0,00	0,0000
212	0	125,89	20.00	0,00	0,0000
213	0	125,89	40.00	0,00	0,0000
214	0	125,89	60.00	0,00	0,0000
215	0	125,89	80.00	0,00	0,0000
216	0	125,89	100.00	0,00	0,0000
217	0	144,54	0.00	0,00	0,0000
218	0	144,54	20.00	0,00	0,0000
219	0	144,54	40.00	0,00	0,0000
220	0	144,54	60.00	0,00	0,0000
221	0	144,54	80.00	0,00	0,0000
222	0	144,54	100.00	0,00	0,0000
223	0	165,96	0.00	0,00	0,0000
224	0	165,96	20.00	0,00	0,0000
225	0	165,96	40.00	0,00	0,0000
226	0	165,96	60.00	0,00	0,0000
227	0	165,96	80.00	0,00	0,0000
228	0	165,96	100.00	0,00	0,0000
229	0	190,55	0.00	0,00	0,0000
230	0	190,55	20.00	0,00	0,0000
231	0	190,55	40.00	0,00	0,0000
232	0	190,55	60.00	0,00	0,0000
233	0	190,55	80.00	0,00	0,0000
234	0	190,55	100.00	0,00	0,0000
235	0	218,78	0.00	0,00	0,0000
236	0	218,78	20.00	0,00	0,0000
237	0	218,78	40.00	0,00	0,0000
238	0	218,78	60.00	0,00	0,0000
239	0	218,78	80.00	0,00	0,0000
240	0	218,78	100.00	0,00	0,0000
241	0	251,19	0.00	0,00	0,0000

(Continued)

Table 2 (Continued)

242	0	251,19	20.00	0,00	0,0000
243	0	251,19	40.00	0,00	0,0000
244	0	251,19	60.00	0,00	0,0000
245	0	251,19	80.00	0,00	0,0000
246	0	251,19	100.00	0,00	0,0000
247	0	288,40	0.00	0,00	0,0000
248	0	288,40	20.00	0,00	0,0000
249	0	288,40	40.00	0,00	0,0000
250	0	288,40	60.00	0,00	0,0000
251	0	288,40	80.00	0,00	0,0000
252	0	288,40	100.00	0,00	0,0000
253	0	331,13	0.00	0,00	0,0000
254	0	331,13	20.00	0,00	0,0000
255	0	331,13	40.00	0,00	0,0000
256	0	331,13	60.00	0,00	0,0000
257	0	331,13	80.00	0,00	0,0000
258	0	331,13	100.00	0,00	0,0000
259	0	380,19	0.00	0,00	0,0000
260	0	380,19	20.00	0,00	0,0000
261	0	380,19	40.00	0,00	0,0000
262	0	380,19	60.00	0,00	0,0000
263	0	380,19	80.00	0,00	0,0000
264	0	380,19	100.00	0,00	0,0000
265	0	436,52	0.00	0,00	0,0000
266	0	436,52	20.00	0,00	0,0000
267	0	436,52	40.00	0,00	0,0000
268	0	436,52	60.00	0,00	0,0000
269	0	436,52	80.00	0,00	0,0000
270	0	436,52	100.00	0,00	0,0000
271	0	501,19	0.00	0,00	0,0000
272	0	501,19	20.00	0,00	0,0000
273	0	501,19	40.00	0,00	0,0000
274	0	501,19	60.00	0,00	0,0000
275	0	501,19	80.00	0,00	0,0000
276	0	501,19	100.00	0,00	0,0000
277	0	575,44	0.00	0,00	0,0000
278	0	575,44	20.00	0,00	0,0000
279	0	575,44	40.00	0,00	0,0000
280	0	575,44	60.00	0,00	0,0000
281	0	575,44	80.00	0,00	0,0000
282	0	575,44	100.00	0,00	0,0000
283	0	660,69	0.00	0,00	0,0000
284	0	660,69	20.00	0,00	0,0000
285	0	660,69	40.00	0,00	0,0000
286	0	660,69	60.00	0,00	0,0000
287	0	660,69	80.00	0,00	0,0000
288	0	660,69	100.00	0,00	0,0000
289	0	758,58	0.00	0,00	0,0000
290	0	758,58	20.00	0,00	0,0000
291	0	758,58	40.00	0,00	0,0000
292	0	758,58	60.00	0,00	0,0000
293	0	758,58	80.00	0,00	0,0000
294	0	758,58	100.00	0,00	0,0000
295	0	870,96	0.00	0,00	0,0000
296	0	870,96	20.00	0,00	0,0000
297	0	870,96	40.00	0,00	0,0000
298	0	870,96	60.00	0,00	0,0000
299	0	870,96	80.00	0,00	0,0000
300	0	870,96	100.00	0,00	0,0000
301	1	1000,00	0.00	0,00	0,0000
302	1	1000,00	20.00	0,00	0,0000
303	1	1000,00	40.00	0,00	0,0000
304	1	1000,00	60.00	0,00	0,0000
305	1	1000,00	80.00	0,00	0,0000
306	1	1000,00	100.00	0,00	0,0000

(Continued)

Table 2 (Continued)

```
                         ELEMENT INFORMATION

  ELMT        #1     #2     #3     #4       MAT       ANGLE

    1          1      7      8      2        1          0,0
    2          2      8      9      3        1          0,0
    3          3      9     10      4        1          0,0
    4          4     10     11      5        1          0,0
    5          5     11     12      6        1          0,0
    6          7     13     14      8        1          0,0
    7          8     14     15      9        1          0,0
    8          9     15     16     10        1          0,0
    9         10     16     17     11        1          0,0
   10         11     17     18     12        1          0,0
   11         13     19     20     14        1          0,0
   12         14     20     21     15        1          0,0
   13         15     21     22     16        1          0,0
   14         16     22     23     17        1          0,0
   15         17     23     24     18        1          0,0
   16         19     25     26     20        1          0,0
   17         20     26     27     21        1          0,0
   18         21     27     28     22        1          0,0
   19         22     28     29     23        1          0,0
   20         23     29     30     24        1          0,0
   21         25     31     32     26        1          0,0
   22         26     32     33     27        1          0,0
   23         27     33     34     28        1          0,0
   24         28     34     35     29        1          0,0
   25         29     35     36     30        1          0,0
   26         31     37     38     32        1          0,0
   27         32     38     39     33        1          0,0
   28         33     39     40     34        1          0,0
   29         34     40     41     35        1          0,0
   30         35     41     42     36        1          0,0
   31         37     43     44     38        1          0,0
   32         38     44     45     39        1          0,0
   33         39     45     46     40        1          0,0
   34         40     46     47     41        1          0,0
   35         41     47     48     42        1          0,0
   36         43     49     50     44        1          0,0
   37         44     50     51     45        1          0,0
   38         45     51     52     46        1          0,0
   39         46     52     53     47        1          0,0
   40         47     53     54     48        1          0,0
   41         49     55     56     50        1          0,0
   42         50     56     57     51        1          0,0
   43         51     57     58     52        1          0,0
   44         52     58     59     53        1          0,0
   45         53     59     60     54        1          0,0
   46         55     61     62     56        1          0,0
   47         56     62     63     57        1          0,0
   48         57     63     64     58        1          0,0
   49         58     64     65     59        1          0,0
   50         59     65     66     60        1          0,0
   51         61     67     68     62        1          0,0
   52         62     68     69     63        1          0,0
```

(Continued)

Table 2 (Continued)

53	63	69	70	64	1	0,0
54	64	70	71	65	1	0,0
55	65	71	72	66	1	0,0
56	67	73	74	68	1	0,0
57	68	74	75	69	1	0,0
58	69	75	76	70	1	0,0
59	70	76	77	71	1	0,0
60	71	77	78	72	1	0,0
61	73	79	80	74	1	0,0
62	74	80	81	75	1	0,0
63	75	81	82	76	1	0,0
64	76	82	83	77	1	0,0
65	77	83	84	78	1	0,0
66	79	85	86	80	1	0,0
67	80	86	87	81	1	0,0
68	81	87	88	82	1	0,0
69	82	88	89	83	1	0,0
70	83	89	90	84	1	0,0
71	85	91	92	86	1	0,0
72	86	92	93	87	1	0,0
73	87	93	94	88	1	0,0
74	88	94	95	89	1	0,0
75	89	95	96	90	1	0,0
76	91	97	98	92	1	0,0
77	92	98	99	93	1	0,0
78	93	99	100	94	1	0,0
79	94	100	101	95	1	0,0
80	95	101	102	96	1	0,0
81	97	103	104	98	1	0,0
82	98	104	105	99	1	0,0
83	99	105	106	100	1	0,0
84	100	106	107	101	1	0,0
85	101	107	108	102	1	0,0
86	103	109	110	104	1	0,0
87	104	110	111	105	1	0,0
88	105	111	112	106	1	0,0
89	106	112	113	107	1	0,0
90	107	113	114	108	1	0,0
91	109	115	116	110	1	0,0
92	110	116	117	111	1	0,0
93	111	117	118	112	1	0,0
94	112	118	119	113	1	0,0
95	113	119	120	114	1	0,0
96	115	121	122	116	1	0,0
97	116	122	123	117	1	0,0
98	117	123	124	118	1	0,0
99	118	124	125	119	1	0,0
100	119	125	126	120	1	0,0
101	121	127	128	122	1	0,0
102	122	128	129	123	1	0,0
103	123	129	130	124	1	0,0
104	124	130	131	125	1	0,0
105	125	131	132	126	1	0,0
106	127	133	134	128	1	0,0
107	128	134	135	129	1	0,0
108	129	135	136	130	1	0,0
109	130	136	137	131	1	0,0
110	131	137	138	132	1	0,0
111	133	139	140	134	1	0,0
112	134	140	141	135	1	0,0
113	135	141	142	136	1	0,0
114	136	142	143	137	1	0,0
115	137	143	144	138	1	0,0

(Continued)

Table 2 (Continued)

116	139	145	146	140	1	0,0
117	140	146	147	141	1	0,0
118	141	147	148	142	1	0,0
119	142	148	149	143	1	0,0
120	143	149	150	144	1	0,0
121	145	151	152	146	1	0,0
122	146	152	153	147	1	0,0
123	147	153	154	148	1	0,0
124	148	154	155	149	1	0,0
125	149	155	156	150	1	0,0
126	151	157	158	152	1	0,0
127	152	158	159	153	1	0,0
128	153	159	160	154	1	0,0
129	154	160	161	155	1	0,0
130	155	161	162	156	1	0,0
131	157	163	164	158	1	0,0
132	158	164	165	159	1	0,0
133	159	165	166	160	1	0,0
134	160	166	167	161	1	0,0
135	161	167	168	162	1	0,0
136	163	169	170	164	1	0,0
137	164	170	171	165	1	0,0
138	165	171	172	166	1	0,0
139	166	172	173	167	1	0,0
140	167	173	174	168	1	0,0
141	169	175	176	170	1	0,0
142	170	176	177	171	1	0,0
143	171	177	178	172	1	0,0
144	172	178	179	173	1	0,0
145	173	179	180	174	1	0,0
146	175	181	182	176	1	0,0
147	176	182	183	177	1	0,0
148	177	183	184	178	1	0,0
149	178	184	185	179	1	0,0
150	179	185	186	180	1	0,0
151	181	187	188	182	1	0,0
152	182	188	189	183	1	0,0
153	183	189	190	184	1	0,0
154	184	190	191	185	1	0,0
155	185	191	192	186	1	0,0
156	187	193	194	188	1	0,0
157	188	194	195	189	1	0,0
158	189	195	196	190	1	0,0
159	190	196	197	191	1	0,0
160	191	197	198	192	1	0,0
161	193	199	200	194	1	0,0
162	194	200	201	195	1	0,0
163	195	201	202	196	1	0,0
164	196	202	203	197	1	0,0
165	197	203	204	198	1	0,0
166	199	205	206	200	1	0,0
167	200	206	207	201	1	0,0
168	201	207	208	202	1	0,0
169	202	208	209	203	1	0,0
170	203	209	210	204	1	0,0
171	205	211	212	206	1	0,0
172	206	212	213	207	1	0,0
173	207	213	214	208	1	0,0
174	208	214	215	209	1	0,0
175	209	215	216	210	1	0,0
176	211	217	218	212	1	0,0
177	212	218	219	213	1	0,0
178	213	219	220	214	1	0,0

(Continued)

Table 2 (Continued)

179	214	220	221	215	1	0,0
180	215	221	222	216	1	0,0
181	217	223	224	218	1	0,0
182	218	224	225	219	1	0,0
183	219	225	226	220	1	0,0
184	220	226	227	221	1	0,0
185	221	227	228	222	1	0,0
186	223	229	230	224	1	0,0
187	224	230	231	225	1	0,0
188	225	231	232	226	1	0,0
189	226	232	233	227	1	0,0
190	227	233	234	228	1	0,0
191	229	235	236	230	1	0,0
192	230	236	237	231	1	0,0
193	231	237	238	232	1	0,0
194	232	238	239	233	1	0,0
195	233	239	240	234	1	0,0
196	235	241	242	236	1	0,0
197	236	242	243	237	1	0,0
198	237	243	244	238	1	0,0
199	238	244	245	239	1	0,0
200	239	245	246	240	1	0,0
201	241	247	248	242	1	0,0
202	242	248	249	243	1	0,0
203	243	249	250	244	1	0,0
204	244	250	251	245	1	0,0
205	245	251	252	246	1	0,0
206	247	253	254	248	1	0,0
207	248	254	255	249	1	0,0
208	249	255	256	250	1	0,0
209	250	256	257	251	1	0,0
210	251	257	258	252	1	0,0
211	253	259	260	254	1	0,0
212	254	260	261	255	1	0,0
213	255	261	262	256	1	0,0
214	256	262	263	257	1	0,0
215	257	263	264	258	1	0,0
216	259	265	266	260	1	0,0
217	260	266	267	261	1	0,0
218	261	267	268	262	1	0,0
219	262	268	269	263	1	0,0
220	263	269	270	264	1	0,0
221	265	271	272	266	1	0,0
222	266	272	273	267	1	0,0
223	267	273	274	268	1	0,0
224	268	274	275	269	1	0,0
225	269	275	276	270	1	0,0
226	271	277	278	272	1	0,0
227	272	278	279	273	1	0,0
228	273	279	280	274	1	0,0
229	274	280	281	275	1	0,0
230	275	281	282	276	1	0,0
231	277	283	284	278	1	0,0
232	278	284	285	279	1	0,0
233	279	285	286	280	1	0,0
234	280	286	287	281	1	0,0
235	281	287	288	282	1	0,0
236	283	289	290	284	1	0,0
237	284	290	291	285	1	0,0
238	285	291	292	286	1	0,0
239	286	292	293	287	1	0,0

(Continued)

Table 2 (Continued)

```
242        290     296     297     291        1        0,0
243        291     297     298     292        1        0,0
244        292     298     299     293        1        0,0
245        293     299     300     294        1        0,0
246        295     301     302     296        1        0,0
247        296     302     303     297        1        0,0
248        297     303     304     298        1        0,0
249        298     304     305     299        1        0,0
250        299     305     306     300        1        0,0



                   ----    TIME =     0,000 ----



                        NODAL HEADS AND FLOWS


                                  PERCENTAGE OF
   NODE              HEAD        AVAILABLE HEAD        FLOW

     1           -,1000E+02          0.0 %          -,1448E+01
     2           -,1000E+02          0,0 %          -,2897E+01
     3           -,1000E+02          0,0 %          -,2897E+01
     4           -,1000E+02          0.0 %          -,2897E+01
     5           -,1000E+02          0.0 %          -,2897E+01
     6           -,1000E+02          0,0 %          -,1448E+01
     7           -,9800E+01          2,0 %
     8           -,9800E+01          2,0 %
     9           -,9800E+01          2,0 %
    10           -,9800E+01          2,0 %
    11           -,9800E+01          2,0 %
    12           -,9800E+01          2,0 %
    13           -,9600E+01          4,0 %
    14           -,9600E+01          4,0 %
    15           -,9600E+01          4,0 %
    16           -,9600E+01          4,0 %
    17           -,9600E+01          4,0 %
    18           -,9600E+01          4,0 %
    19           -,9400E+01          6,0 %
    20           -,9400E+01          6,0 %
    21           -,9400E+01          6,0 %
    22           -,9400E+01          6,0 %
    23           -,9400E+01          6,0 %
    24           -,9400E+01          6,0 %
    25           -,9200E+01          8,0 %
    26           -,9200E+01          8.0 %
    27           -.9200E+01          8,0 %
    28           -,9200E+01          8,0 %
    29           -,9200E+01          8,0 %
    30           -,9200E+01          8,0 %
    31           -,9000E+01         10,0 %
    32           -,9000E+01         10,0 %
    33           -,9000E+01         10,0 %
    34           -,9000E+01         10,0 %
    35           -,9000E+01         10,0 %
    36           -,9000E+01         10,0 %
    37           -,8799E+01         12.0 %
    38           -,8799E+01         12.0 %
```

(Continued)

Table 2 (Continued)

39	-,8799E+01	12.0 %
40	-,8799E+01	12.0 %
41	-,8799E+01	12.0 %
42	-,8799E+01	12.0 %
43	-,8599E+01	14.0 %
44	-,8599E+01	14.0 %
45	-,8599E+01	14.0 %
46	-,8599E+01	14.0 %
47	-,8599E+01	14.0 %
48	-,8599E+01	14.0 %
49	-,8399E+01	16.0 %
50	-,8399E+01	16.0 %
51	-,8399E+01	16.0 %
52	-,8399E+01	16.0 %
53	-,8399E+01	16.0 %
54	-,8399E+01	16.0 %
55	-,8199E+01	18.0 %
56	-,8199E+01	18.0 %
57	-,8199E+01	18.0 %
58	-,8199E+01	18.0 %
59	-,8199E+01	18.0 %
60	-,8199E+01	18.0 %
61	-,7999E+01	20.0 %
62	-,7999E+01	20.0 %
63	-,7999E+01	20.0 %
64	-,7999E+01	20.0 %
65	-,7999E+01	20.0 %
66	-,7999E+01	20.0 %
67	-,7799E+01	22.0 %
68	-,7799E+01	22.0 %
69	-,7799E+01	22.0 %
70	-,7799E+01	22.0 %
71	-,7799E+01	22.0 %
72	-,7799E+01	22.0 %
73	-,7599E+01	24.0 %
74	-,7599E+01	24.0 %
75	-,7599E+01	24.0 %
76	-,7599E+01	24.0 %
77	-,7599E+01	24.0 %
78	-,7599E+01	24.0 %
79	-,7399E+01	26.0 %
80	-,7399E+01	26.0 %
81	-,7399E+01	26.0 %
82	-,7399E+01	26.0 %
83	-,7399E+01	26.0 %
84	-,7399E+01	26.0 %
85	-,7199E+01	28.0 %
86	-,7199E+01	28.0 %
87	-,7199E+01	28.0 %
88	-,7199E+01	28.0 %
89	-,7199E+01	28.0 %
90	-,7199E+01	28.0 %
91	-,6999E+01	30.0 %
92	-,6999E+01	30.0 %
93	-,6999E+01	30.0 %
94	-,6999E+01	30.0 %
95	-,6999E+01	30.0 %
96	-,6999E+01	30.0 %
97	-,6799E+01	32.0 %
98	-,6799E+01	32.0 %
99	-,6799E+01	32.0 %
100	-,6799E+01	32.0 %
101	-,6799E+01	32.0 %

(Continued)

Table 2 (Continued)

102	-,6799E+01	32,0 %
103	-,6598E+01	34,0 %
104	-,6598E+01	34,0 %
105	-,6598E+01	34,0 %
106	-,6598E+01	34,0 %
107	-,6598E+01	34.0 %
108	-,6598E+01	34,0 %
109	-,6398E+01	36.0 %
110	-,6398E+01	36,0 %
111	-,6398E+01	36,0 %
112	-,6398E+01	36,0 %
113	-,6398E+01	36.0 %
114	-,6398E+01	36,0 %
115	-,6198E+01	38,0 %
116	-.6198E+01	38,0 %
117	-.6198E+01	38,0 %
118	-,6198E+01	38,0 %
119	-,6198E+01	38,0 %
120	-,6198E+01	38,0 %
121	-,5998E+01	40,0 %
122	-,5998E+01	40,0 %
123	-,5998E+01	40,0 %
124	-,5998E+01	40.0 %
125	-,5998E+01	40,0 %
126	-,5998E+01	40,0 %
127	-,5798E+01	42,0 %
128	-,5798E+01	42,0 %
129	-,5798E+01	42,0 %
130	-,5798E+01	42,0 %
131	-,5798E+01	42,0 %
132	-,5798E+01	42,0 %
133	-,5598E+01	44,0 %
134	-,5598E+01	44,0 %
135	-,5598E+01	44,0 %
136	-,5598E+01	44.0 %
137	-,5598E+01	44,0 %
138	-,5598E+01	44,0 %
139	-,5398E+01	46,0 %
140	-,5398E+01	46.0 %
141	-,5398E+01	46.0 %
142	-,5398E+01	46.0 %
143	-,5398E+01	46.0 %
144	-,5398E+01	46,0 %
145	-,5198E+01	48,0 %
146	-,5198E+01	48,0 %
147	-,5198E+01	48,0 %
148	-,5198E+01	48,0 %
149	-,5198E+01	48.0 %
150	-,5198E+01	48,0 %
151	-,4998E+01	50,0 %
152	-,4998E+01	50,0 %
153	-,4998E+01	50,0 %
154	-,4998E+01	50,0 %
155	-,4998E+01	50.0 %
156	-.4998E+01	50.0 %
157	-,4798E+01	52,0 %
158	-,4798E+01	52,0 %
159	-.4798E+01	52.0 %
160	-,4798E+01	52,0 %
161	-.4798E+01	52,0 %
162	-,4798E+01	52,0 %
163	-.4598E+01	54.0 %
164	-.4598E+01	54.0 %

(Continued)

Table 2 (Continued)

165	-,4598E+01	54,0 %
166	-,4598E+01	54,0 %
167	-,4598E+01	54,0 %
168	-,4598E+01	54,0 %
169	-,4398E+01	56,0 %
170	-,4398E+01	56,0 %
171	-,4398E+01	56,0 %
172	-,4398E+01	56,0 %
173	-,4398E+01	56,0 %
174	-,4398E+01	56,0 %
175	-,4198E+01	58,0 %
176	-,4198E+01	58,0 %
177	-,4198E+01	58,0 %
178	-,4198E+01	58,0 %
179	-,4198E+01	58,0 %
180	-,4198E+01	58,0 %
181	-,3998E+01	60,0 %
182	-,3998E+01	60,0 %
183	-,3998E+01	60,0 %
184	-,3998E+01	60,0 %
185	-,3998E+01	60,0 %
186	-,3998E+01	60,0 %
187	-,3797E+01	62,0 %
188	-,3797E+01	62,0 %
189	-,3797E+01	62,0 %
190	-,3797E+01	62,0 %
191	-,3797E+01	62,0 %
192	-,3797E+01	62,0 %
193	-,3597E+01	64,0 %
194	-,3597E+01	64,0 %
195	-,3597E+01	64,0 %
196	-,3597E+01	64,0 %
197	-,3597E+01	64,0 %
198	-,3597E+01	64,0 %
199	-,3397E+01	66,0 %
200	-,3397E+01	66,0 %
201	-,3397E+01	66,0 %
202	-,3397E+01	66,0 %
203	-,3397E+01	66,0 %
204	-,3397E+01	66,0 %
205	-,3197E+01	68,0 %
206	-,3197E+01	68,0 %
207	-,3197E+01	68,0 %
208	-,3197E+01	68,0 %
209	-,3197E+01	68,0 %
210	-,3197E+01	68,0 %
211	-,2998E+01	70,0 %
212	-,2998E+01	70,0 %
213	-,2998E+01	70,0 %
214	-,2998E+01	70,0 %
215	-,2998E+01	70,0 %
216	-,2998E+01	70,0 %
217	-,2798E+01	72,0 %
218	-,2798E+01	72,0 %
219	-,2798E+01	72,0 %
220	-,2798E+01	72,0 %
221	-,2798E+01	72,0 %
222	-,2798E+01	72,0 %
223	-,2598E+01	74,0 %
224	-,2598E+01	74,0 %
225	-,2598E+01	74,0 %
226	-,2598E+01	74,0 %
227	-,2598E+01	74,0 %

(Continued)

Table 2 (Continued)

228	-,2598E+01	74,0 %
229	-,2398E+01	76.0 %
230	-,2398E+01	76.0 %
231	-,2398E+01	76.0 %
232	-,2398E+01	76,0 %
233	-,2398E+01	76,0 %
234	-,2398E+01	76,0 %
235	-,2198E+01	78,0 %
236	-.2198E+01	78.0 %
237	-,2198E+01	78,0 %
238	-,2198E+01	78.0 %
239	-,2198E+01	78,0 %
240	-,2198E+01	78.0 %
241	-,1998E+01	80,0 %
242	-,1998E+01	80.0 %
243	-,1998E+01	80,0 %
244	-,1998E+01	80.0 %
245	-,1998E+01	80.0 %
246	-,1998E+01	80.0 %
247	-,1798E+01	82.0 %
248	-,1798E+01	82.0 %
249	-,1798E+01	82.0 %
250	-,1798E+01	82,0 %
251	-,1798E+01	82.0 %
252	-,1798E+01	82.0 %
253	-.1598E+01	84.0 %
254	-,1598E+01	84.0 %
255	-,1598E+01	84.0 %
256	-,1598E+01	84.0 %
257	-,1598E+01	84,0 %
258	-,1598E+01	84.0 %
259	-,1399E+01	86,0 %
260	-,1399E+01	86.0 %
261	-.1399E+01	86.0 %
262	-,1399E+01	86.0 %
263	-,1399E+01	86.0 %
264	-,1399E+01	86.0 %
265	-,1198E+01	88,0 %
266	-,1198E+01	88.0 %
267	-.1198E+01	88.0 %
268	-,1198E+01	88,0 %
269	-.1198E+01	88.0 %
270	-,1198E+01	88.0 %
271	-,9989E+00	90.0 %
272	-,9989E+00	90.0 %
273	-,9989E+00	90,0 %
274	-,9989E+00	90.0 %
275	-.9989E+00	90.0 %
276	-,9989E+00	90.0 %
277	-,7991E+00	92.0 %
278	-.7991E+00	92.0 %
279	-,7991E+00	92.0 %
280	-,7991E+00	92.0 %
281	-.7991E+00	92,0 %
282	-,7991E+00	92,0 %
283	-,5993E+00	94.0 %
284	-.5993E+00	94.0 %
285	-,5993E+00	94,0 %
286	-,5993E+00	94.0 %
287	-,5993E+00	94,0 %
288	-,5993E+00	94,0 %
289	-,3996E+00	96.0 %
290	-.3996E+00	96,0 %

(Continued)

Table 2 (Continued)

```
291          -.3996E+00        96.0 %
292          -.3996E+00        96.0 %
293          -.3996E+00        96.0 %
294          -.3996E+00        96.0 %
295          -.1998E+00        98.0 %
296          -.1998E+00        98.0 %
297          -.1998E+00        98.0 %
298          -.1998E+00        98.0 %
299          -.1998E+00        98.0 %
300          -.1998E+00        98.0 %
301          0.0000E+00       100.0 %          0.1448E+01
302          0.0000E+00       100.0 %          0.2897E+01
303          0.0000E+00       100.0 %          0.2897E+01
304          0.0000E+00       100.0 %          0.2897E+01
305          0.0000E+00       100.0 %          0.2897E+01
306          0.0000E+00       100.0 %          0.1448E+01


                          ELEMENT FLOWRATES


ELMT      V1          V2       P-AXIS ANG     RES V         DIR OF V

  1   -.135E+00   -.163E-10   0.000E+00   0.135E+00     -.180E+03
  2   -.135E+00   0.140E-10   0.000E+00   0.135E+00     0.180E+03
  3   -.135E+00   -.256E-10   0.000E+00   0.135E+00     -.180E+03
  4   -.135E+00   0.279E-10   0.000E+00   0.135E+00     0.180E+03
  5   -.135E+00   -.303E-10   0.000E+00   0.135E+00     -.180E+03
  6   -.117E+00   -.512E-10   0.000E+00   0.117E+00     -.180E+03
  7   -.117E+00   0.442E-10   0.000E+00   0.117E+00     0.180E+03
  8   -.117E+00   -.792E-10   0.000E+00   0.117E+00     -.180E+03
  9   -.117E+00   0.931E-10   0.000E+00   0.117E+00     0.180E+03
 10   -.117E+00   -.100E-09   0.000E+00   0.117E+00     -.180E+03
 11   -.102E+00   -.954E-10   0.000E+00   0.102E+00     -.180E+03
 12   -.102E+00   0.769E-10   0.000E+00   0.102E+00     0.180E+03
 13   -.102E+00   -.133E-09   0.000E+00   0.102E+00     -.180E+03
 14   -.102E+00   0.158E-09   0.000E+00   0.102E+00     0.180E+03
 15   -.102E+00   -.182E-09   0.000E+00   0.102E+00     -.180E+03
 16   -.892E-01   -.151E-09   0.000E+00   0.892E-01     -.180E+03
 17   -.892E-01   0.121E-09   0.000E+00   0.892E-01     0.180E+03
 18   -.892E-01   -.175E-09   0.000E+00   0.892E-01     -.180E+03
 19   -.892E-01   0.212E-09   0.000E+00   0.892E-01     0.180E+03
 20   -.892E-01   -.244E-09   0.000E+00   0.892E-01     -.180E+03
 21   -.777E-01   -.191E-09   0.000E+00   0.777E-01     -.180E+03
 22   -.777E-01   0.154E-09   0.000E+00   0.777E-01     0.180E+03
 23   -.777E-01   -.198E-09   0.000E+00   0.777E-01     -.180E+03
 24   -.777E-01   0.242E-09   0.000E+00   0.777E-01     0.180E+03
 25   -.777E-01   -.275E-09   0.000E+00   0.777E-01     -.180E+03
 26   -.677E-01   -.219E-09   0.000E+00   0.677E-01     -.180E+03
 27   -.677E-01   0.177E-09   0.000E+00   0.677E-01     0.180E+03
 28   -.677E-01   -.214E-09   0.000E+00   0.677E-01     -.180E+03
 29   -.677E-01   0.263E-09   0.000E+00   0.677E-01     0.180E+03
 30   -.677E-01   -.296E-09   0.000E+00   0.677E-01     -.180E+03
 31   -.590E-01   -.244E-09   0.000E+00   0.590E-01     -.180E+03
 32   -.590E-01   0.200E-09   0.000E+00   0.590E-01     0.180E+03
 33   -.590E-01   -.231E-09   0.000E+00   0.590E-01     -.180E+03
 34   -.590E-01   0.268E-09   0.000E+00   0.590E-01     0.180E+03
 35   -.590E-01   -.298E-09   0.000E+00   0.590E-01     -.180E+03
 36   -.513E-01   -.258E-09   0.000E+00   0.513E-01     -.180E+03
 37   -.513E-01   0.214E-09   0.000E+00   0.513E-01     0.180E+03
 38   -.513E-01   -.233E-09   0.000E+00   0.513E-01     -.180E+03
 39   -.513E-01   0.268E-09   0.000E+00   0.513E-01     0.180E+03
 40   -.513E-01   -.296E-09   0.000E+00   0.513E-01     -.180E+03
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(Continued)

Table 2 (Continued)

41	-.447E-01	-.258E-09	0.000E+00	0.447E-01	-.180E+03
42	-.447E-01	0.212E-09	0.000E+00	0.447E-01	0.180E+03
43	-.447E-01	-.219E-09	0.000E+00	0.447E-01	-.180E+03
44	-.447E-01	0.256E-09	0.000E+00	0.447E-01	0.180E+03
45	-.447E-01	-.293E-09	0.000E+00	0.447E-01	-.180E+03
46	-.390E-01	-.247E-09	0.000E+00	0.390E-01	-.180E+03
47	-.390E-01	0.205E-09	0.000E+00	0.390E-01	0.180E+03
48	-.390E-01	-.196E-09	0.000E+00	0.390E-01	-.180E+03
49	-.390E-01	0.238E-09	0.000E+00	0.390E-01	0.180E+03
50	-.390E-01	-.286E-09	0.000E+00	0.390E-01	-.180E+03
51	-.339E-01	-.230E-09	0.000E+00	0.339E-01	-.180E+03
52	-.339E-01	0.189E-09	0.000E+00	0.339E-01	0.180E+03
53	-.339E-01	-.172E-09	0.000E+00	0.339E-01	-.180E+03
54	-.339E-01	0.214E-09	0.000E+00	0.339E-01	0.180E+03
55	-.339E-01	-.270E-09	0.000E+00	0.339E-01	-.180E+03
56	-.295E-01	-.223E-09	0.000E+00	0.295E-01	-.180E+03
57	-.295E-01	0.172E-09	0.000E+00	0.295E-01	0.180E+03
58	-.295E-01	-.133E-09	0.000E+00	0.295E-01	-.180E+03
59	-.295E-01	0.182E-09	0.000E+00	0.295E-01	0.180E+03
60	-.295E-01	-.254E-09	0.000E+00	0.295E-01	-.180E+03
61	-.257E-01	-.205E-09	0.000E+00	0.257E-01	-.180E+03
62	-.257E-01	0.154E-09	0.000E+00	0.257E-01	0.180E+03
63	-.257E-01	-.978E-10	0.000E+00	0.257E-01	-.180E+03
64	-.257E-01	0.154E-09	0.000E+00	0.257E-01	0.180E+03
65	-.257E-01	-.237E-09	0.000E+00	0.257E-01	-.180E+03
66	-.224E-01	-.177E-09	0.000E+00	0.224E-01	-.180E+03
67	-.224E-01	0.133E-09	0.000E+00	0.224E-01	0.180E+03
68	-.224E-01	-.652E-10	0.000E+00	0.224E-01	-.180E+03
69	-.224E-01	0.114E-09	0.000E+00	0.224E-01	0.180E+03
70	-.224E-01	-.210E-09	0.000E+00	0.224E-01	-.180E+03
71	-.195E-01	-.149E-09	0.000E+00	0.195E-01	-.180E+03
72	-.195E-01	0.111E-09	0.000E+00	0.195E-01	0.180E+03
73	-.195E-01	-.279E-10	0.000E+00	0.195E-01	-.180E+03
74	-.195E-01	0.652E-10	0.000E+00	0.195E-01	0.180E+03
75	-.195E-01	-.168E-09	0.000E+00	0.195E-01	-.180E+03
76	-.170E-01	-.109E-09	0.000E+00	0.170E-01	-.180E+03
77	-.170E-01	0.815E-10	0.000E+00	0.170E-01	0.180E+03
78	-.170E-01	-.230E-11	0.000E+00	0.170E-01	-.180E+03
79	-.170E-01	0.187E-10	0.000E+00	0.170E-01	0.180E+03
80	-.170E-01	-.130E-09	0.000E+00	0.170E-01	-.180E+03
81	-.148E-01	-.722E-10	0.000E+00	0.148E-01	-.180E+03
82	-.148E-01	0.489E-10	0.000E+00	0.148E-01	0.180E+03
83	-.148E-01	0.210E-10	0.000E+00	0.148E-01	0.180E+03
84	-.148E-01	-.186E-10	0.000E+00	0.148E-01	-.180E+03
85	-.148E-01	-.104E-09	0.000E+00	0.148E-01	-.180E+03
86	-.129E-01	-.559E-10	0.000E+00	0.129E-01	-.180E+03
87	-.129E-01	0.326E-10	0.000E+00	0.129E-01	0.180E+03
88	-.129E-01	0.373E-10	0.000E+00	0.129E-01	0.180E+03
89	-.129E-01	-.442E-10	0.000E+00	0.129E-01	-.180E+03
90	-.129E-01	-.954E-10	0.000E+00	0.129E-01	-.180E+03
91	-.112E-01	-.559E-10	0.000E+00	0.112E-01	-.180E+03
92	-.112E-01	0.303E-10	0.000E+00	0.112E-01	0.180E+03
93	-.112E-01	0.349E-10	0.000E+00	0.112E-01	0.180E+03
94	-.112E-01	-.675E-10	0.000E+00	0.112E-01	-.180E+03
95	-.112E-01	-.815E-10	0.000E+00	0.112E-01	-.180E+03
96	-.978E-02	-.582E-10	0.000E+00	0.978E-02	-.180E+03
97	-.978E-02	0.256E-10	0.000E+00	0.978E-02	0.180E+03
98	-.978E-02	0.279E-10	0.000E+00	0.978E-02	0.180E+03
99	-.978E-02	-.745E-10	0.000E+00	0.978E-02	-.180E+03
100	-.978E-02	-.652E-10	0.000E+00	0.978E-02	-.180E+03
101	-.852E-02	-.675E-10	0.000E+00	0.852E-02	-.180E+03
102	-.852E-02	0.210E-10	0.000E+00	0.852E-02	0.180E+03
103	-.852E-02	0.187E-10	0.000E+00	0.852E-02	0.180E+03
104	-.852E-02	-.675E-10	0.000E+00	0.852E-02	-.180E+03

(Continued)

Table 2 (Continued)

105	-.852E-02	-.628E-10	0.000E+00	0.852E-02	-.180E+03
106	-.742E-02	-.792E-10	0.000E+00	0.742E-02	-.180E+03
107	-.742E-02	0.256E-10	0.000E+00	0.742E-02	0.180E+03
108	-.742E-02	0.698E-11	0.000E+00	0.742E-02	0.180E+03
109	-.742E-02	-.605E-10	0.000E+00	0.742E-02	-.180E+03
110	-.742E-02	-.559E-10	0.000E+00	0.742E-02	-.180E+03
111	-.646E-02	-.768E-10	0.000E+00	0.646E-02	-.180E+03
112	-.646E-02	0.186E-10	0.000E+00	0.646E-02	0.180E+03
113	-.646E-02	0.468E-11	0.000E+00	0.646E-02	0.180E+03
114	-.646E-02	-.512E-10	0.000E+00	0.646E-02	-.180E+03
115	-.646E-02	-.535E-10	0.000E+00	0.646E-02	-.180E+03
116	-.563E-02	-.582E-10	0.000E+00	0.563E-02	-.180E+03
117	-.563E-02	0.466E-11	0.000E+00	0.563E-02	0.180E+03
118	-.563E-02	0.466E-11	0.000E+00	0.563E-02	0.180E+03
119	-.563E-02	-.466E-10	0.000E+00	0.563E-02	-.180E+03
120	-.563E-02	-.512E-10	0.000E+00	0.563E-02	-.180E+03
121	-.490E-02	-.396E-10	0.000E+00	0.490E-02	-.180E+03
122	-.490E-02	-.466E-11	0.000E+00	0.490E-02	-.180E+03
123	-.490E-02	-.233E-11	0.000E+00	0.490E-02	-.180E+03
124	-.490E-02	-.419E-10	0.000E+00	0.490E-02	-.180E+03
125	-.490E-02	-.489E-10	0.000E+00	0.490E-02	-.180E+03
126	-.427E-02	-.233E-10	0.000E+00	0.427E-02	-.180E+03
127	-.427E-02	-.697E-11	0.000E+00	0.427E-02	-.180E+03
128	-.427E-02	-.116E-10	0.000E+00	0.427E-02	-.180E+03
129	-.427E-02	-.349E-10	0.000E+00	0.427E-02	-.180E+03
130	-.427E-02	-.442E-10	0.000E+00	0.427E-02	-.180E+03
131	-.372E-02	-.210E-10	0.000E+00	0.372E-02	-.180E+03
132	-.372E-02	-.931E-11	0.000E+00	0.372E-02	-.180E+03
133	-.372E-02	-.931E-11	0.000E+00	0.372E-02	-.180E+03
134	-.372E-02	-.349E-10	0.000E+00	0.372E-02	-.180E+03
135	-.372E-02	-.279E-10	0.000E+00	0.372E-02	-.180E+03
136	-.324E-02	-.140E-10	0.000E+00	0.324E-02	-.180E+03
137	-.324E-02	-.929E-11	0.000E+00	0.324E-02	-.180E+03
138	-.324E-02	-.140E-10	0.000E+00	0.324E-02	-.180E+03
139	-.324E-02	-.279E-10	0.000E+00	0.324E-02	-.180E+03
140	-.324E-02	-.209E-10	0.000E+00	0.324E-02	-.180E+03
141	-.282E-02	-.116E-10	0.000E+00	0.282E-02	-.180E+03
142	-.282E-02	-.186E-10	0.000E+00	0.282E-02	-.180E+03
143	-.282E-02	-.163E-10	0.000E+00	0.282E-02	-.180E+03
144	-.282E-02	-.233E-10	0.000E+00	0.282E-02	-.180E+03
145	-.282E-02	-.140E-10	0.000E+00	0.282E-02	-.180E+03
146	-.246E-02	-.697E-11	0.000E+00	0.246E-02	-.180E+03
147	-.246E-02	-.233E-10	0.000E+00	0.246E-02	-.180E+03
148	-.246E-02	-.163E-10	0.000E+00	0.246E-02	-.180E+03
149	-.246E-02	-.209E-10	0.000E+00	0.246E-02	-.180E+03
150	-.246E-02	-.231E-11	0.000E+00	0.246E-02	-.180E+03
151	-.214E-02	-.696E-11	0.000E+00	0.214E-02	-.180E+03
152	-.214E-02	-.279E-10	0.000E+00	0.214E-02	-.180E+03
153	-.214E-02	-.139E-10	0.000E+00	0.214E-02	-.180E+03
154	-.214E-02	-.463E-11	0.000E+00	0.214E-02	-.180E+03
155	-.214E-02	-.463E-11	0.000E+00	0.214E-02	-.180E+03
156	-.186E-02	-.116E-10	0.000E+00	0.186E-02	-.180E+03
157	-.186E-02	-.233E-10	0.000E+00	0.186E-02	-.180E+03
158	-.186E-02	-.696E-11	0.000E+00	0.186E-02	-.180E+03
159	-.186E-02	-.231E-11	0.000E+00	0.186E-02	-.180E+03
160	-.186E-02	-.929E-11	0.000E+00	0.186E-02	-.180E+03
161	-.162E-02	-.140E-10	0.000E+00	0.162E-02	-.180E+03
162	-.162E-02	-.931E-11	0.000E+00	0.162E-02	-.180E+03
163	-.162E-02	-.466E-11	0.000E+00	0.162E-02	-.180E+03
164	-.162E-02	-.233E-11	0.000E+00	0.162E-02	-.180E+03
165	-.162E-02	0.000E+00	0.000E+00	0.162E-02	-.180E+03
166	-.141E-02	-.931E-11	0.000E+00	0.141E-02	-.180E+03
167	-.141E-02	-.466E-11	0.000E+00	0.141E-02	-.180E+03

(Continued)

Table 2 (Continued)

168	-.141E-02	0.000E+00	0.000E+00	0.141E-02	-.180E+03
169	-.141E-02	-.233E-11	0.000E+00	0.141E-02	-.180E+03
170	-.141E-02	0.000E+00	0.000E+00	0.141E-02	-.180E+03
171	-.123E-02	-.140E-10	0.000E+00	0.123E-02	-.180E+03
172	-.123E-02	-.466E-11	0.000E+00	0.123E-02	-.180E+03
173	-.123E-02	0.233E-11	0.000E+00	0.123E-02	0.180E+03
174	-.123E-02	-.466E-11	0.000E+00	0.123E-02	-.180E+03
175	-.123E-02	0.233E-11	0.000E+00	0.123E-02	0.180E+03
176	-.107E-02	-.139E-10	0.000E+00	0.107E-02	-.180E+03
177	-.107E-02	-.462E-11	0.000E+00	0.107E-02	-.180E+03
178	-.107E-02	-.229E-11	0.000E+00	0.107E-02	-.180E+03
179	-.107E-02	0.374E-13	0.000E+00	0.107E-02	0.180E+03
180	-.107E-02	0.469E-11	0.000E+00	0.107E-02	0.180E+03
181	-.934E-03	-.698E-11	0.000E+00	0.934E-03	-.180E+03
182	-.934E-03	-.698E-11	0.000E+00	0.934E-03	-.180E+03
183	-.934E-03	-.233E-11	0.000E+00	0.934E-03	-.180E+03
184	-.934E-03	0.233E-11	0.000E+00	0.934E-03	0.180E+03
185	-.934E-03	0.233E-11	0.000E+00	0.934E-03	0.180E+03
186	-.813E-03	-.698E-11	0.000E+00	0.813E-03	-.180E+03
187	-.813E-03	-.698E-11	0.000E+00	0.813E-03	-.180E+03
188	-.813E-03	0.466E-11	0.000E+00	0.813E-03	0.180E+03
189	-.813E-03	0.233E-11	0.000E+00	0.813E-03	0.180E+03
190	-.813E-03	0.000E+00	0.000E+00	0.813E-03	-.180E+03
191	-.708E-03	-.697E-11	0.000E+00	0.708E-03	-.180E+03
192	-.708E-03	-.697E-11	0.000E+00	0.708E-03	-.180E+03
193	-.708E-03	0.165E-13	0.000E+00	0.708E-03	0.180E+03
194	-.708E-03	0.165E-13	0.000E+00	0.708E-03	0.180E+03
195	-.708E-03	0.467E-11	0.000E+00	0.708E-03	0.180E+03
196	-.617E-03	-.697E-11	0.000E+00	0.617E-03	-.180E+03
197	-.617E-03	0.144E-13	0.000E+00	0.617E-03	0.180E+03
198	-.617E-03	-.464E-11	0.000E+00	0.617E-03	-.180E+03
199	-.617E-03	0.234E-11	0.000E+00	0.617E-03	0.180E+03
200	-.617E-03	-.464E-11	0.000E+00	0.617E-03	-.180E+03
201	-.537E-03	-.929E-11	0.000E+00	0.537E-03	-.180E+03
202	-.537E-03	0.468E-11	0.000E+00	0.537E-03	0.180E+03
203	-.537E-03	0.468E-11	0.000E+00	0.537E-03	0.180E+03
204	-.537E-03	0.250E-13	0.000E+00	0.537E-03	0.180E+03
205	-.537E-03	-.929E-11	0.000E+00	0.537E-03	-.180E+03
206	-.468E-03	-.463E-11	0.000E+00	0.468E-03	-.180E+03
207	-.468E-03	0.218E-13	0.000E+00	0.468E-03	0.180E+03
208	-.468E-03	0.701E-11	0.000E+00	0.468E-03	0.180E+03
209	-.468E-03	-.696E-11	0.000E+00	0.468E-03	-.180E+03
210	-.468E-03	-.231E-11	0.000E+00	0.468E-03	-.180E+03
211	-.407E-03	-.116E-10	0.000E+00	0.407E-03	-.180E+03
212	-.407E-03	-.466E-11	0.000E+00	0.407E-03	-.180E+03
213	-.407E-03	0.000E+00	0.000E+00	0.407E-03	-.180E+03
214	-.407E-03	-.233E-11	0.000E+00	0.407E-03	-.180E+03
215	-.407E-03	-.233E-11	0.000E+00	0.407E-03	-.180E+03
216	-.355E-03	-.140E-10	0.000E+00	0.355E-03	-.180E+03
217	-.355E-03	-.233E-11	0.000E+00	0.355E-03	-.180E+03
218	-.355E-03	-.466E-11	0.000E+00	0.355E-03	-.180E+03
219	-.355E-03	-.466E-11	0.000E+00	0.355E-03	-.180E+03
220	-.355E-03	-.466E-11	0.000E+00	0.355E-03	-.180E+03
221	-.309E-03	-.931E-11	0.000E+00	0.309E-03	-.180E+03
222	-.309E-03	-.931E-11	0.000E+00	0.309E-03	-.180E+03
223	-.309E-03	-.466E-11	0.000E+00	0.309E-03	-.180E+03
224	-.309E-03	-.233E-11	0.000E+00	0.309E-03	-.180E+03
225	-.309E-03	-.233E-11	0.000E+00	0.309E-03	-.180E+03
226	-.269E-03	-.116E-10	0.000E+00	0.269E-03	-.180E+03
227	-.269E-03	-.140E-10	0.000E+00	0.269E-03	-.180E+03
228	-.269E-03	0.000E+00	0.000E+00	0.269E-03	-.180E+03
229	-.269E-03	-.233E-11	0.000E+00	0.269E-03	-.180E+03
230	-.269E-03	-.466E-11	0.000E+00	0.269E-03	-.180E+03

(Continued)

Table 2 (Concluded)

231	-.234E-03	-.140E-10	0.000E+00	0.234E-03	-.180E+03
232	-.234E-03	-.466E-11	0.000E+00	0.234E-03	-.180E+03
233	-.234E-03	0.000E+00	0.000E+00	0.234E-03	-.180E+03
234	-.234E-03	-.116E-10	0.000E+00	0.234E-03	-.180E+03
235	-.234E-03	-.116E-10	0.000E+00	0.234E-03	-.180E+03
236	-.204E-03	-.116E-10	0.000E+00	0.204E-03	-.180E+03
237	-.204E-03	0.000E+00	0.000E+00	0.204E-03	-.180E+03
238	-.204E-03	-.466E-11	0.000E+00	0.204E-03	-.180E+03
239	-.204E-03	-.931E-11	0.000E+00	0.204E-03	-.180E+03
240	-.204E-03	-.698E-11	0.000E+00	0.204E-03	-.180E+03
241	-.178E-03	-.931E-11	0.000E+00	0.178E-03	-.180E+03
242	-.178E-03	0.000E+00	0.000E+00	0.178E-03	-.180E+03
243	-.178E-03	-.698E-11	0.000E+00	0.178E-03	-.180E+03
244	-.178E-03	-.466E-11	0.000E+00	0.178E-03	-.180E+03
245	-.178E-03	-.233E-11	0.000E+00	0.178E-03	-.180E+03
246	-.155E-03	-.464E-11	0.000E+00	0.155E-03	-.180E+03
247	-.155E-03	-.464E-11	0.000E+00	0.155E-03	-.180E+03
248	-.155E-03	-.464E-11	0.000E+00	0.155E-03	-.180E+03
249	-.155E-03	0.144E-13	0.000E+00	0.155E-03	0.180E+03
250	-.155E-03	0.144E-13	0.000E+00	0.155E-03	0.180E+03

Table 3

Input for Problem 2

Steady-State Flow to a Well Being Pumped

```
STEADY-STATE FLOW TO A WELL BEING PUMPED
 306  250    1    0     0     1 CONF AXSY        5.00           0.          160.
   1      0.1         0.1        0.3
   1   -1    1.0000    0.0000  -1.44765
   2 1 -1    1.0000   20.0000   -2.8953
   5   -1    1.0000   80.0000   -2.8953
   6   -1    1.0000  100.0000  -1.44765
   7    0    1.1482    0.0000    0.0000
  12    0    1.1482  100.0000    0.0000
  13    0    1.3183    0.0000    0.0000
  18    0    1.3183  100.0000    0.0000
  19    0    1.5136    0.0000    0.0000
  24    0    1.5136  100.0000    0.0000
  25    0    1.7378    0.0000    0.0000
  30    0    1.7378  100.0000    0.0000
  31    0    1.9953    0.0000    0.0000
  36    0    1.9953  100.0000    0.0000
  37    0    2.2909    0.0000    0.0000
  42    0    2.2909  100.0000    0.0000
  43    0    2.6303    0.0000    0.0000
  48    0    2.6303  100.0000    0.0000
  49    0    3.0200    0.0000    0.0000
  54    0    3.0200  100.0000    0.0000
  55    0    3.4674    0.0000    0.0000
  60    0    3.4674  100.0000    0.0000
  61    0    3.9811    0.0000    0.0000
  66    0    3.9811  100.0000    0.0000
  67    0    4.5709    0.0000    0.0000
  72    0    4.5709  100.0000    0.0000
  73    0    5.2481    0.0000    0.0000
  78    0    5.2481  100.0000    0.0000
  79    0    6.0256    0.0000    0.0000
  84    0    6.0256  100.0000    0.0000
  85    0    6.9183    0.0000    0.0000
  90    0    6.9183  100.0000    0.0000
  91    0    7.9433    0.0000    0.0000
  96    0    7.9433  100.0000    0.0000
  97    0    9.1201    0.0000    0.0000
 102    0    9.1201  100.0000    0.0000
 103    0   10.4713    0.0000    0.0000
 108    0   10.4713  100.0000    0.0000
 109    0   12.0226    0.0000    0.0000
 114    0   12.0226  100.0000    0.0000
 115    0   13.8038    0.0000    0.0000
 120    0   13.8038  100.0000    0.0000
 121    0   15.8489    0.0000    0.0000
 126    0   15.8489  100.0000    0.0000
 127    0   18.1970    0.0000    0.0000
 132    0   18.1970  100.0000    0.0000
 133    0   20.8930    0.0000    0.0000
 138    0   20.8930  100.0000    0.0000
 139    0   23.9883    0.0000    0.0000
```

(Continued)

Table 3 (Continued)

144	0	23.9883	100.0000	0.0000
145	0	27.5423	0.0000	0.0000
150	0	27.5423	100.0000	0.0000
151	0	31.6228	0.0000	0.0000
156	0	31.6228	100.0000	0.0000
157	0	36.3078	0.0000	0.0000
162	0	36.3078	100.0000	0.0000
163	0	41.6869	0.0000	0.0000
168	0	41.6869	100.0000	0.0000
169	0	47.8630	0.0000	0.0000
174	0	47.8630	100.0000	0.0000
175	0	54.9541	0.0000	0.0000
180	0	54.9541	100.0000	0.0000
181	0	63.0957	0.0000	0.0000
186	0	63.0957	100.0000	0.0000
187	0	72.4436	0.0000	0.0000
192	0	72.4436	100.0000	0.0000
193	0	83.1764	0.0000	0.0000
198	0	83.1764	100.0000	0.0000
199	0	95.4993	0.0000	0.0000
204	0	95.4993	100.0000	0.0000
205	0	109.6478	0.0000	0.0000
210	0	109.6478	100.0000	0.0000
211	0	125.8925	0.0000	0.0000
216	0	125.8925	100.0000	0.0000
217	0	144.5440	0.0000	0.0000
222	0	144.5440	100.0000	0.0000
223	0	165.9587	0.0000	0.0000
228	0	165.9587	100.0000	0.0000
229	0	190.5461	0.0000	0.0000
234	0	190.5461	100.0000	0.0000
235	0	218.7762	0.0000	0.0000
240	0	218.7762	100.0000	0.0000
241	0	251.1886	0.0000	0.0000
246	0	251.1886	100.0000	0.0000
247	0	288.4032	0.0000	0.0000
252	0	288.4032	100.0000	0.0000
253	0	331.1311	0.0000	0.0000
258	0	331.1311	100.0000	0.0000
259	0	380.1894	0.0000	0.0000
264	0	380.1894	100.0000	0.0000
265	0	436.5158	0.0000	0.0000
270	0	436.5158	100.0000	0.0000
271	0	501.1872	0.0000	0.0000
276	0	501.1872	100.0000	0.0000
277	0	575.4399	0.0000	0.0000
282	0	575.4399	100.0000	0.0000
283	0	660.6934	0.0000	0.0000
288	0	660.6934	100.0000	0.0000
289	0	758.5776	0.0000	0.0000
294	0	758.5776	100.0000	0.0000
295	0	870.9636	0.0000	0.0000

(Continued)

Table 3 (Concluded)

```
300      0   870,9636  100,0000     0,0000
301  1   1  1000,0000    0,0000     0,0000
306      1  1000,0000  100,0000     0,0000
  1      1     7     8     2     1
  6      7    13    14     8     1
 11     13    19    20    14     1
 16     19    25    26    20     1
 21     25    31    32    26     1
 26     31    37    38    32     1
 31     37    43    44    38     1
 36     43    49    50    44     1
 41     49    55    56    50     1
 46     55    61    62    56     1
 51     61    67    68    62     1
 56     67    73    74    68     1
 61     73    79    80    74     1
 66     79    85    86    80     1
 71     85    91    92    86     1
 76     91    97    98    92     1
 81     97   103   104    98     1
 86    103   109   110   104     1
 91    109   115   116   110     1
 96    115   121   122   116     1
101    121   127   128   122     1
106    127   133   134   128     1
111    133   139   140   134     1
116    139   145   146   140     1
121    145   151   152   146     1
126    151   157   158   152     1
131    157   163   164   158     1
136    163   169   170   164     1
141    169   175   176   170     1
146    175   181   182   176     1
151    181   187   188   182     1
156    187   193   194   188     1
161    193   199   200   194     1
166    199   205   206   200     1
171    205   211   212   206     1
176    211   217   218   212     1
181    217   223   224   218     1
186    223   229   230   224     1
191    229   235   236   230     1
196    235   241   242   236     1
201    241   247   248   242     1
206    247   253   254   248     1
211    253   259   260   254     1
216    259   265   266   260     1
221    265   271   272   266     1
226    271   277   278   272     1
231    277   283   284   278     1
236    283   289   290   284     1
241    289   295   296   290     1
246    295   301   302   296     1
250    299   305   306   300     1
```

(3 of 3 sheets)

Table 4

Output for Problem 2

Steady-State Flow to a Well Being Pumped

```
STEADY-STATE FLOW TO A WELL BEING PUMPED


  NUMBER OF NODAL POINTS------306

  NUMBER OF ELEMENTS----------250

  NUMBER OF DIFF. MATERIALS---  1

  NUMBER OF TIME STEPS--------  0

  PRINT INTERVAL--------------  1

  TIME INCREMENT------------       5.000

  INFILTRATION RATE-----------     0.000

  ELEVATION OF DATUM----------   160.000




                              MATERIAL PROPERTIES

                    MAT          K1             K2          STOR

                     1       0.100E+00      0.100E+00       0.300
```

(Continued)

Table 4 (Continued)

```
                    NODE POINT INFORMATION

NODE  BC          X            Y       FLOW-HEAD    BC RATE

  1   -1        1,00         0.00       -1,45       0,0000
  2   -1        1.00        20.00       -2,90       0.0000
  3   -1        1,00        40.00       -2,90       0.0000
  4   -1        1,00        60.00       -2,90       0.0000
  5   -1        1,00        80.00       -2,90       0.0000
  6   -1        1,00       100.00       -1,45       0.0000
  7    0        1,15         0.00        0,00       0,0000
  8    0        1,15        20.00        0,00       0.0000
  9    0        1,15        40.00        0,00       0,0000
 10    0        1,15        60.00        0,00       0,0000
 11    0        1,15        80,00        0,00       0,0000
 12    0        1.15       100,00        0.00       0,0000
 13    0        1,32         0.00        0.00       0,0000
 14    0        1,32        20,00        0,00       0,0000
 15    0        1,32        40.00        0.00       0,0000
 16    0        1,32        60.00        0,00       0,0000
 17    0        1,32        80.00        0,00       0.0000
 18    0        1,32       100,00        0,00       0.0000
 19    0        1,51         0.00        0,00       0.0000
 20    0        1,51        20.00        0,00       0.0000
 21    0        1,51        40.00        0,00       0.0000
 22    0        1,51        60.00        0,00       0.0000
 23    0        1,51        80.00        0,00       0.0000
 24    0        1.51       100.00        0,00       0,0000
 25    0        1,74         0.00        0,00       0.0000
 26    0        1,74        20,00        0,00       0,0000
 27    0        1,74        40.00        0,00       0,0000
 28    0        1,74        60.00        0,00       0,0000
 29    0        1,74        80.00        0,00       0,0000
 30    0        1,74       100.00        0,00       0,0000
 31    0        2,00         0.00        0,00       0,0000
 32    0        2,00        20,00        0,00       0,0000
 33    0        2,00        40.00        0,00       0,0000
 34    0        2,00        60.00        0,00       0.0000
 35    0        2,00        80.00        0,00       0.0000
 36    0        2,00       100.00        0,00       0.0000
 37    0        2,29         0.00        0,00       0,0000
 38    0        2,29        20.00        0,00       0.0000
 39    0        2,29        40.00        0,00       0.0000
 40    0        2,29        60.00        0,00       0.0000
 41    0        2,29        80.00        0,00       0,0000
 42    0        2,29       100.00        0,00       0.0000
 43    0        2,63         0.00        0,00       0,0000
 44    0        2,63        20.00        0,00       0,0000
 45    0        2,63        40.00        0,00       0,0000
 46    0        2,63        60,00        0,00       0.0000
 47    0        2,63        80.00        0,00       0,0000
 48    0        2,63       100.00        0.00       0,0000
 49    0        3,02         0.00        0.00       0,0000
 50    0        3,02        20.00        0,00       0.0000
 51    0        3,02        40.00        0,00       0,0000
 52    0        3,02        60.00        0.00       0.0000
```

(Continued)

Table 4 (Continued)

53	0	3,02	80.00	0,00	0,0000
54	0	3,02	100.00	0.00	0.0000
55	0	3,47	0.00	0,00	0.0000
56	0	3,47	20.00	0,00	0,0000
57	0	3,47	40.00	0,00	0,0000
58	0	3,47	60.00	0,00	0,0000
59	0	3,47	80.00	0,00	0.0000
60	0	3,47	100.00	0,00	0,0000
61	0	3,98	0.00	0,00	0.0000
62	0	3,98	20.00	0,00	0,0000
63	0	3,98	40.00	0,00	0.0000
64	0	3,98	60.00	0,00	0.0000
65	0	3,98	80.00	0,00	0.0000
66	0	3,98	100.00	0,00	0,0000
67	0	4,57	0.00	0,00	0,0000
68	0	4,57	20.00	0,00	0,0000
69	0	4,57	40.00	0,00	0,0000
70	0	4,57	60.00	0,00	0.0000
71	0	4,57	80.00	0,00	0,0000
72	0	4,57	100.00	0,00	0,0000
73	0	5,25	0.00	0,00	0,0000
74	0	5,25	20.00	0,00	0,0000
75	0	5,25	40.00	0,00	0,0000
76	0	5,25	60.00	0,00	0,0000
77	0	5,25	80.00	0,00	0,0000
78	0	5,25	100.00	0,00	0,0000
79	0	6,03	0.00	0,00	0.0000
80	0	6,03	20.00	0,00	0.0000
81	0	6,03	40.00	0,00	0.0000
82	0	6,03	60.00	0,00	0,0000
83	0	6,03	80.00	0,00	0,0000
84	0	6,03	100.00	0,00	0,0000
85	0	6,92	0.00	0,00	0.0000
86	0	6,92	20,00	0,00	0,0000
87	0	6,92	40.00	0,00	0,0000
88	0	6,92	60.00	0,00	0,0000
89	0	6,92	80.00	0,00	0.0000
90	0	6,92	100.00	0,00	0,0000
91	0	7,94	0.00	0,00	0,0000
92	0	7,94	20.00	0,00	0,0000
93	0	7,94	40.00	0,00	0,0000
94	0	7,94	60.00	0,00	0,0000
95	0	7,94	80.00	0,00	0,0000
96	0	7,94	100.00	0,00	0.0000
97	0	9,12	0.00	0,00	0.0000
98	0	9,12	20.00	0,00	0,0000
99	0	9,12	40.00	0,00	0,0000
100	0	9,12	60.00	0,00	0,0000
101	0	9,12	80.00	0,00	0.0000
102	0	9,12	100.00	0,00	0.0000
103	0	10,47	0.00	0,00	0.0000
104	0	10,47	20.00	0,00	0.0000
105	0	10,47	40.00	0,00	0.0000
106	0	10,47	60.00	0,00	0.0000
107	0	10,47	80.00	0,00	0.0000
108	0	10,47	100.00	0,00	0.0000
109	0	12,02	0.00	0.00	0.0000
110	0	12,02	20.00	0,00	0,0000
111	0	12,02	40.00	0,00	0,0000
112	0	12,02	60.00	0,00	0,0000
113	0	12,02	80.00	0,00	0,0000
114	0	12,02	100.00	0,00	0,0000
115	0	13,80	0.00	0,00	0,0000

(Continued)

Table 4 (Continued)

116	0	13,80	20.00	0,00	0,0000
117	0	13,80	40.00	0,00	0,0000
118	0	13,80	60.00	0,00	0,0000
119	0	13,80	80.00	0,00	0,0000
120	0	13,80	100.00	0,00	0,0000
121	0	15,85	0.00	0,00	0,0000
122	0	15,85	20.00	0.00	0,0000
123	0	15,85	40.00	0,00	0,0000
124	0	15,85	60,00	0,00	0,0000
125	0	15,85	80.00	0,00	0,0000
126	0	15,85	100.00	0,00	0,0000
127	0	18,20	0.00	0,00	0,0000
128	0	18,20	20.00	0,00	0,0000
129	0	18,20	40.00	0,00	0.0000
130	0	18,20	60.00	0,00	0,0000
131	0	18,20	80.00	0,00	0.0000
132	0	18,20	100,00	0,00	0,0000
133	0	20,89	0.00	0,00	0,0000
134	0	20,89	20.00	0,00	0,0000
135	0	20.89	40.00	0,00	0,0000
136	0	20,89	60.00	0,00	0,0000
137	0	20,89	80.00	0,00	0,0000
138	0	20,89	100.00	0,00	0.0000
139	0	23,99	0.00	0,00	0,0000
140	0	23,99	20.00	0,00	0.0000
141	0	23,99	40.00	0,00	0.0000
142	0	23.99	60,00	0,00	0.0000
143	0	23,99	80.00	0,00	0.0000
144	0	23,99	100.00	0,00	0,0000
145	0	27,54	0.00	0,00	0,0000
146	0	27,54	20,00	0,00	0,0000
147	0	27,54	40.00	0,00	0.0000
148	0	27,54	60.00	0,00	0.0000
149	0	27,54	80.00	0,00	0,0000
150	0	27,54	100.00	0,00	0,0000
151	0	31,62	0.00	0,00	0,0000
152	0	31,62	20.00	0,00	0,0000
153	0	31,62	40.00	0,00	0,0000
154	0	31.62	60.00	0,00	0.0000
155	0	31.62	80.00	0,00	0.0000
156	0	31.62	100.00	0,00	0.0000
157	0	36.31	0.00	0,00	0,0000
158	0	36,31	20.00	0,00	0,0000
159	0	36,31	40.00	0.00	0,0000
160	0	36,31	60.00	0.00	0,0000
161	0	36,31	80.00	0,00	0,0000
162	0	36,31	100.00	0.00	0.0000
163	0	41,69	0.00	0,00	0,0000
164	0	41,69	20.00	0,00	0.0000
165	0	41,69	40.00	0,00	0.0000
166	0	41,69	60.00	0,00	0.0000
167	0	41,69	80.00	0,00	0.0000
168	0	41,69	100.00	0,00	0.0000
169	0	47,86	0.00	0,00	0.0000
170	0	47,86	20.00	0,00	0.0000
171	0	47,86	40.00	0.00	0,0000
172	0	47,86	60.00	0,00	0,0000
173	0	47,86	80,00	0,00	0.0000
174	0	47,86	100.00	0,00	0.0000
175	0	54,95	0.00	0,00	0.0000
176	0	54,95	20.00	0,00	0,0000
177	0	54,95	40.00	0,00	0,0000
178	0	54,95	60.00	0,00	0.0000

(Continued)

Table 4 (Continued)

179	0	54,95	80.00	0,00	0,0000
180	0	54,95	100.00	0,00	0,0000
181	0	63,10	0.00	0,00	0,0000
182	0	63,10	20.00	0,00	0,0000
183	0	63,10	40.00	0,00	0,0000
184	0	63.10	60.00	0,00	0,0000
185	0	63,10	80.00	0,00	0.0000
186	0	63.10	100.00	0,00	0,0000
187	0	72,44	0.00	0,00	0,0000
188	0	72,44	20.00	0,00	0,0000
189	0	72,44	40.00	0,00	0,0000
190	0	72,44	60.00	0,00	0,0000
191	0	72,44	80.00	0,00	0,0000
192	0	72,44	100.00	0,00	0.0000
193	0	83,18	0.00	0,00	0.0000
194	0	83.18	20.00	0,00	0,0000
195	0	83,18	40.00	0,00	0,0000
196	0	83,18	60.00	0,00	0,0000
197	0	83.18	80.00	0,00	0,0000
198	0	83,18	100.00	0,00	0,0000
199	0	95,50	0.00	0,00	0,0000
200	0	95,50	20.00	0,00	0,0000
201	0	95,50	40.00	0,00	0.0000
202	0	95,50	60.00	0,00	0,0000
203	0	95,50	80.00	0,00	0,0000
204	0	95.50	100.00	0,00	0,0000
205	0	109,65	0.00	0,00	0,0000
206	0	109,65	20.00	0,00	0,0000
207	0	109,65	40.00	0,00	0,0000
208	0	109,65	60.00	0,00	0,0000
209	0	109,65	80.00	0,00	0,0000
210	0	109,65	100.00	0,00	0,0000
211	0	125,89	0.00	0,00	0,0000
212	0	125,89	20.00	0,00	0.0000
213	0	125,89	40.00	0,00	0.0000
214	0	125,89	60.00	0,00	0.0000
215	0	125,89	80.00	0,00	0.0000
216	0	125,89	100.00	0,00	0,0000
217	0	144,54	0.00	0,00	0.0000
218	0	144,54	20.00	0,00	0,0000
219	0	144,54	40.00	0,00	0.0000
220	0	144,54	60.00	0,00	0.0000
221	0	144,54	80.00	0,00	0.0000
222	0	144,54	100.00	0,00	0.0000
223	0	165,96	0.00	0,00	0.0000
224	0	165,96	20.00	0,00	0,0000
225	0	165,96	40.00	0,00	0,0000
226	0	165,96	60.00	0,00	0,0000
227	0	165,96	80.00	0,00	0,0000
228	0	165,96	100.00	0,00	0.0000
229	0	190,55	0.00	0,00	0,0000
230	0	190,55	20.00	0,00	0.0000
231	0	190,55	40.00	0,00	0.0000
232	0	190,55	60.00	0,00	0.0000
233	0	190.55	80.00	0,00	0.0000
234	0	190,55	100.00	0,00	0,0000
235	0	218,78	0.00	0,00	0.0000
236	0	218,78	20.00	0,00	0.0000
237	0	218,78	40.00	0,00	0,0000
238	0	218.78	60.00	0,00	0,0000
239	0	218,78	80.00	0,00	0,0000
240	0	218,78	100.00	0,00	0,0000
241	0	251,19	0.00	0,00	0.0000

(Continued)

Table 4 (Continued)

242	0	251,19	20.00	0,00	0,0000
243	0	251.19	40.00	0,00	0,0000
244	0	251.19	60.00	0.00	0,0000
245	0	251,19	80.00	0,00	0,0000
246	0	251,19	100.00	0,00	0.0000
247	0	288.40	0.00	0,00	0.0000
248	0	288,40	20.00	0,00	0,0000
249	0	288,40	40.00	0,00	0,0000
250	0	288,40	60.00	0,00	0.0000
251	0	288,40	80.00	0,00	0.0000
252	0	288,40	100.00	0,00	0.0000
253	0	331.13	0.00	0,00	0,0000
254	0	331.13	20.00	0,00	0,0000
255	0	331,13	40,00	0,00	0,0000
256	0	331.13	60.00	0,00	0.0000
257	0	331,13	80.00	0,00	0.0000
258	0	331,13	100.00	0,00	0.0000
259	0	380,19	0.00	0,00	0.0000
260	0	380,19	20.00	0,00	0,0000
261	0	380,19	40,00	0,00	0,0000
262	0	380,19	60.00	0,00	0,0000
263	0	380,19	80.00	0,00	0.0000
264	0	380,19	100.00	0.00	0.0000
265	0	436,52	0.00	0,00	0.0000
266	0	436,52	20,00	0,00	0,0000
267	0	436,52	40.00	0,00	0.0000
268	0	436,52	60,00	0,00	0,0000
269	0	436,52	80.00	0,00	0.0000
270	0	436,52	100.00	0,00	0,0000
271	0	501,19	0.00	0,00	0,0000
272	0	501,19	20.00	0,00	0.0000
273	0	501,19	40.00	0,00	0.0000
274	0	501,19	60.00	0,00	0,0000
275	0	501,19	80.00	0,00	0.0000
276	0	501,19	100.00	0,00	0,0000
277	0	575,44	0.00	0,00	0,0000
278	0	575,44	20.00	0,00	0.0000
279	0	575,44	40.00	0,00	0.0000
280	0	575,44	60.00	0,00	0.0000
281	0	575,44	80.00	0,00	0.0000
282	0	575,44	100.00	0,00	0.0000
283	0	660,69	0.00	0,00	0.0000
284	0	660,69	20.00	0,00	0,0000
285	0	660,69	40.00	0,00	0.0000
286	0	660,69	60.00	0,00	0.0000
287	0	660,69	80.00	0,00	0.0000
288	0	660,69	100.00	0,00	0.0000
289	0	758,58	0.00	0,00	0.0000
290	0	758,58	20.00	0,00	0,0000
291	0	758,58	40.00	0,00	0,0000
292	0	758,58	60.00	0,00	0.0000
293	0	758,58	80.00	0,00	0,0000
294	0	758,58	100.00	0,00	0.0000
295	0	870,96	0.00	0,00	0.0000
296	0	870,96	20.00	0,00	0,0000
297	0	870,96	40.00	0,00	0.0000
298	0	870,96	60.00	0.00	0,0000
299	0	870,96	80.00	0,00	0.0000
300	0	870,96	100.00	0,00	0.0000
301	1	1000,00	0.00	0,00	0,0000
302	1	1000,00	20.00	0,00	0,0000
303	1	1000,00	40.00	0,00	0.0000
304	1	1000,00	60.00	0,00	0.0000
305	1	1000,00	80.00	0,00	0,0000
306	1	1000.00	100.00	0,00	0.0000

(Continued)

Table 4 (Continued)

ELEMENT INFORMATION

ELMT	#1	#2	#3	#4	MAT	ANGLE
1	1	7	8	2	1	0,0
2	2	8	9	3	1	0,0
3	3	9	10	4	1	0,0
4	4	10	11	5	1	0,0
5	5	11	12	6	1	0,0
6	7	13	14	8	1	0,0
7	8	14	15	9	1	0,0
8	9	15	16	10	1	0,0
9	10	16	17	11	1	0,0
10	11	17	18	12	1	0,0
11	13	19	20	14	1	0,0
12	14	20	21	15	1	0,0
13	15	21	22	16	1	0,0
14	16	22	23	17	1	0,0
15	17	23	24	18	1	0,0
16	19	25	26	20	1	0,0
17	20	26	27	21	1	0,0
18	21	27	28	22	1	0,0
19	22	28	29	23	1	0,0
20	23	29	30	24	1	0,0
21	25	31	32	26	1	0,0
22	26	32	33	27	1	0,0
23	27	33	34	28	1	0,0
24	28	34	35	29	1	0,0
25	29	35	36	30	1	0,0
26	31	37	38	32	1	0,0
27	32	38	39	33	1	0.0
28	33	39	40	34	1	0,0
29	34	40	41	35	1	0,0
30	35	41	42	36	1	0,0
31	37	43	44	38	1	0,0
32	38	44	45	39	1	0,0
33	39	45	46	40	1	0,0
34	40	46	47	41	1	0,0
35	41	47	48	42	1	0,0
36	43	49	50	44	1	0,0
37	44	50	51	45	1	0,0
38	45	51	52	46	1	0,0
39	46	52	53	47	1	0,0
40	47	53	54	48	1	0,0
41	49	55	56	50	1	0,0
42	50	56	57	51	1	0,0
43	51	57	58	52	1	0,0
44	52	58	59	53	1	0,0
45	53	59	60	54	1	0,0
46	55	61	62	56	1	0,0
47	56	62	63	57	1	0,0
48	57	63	64	58	1	0,0
49	58	64	65	59	1	0,0
50	59	65	66	60	1	0,0
51	61	67	68	62	1	0,0
52	62	68	69	63	1	0,0

(Continued)

Table 4 (Continued)

53	63	69	70	64	1	0,0
54	64	70	71	65	1	0,0
55	65	71	72	66	1	0,0
56	67	73	74	68	1	0,0
57	68	74	75	69	1	0,0
58	69	75	76	70	1	0,0
59	70	76	77	71	1	0,0
60	71	77	78	72	1	0,0
61	73	79	80	74	1	0,0
62	74	80	81	75	1	0,0
63	75	81	82	76	1	0,0
64	76	82	83	77	1	0,0
65	77	83	84	78	1	0,0
66	79	85	86	80	1	0,0
67	80	86	87	81	1	0,0
68	81	87	88	82	1	0,0
69	82	88	89	83	1	0,0
70	83	89	90	84	1	0,0
71	85	91	92	86	1	0,0
72	86	92	93	87	1	0,0
73	87	93	94	88	1	0,0
74	88	94	95	89	1	0,0
75	89	95	96	90	1	0,0
76	91	97	98	92	1	0,0
77	92	98	99	93	1	0,0
78	93	99	100	94	1	0,0
79	94	100	101	95	1	0,0
80	95	101	102	96	1	0,0
81	97	103	104	98	1	0,0
82	98	104	105	99	1	0,0
83	99	105	106	100	1	0,0
84	100	106	107	101	1	0,0
85	101	107	108	102	1	0,0
86	103	109	110	104	1	0,0
87	104	110	111	105	1	0,0
88	105	111	112	106	1	0,0
89	106	112	113	107	1	0,0
90	107	113	114	108	1	0,0
91	109	115	116	110	1	0,0
92	110	116	117	111	1	0,0
93	111	117	118	112	1	0,0
94	112	118	119	113	1	0,0
95	113	119	120	114	1	0,0
96	115	121	122	116	1	0,0
97	116	122	123	117	1	0,0
98	117	123	124	118	1	0,0
99	118	124	125	119	1	0,0
100	119	125	126	120	1	0,0
101	121	127	128	122	1	0,0
102	122	128	129	123	1	0,0
103	123	129	130	124	1	0,0
104	124	130	131	125	1	0,0
105	125	131	132	126	1	0,0
106	127	133	134	128	1	0,0
107	128	134	135	129	1	0,0
108	129	135	136	130	1	0,0
109	130	136	137	131	1	0,0
110	131	137	138	132	1	0,0
111	133	139	140	134	1	0,0
112	134	140	141	135	1	0,0
113	135	141	142	136	1	0,0
114	136	142	143	137	1	0,0
115	137	143	144	138	1	0,0

(Continued)

Table 4 (Continued)

116	139	145	146	140	1	0,0
117	140	146	147	141	1	0,0
118	141	147	148	142	1	0,0
119	142	148	149	143	1	0,0
120	143	149	150	144	1	0,0
121	145	151	152	146	1	0,0
122	146	152	153	147	1	0,0
123	147	153	154	148	1	0,0
124	148	154	155	149	1	0,0
125	149	155	156	150	1	0,0
126	151	157	158	152	1	0,0
127	152	158	159	153	1	0,0
128	153	159	160	154	1	0,0
129	154	160	161	155	1	0,0
130	155	161	162	156	1	0,0
131	157	163	164	158	1	0,0
132	158	164	165	159	1	0,0
133	159	165	166	160	1	0,0
134	160	166	167	161	1	0,0
135	161	167	168	162	1	0,0
136	163	169	170	164	1	0,0
137	164	170	171	165	1	0,0
138	165	171	172	166	1	0,0
139	166	172	173	167	1	0,0
140	167	173	174	168	1	0,0
141	169	175	176	170	1	0,0
142	170	176	177	171	1	0,0
143	171	177	178	172	1	0,0
144	172	178	179	173	1	0,0
145	173	179	180	174	1	0,0
146	175	181	182	176	1	0,0
147	176	182	183	177	1	0,0
148	177	183	184	178	1	0,0
149	178	184	185	179	1	0,0
150	179	185	186	180	1	0,0
151	181	187	188	182	1	0,0
152	182	188	189	183	1	0,0
153	183	189	190	184	1	0,0
154	184	190	191	185	1	0,0
155	185	191	192	186	1	0,0
156	187	193	194	188	1	0,0
157	188	194	195	189	1	0,0
158	189	195	196	190	1	0,0
159	190	196	197	191	1	0,0
160	191	197	198	192	1	0,0
161	193	199	200	194	1	0,0
162	194	200	201	195	1	0,0
163	195	201	202	196	1	0,0
164	196	202	203	197	1	0,0
165	197	203	204	198	1	0,0
166	199	205	206	200	1	0,0
167	200	206	207	201	1	0,0
168	201	207	208	202	1	0,0
169	202	208	209	203	1	0,0
170	203	209	210	204	1	0,0
171	205	211	212	206	1	0,0
172	206	212	213	207	1	0,0
173	207	213	214	208	1	0,0
174	208	214	215	209	1	0.0
175	209	215	216	210	1	0.0
176	211	217	218	212	1	0,0
177	212	218	219	213	1	0,0
178	213	219	220	214	1	0,0

(Continued)

Table 4 (Continued)

179	214	220	221	215	1	0,0
180	215	221	222	216	1	0,0
181	217	223	224	218	1	0,0
182	218	224	225	219	1	0,0
183	219	225	226	220	1	0,0
184	220	226	227	221	1	0,0
185	221	227	228	222	1	0,0
186	223	229	230	224	1	0,0
187	224	230	231	225	1	0,0
188	225	231	232	226	1	0,0
189	226	232	233	227	1	0,0
190	227	233	234	228	1	0,0
191	229	235	236	230	1	0,0
192	230	236	237	231	1	0,0
193	231	237	238	232	1	0,0
194	232	238	239	233	1	0,0
195	233	239	240	234	1	0,0
196	235	241	242	236	1	0,0
197	236	242	243	237	1	0,0
198	237	243	244	238	1	0,0
199	238	244	245	239	1	0,0
200	239	245	246	240	1	0,0
201	241	247	248	242	1	0,0
202	242	248	249	243	1	0,0
203	243	249	250	244	1	0,0
204	244	250	251	245	1	0,0
205	245	251	252	246	1	0,0
206	247	253	254	248	1	0,0
207	248	254	255	249	1	0,0
208	249	255	256	250	1	0,0
209	250	256	257	251	1	0,0
210	251	257	258	252	1	0,0
211	253	259	260	254	1	0,0
212	254	260	261	255	1	0,0
213	255	261	262	256	1	0,0
214	256	262	263	257	1	0,0
215	257	263	264	258	1	0,0
216	259	265	266	260	1	0,0
217	260	266	267	261	1	0,0
218	261	267	268	262	1	0,0
219	262	268	269	263	1	0,0
220	263	269	270	264	1	0,0
221	265	271	272	266	1	0,0
222	266	272	273	267	1	0,0
223	267	273	274	268	1	0,0
224	268	274	275	269	1	0,0
225	269	275	276	270	1	0,0
226	271	277	278	272	1	0,0
227	272	278	279	273	1	0,0
228	273	279	280	274	1	0,0
229	274	280	281	275	1	0,0
230	275	281	282	276	1	0,0
231	277	283	284	278	1	0,0
232	278	284	285	279	1	0,0
233	279	285	286	280	1	0,0
234	280	286	287	281	1	0,0
235	281	287	288	282	1	0,0
236	283	289	290	284	1	0,0
237	284	290	291	285	1	0,0
238	285	291	292	286	1	0,0
239	286	292	293	287	1	0,0
240	287	293	294	288	1	0,0
241	289	295	296	290	1	0,0

(Continued)

Table 4 (Continued)

```
242          290       296       297       291           1           0,0
243          291       297       298       292           1           0,0
244          292       298       299       293           1           0,0
245          293       299       300       294           1           0.0
246          295       301       302       296           1           0,0
247          296       302       303       297           1           0,0
248          297       303       304       298           1           0,0
249          298       304       305       299           1           0,0
250          299       305       306       300           1           0,0



                ----    TIME =      0.000 ----



                         NODAL HEADS AND FLOWS

                                        PERCENTAGE OF
  NODE              HEAD             AVAILABLE HEAD          FLOW

   1             -,9996E+01              0.0 %            -,1448E+01
   2             -,9996E+01              0.0 %            -.2895E+01
   3             -,9996E+01              0.0 %            -.2895E+01
   4             -.9996E+01              0.0 %            -.2895E+01
   5             -,9996E+01              0.0 %            -.2895E+01
   6             -,9996E+01              0.0 %            -.1448E+01
   7             -,9795E+01              2.0 %
   8             -,9795E+01              2.0 %
   9             -,9795E+01              2.0 %
  10             -,9795E+01              2.0 %
  11             -,9795E+01              2.0 %
  12             -,9795E+01              2.0 %
  13             -,9595E+01              4.0 %
  14             -,9595E+01              4.0 %
  15             -,9595E+01              4.0 %
  16             -.9595E+01              4.0 %
  17             -,9595E+01              4.0 %
  18             -,9595E+01              4.0 %
  19             -.9395E+01              6.0 %
  20             -.9395E+01              6.0 %
  21             -,9395E+01              6.0 %
  22             -.9395E+01              6.0 %
  23             -,9395E+01              6.0 %
  24             -,9395E+01              6.0 %
  25             -.9196E+01              8.0 %
  26             -,9196E+01              8.0 %
  27             -.9196E+01              8.0 %
  28             -,9196E+01              8.0 %
  29             -,9196E+01              8.0 %
  30             -,9196E+01              8.0 %
  31             -,8996E+01             10,0 %
  32             -,8996E+01             10.0 %
  33             -,8996E+01             10.0 %
  34             -,8996E+01             10.0 %
  35             -,8996E+01             10.0 %
  36             -.8996E+01             10.0 %
  37             -,8796E+01             12.0 %
  38             -,8796E+01             12,0 %
```

(Continued)

Table 4 (Continued)

39	-.8796E+01	12.0 %
40	-.8796E+01	12.0 %
41	-.8796E+01	12.0 %
42	-.8796E+01	12.0 %
43	-.8596E+01	14.0 %
44	-.8596E+01	14.0 %
45	-.8596E+01	14.0 %
46	-.8596E+01	14.0 %
47	-.8596E+01	14.0 %
48	-.8596E+01	14.0 %
49	-.8396E+01	16.0 %
50	-.8396E+01	16.0 %
51	-.8396E+01	16.0 %
52	-.8396E+01	16.0 %
53	-.8396E+01	16.0 %
54	-.8396E+01	16.0 %
55	-.8196E+01	18.0 %
56	-.8196E+01	18.0 %
57	-.8196E+01	18.0 %
58	-.8196E+01	18.0 %
59	-.8196E+01	18.0 %
60	-.8196E+01	18.0 %
61	-.7996E+01	20.0 %
62	-.7996E+01	20.0 %
63	-.7996E+01	20.0 %
64	-.7996E+01	20.0 %
65	-.7996E+01	20.0 %
66	-.7996E+01	20.0 %
67	-.7796E+01	22.0 %
68	-.7796E+01	22.0 %
69	-.7796E+01	22.0 %
70	-.7796E+01	22.0 %
71	-.7796E+01	22.0 %
72	-.7796E+01	22.0 %
73	-.7596E+01	24.0 %
74	-.7596E+01	24.0 %
75	-.7596E+01	24.0 %
76	-.7596E+01	24.0 %
77	-.7596E+01	24.0 %
78	-.7596E+01	24.0 %
79	-.7396E+01	26.0 %
80	-.7396E+01	26.0 %
81	-.7396E+01	26.0 %
82	-.7396E+01	26.0 %
83	-.7396E+01	26.0 %
84	-.7396E+01	26.0 %
85	-.7196E+01	28.0 %
86	-.7196E+01	28.0 %
87	-.7196E+01	28.0 %
88	-.7196E+01	28.0 %
89	-.7196E+01	28.0 %
90	-.7196E+01	28.0 %
91	-.6996E+01	30.0 %
92	-.6996E+01	30.0 %
93	-.6996E+01	30.0 %
94	-.6996E+01	30.0 %
95	-.6996E+01	30.0 %
96	-.6996E+01	30.0 %
97	-.6796E+01	32.0 %
98	-.6796E+01	32.0 %
99	-.6796E+01	32.0 %
100	-.6796E+01	32.0 %
101	-.6796E+01	32.0 %

(Continued)

Table 4 (Continued)

102	-.6796E+01	32.0 %
103	-.6596E+01	34.0 %
104	-.6596E+01	34.0 %
105	-.6596E+01	34.0 %
106	-.6596E+01	34.0 %
107	-.6596E+01	34.0 %
108	-.6596E+01	34.0 %
109	-.6396E+01	36.0 %
110	-.6396E+01	36.0 %
111	-.6396E+01	36.0 %
112	-.6396E+01	36.0 %
113	-.6396E+01	36.0 %
114	-.6396E+01	36.0 %
115	-.6196E+01	38.0 %
116	-.6196E+01	38.0 %
117	-.6196E+01	38.0 %
118	-.6196E+01	38.0 %
119	-.6196E+01	38.0 %
120	-.6196E+01	38.0 %
121	-.5996E+01	40.0 %
122	-.5996E+01	40.0 %
123	-.5996E+01	40.0 %
124	-.5996E+01	40.0 %
125	-.5996E+01	40.0 %
126	-.5996E+01	40.0 %
127	-.5796E+01	42.0 %
128	-.5796E+01	42.0 %
129	-.5796E+01	42.0 %
130	-.5796E+01	42.0 %
131	-.5796E+01	42.0 %
132	-.5796E+01	42.0 %
133	-.5596E+01	44.0 %
134	-.5596E+01	44.0 %
135	-.5596E+01	44.0 %
136	-.5596E+01	44.0 %
137	-.5596E+01	44.0 %
138	-.5596E+01	44.0 %
139	-.5396E+01	46.0 %
140	-.5396E+01	46.0 %
141	-.5396E+01	46.0 %
142	-.5396E+01	46.0 %
143	-.5396E+01	46.0 %
144	-.5396E+01	46.0 %
145	-.5196E+01	48.0 %
146	-.5196E+01	48.0 %
147	-.5196E+01	48.0 %
148	-.5196E+01	48.0 %
149	-.5196E+01	48.0 %
150	-.5196E+01	48.0 %
151	-.4996E+01	50.0 %
152	-.4996E+01	50.0 %
153	-.4996E+01	50.0 %
154	-.4996E+01	50.0 %
155	-.4996E+01	50.0 %
156	-.4996E+01	50.0 %
157	-.4796E+01	52.0 %
158	-.4796E+01	52.0 %
159	-.4796E+01	52.0 %
160	-.4796E+01	52.0 %
161	-.4796E+01	52.0 %
162	-.4796E+01	52.0 %
163	-.4596E+01	54.0 %
164	-.4596E+01	54.0 %

(Continued)

Table 4 (Continued)

165	-.4596E+01	54.0 %
166	-.4596E+01	54.0 %
167	-.4596E+01	54.0 %
168	-.4596E+01	54.0 %
169	-.4396E+01	56.0 %
170	-.4396E+01	56.0 %
171	-.4396E+01	56.0 %
172	-.4396E+01	56.0 %
173	-.4396E+01	56.0 %
174	-.4396E+01	56.0 %
175	-.4196E+01	58.0 %
176	-.4196E+01	58.0 %
177	-.4196E+01	58.0 %
178	-.4196E+01	58.0 %
179	-.4196E+01	58.0 %
180	-.4196E+01	58.0 %
181	-.3996E+01	60.0 %
182	-.3996E+01	60.0 %
183	-.3996E+01	60.0 %
184	-.3996E+01	60.0 %
185	-.3996E+01	60.0 %
186	-.3996E+01	60.0 %
187	-.3796E+01	62.0 %
188	-.3796E+01	62.0 %
189	-.3796E+01	62.0 %
190	-.3796E+01	62.0 %
191	-.3796E+01	62.0 %
192	-.3796E+01	62.0 %
193	-.3596E+01	64.0 %
194	-.3596E+01	64.0 %
195	-.3596E+01	64.0 %
196	-.3596E+01	64.0 %
197	-.3596E+01	64.0 %
198	-.3596E+01	64.0 %
199	-.3396E+01	66.0 %
200	-.3396E+01	66.0 %
201	-.3396E+01	66.0 %
202	-.3396E+01	66.0 %
203	-.3396E+01	66.0 %
204	-.3396E+01	66.0 %
205	-.3196E+01	68.0 %
206	-.3196E+01	68.0 %
207	-.3196E+01	68.0 %
208	-.3196E+01	68.0 %
209	-.3196E+01	68.0 %
210	-.3196E+01	68.0 %
211	-.2996E+01	70.0 %
212	-.2996E+01	70.0 %
213	-.2996E+01	70.0 %
214	-.2996E+01	70.0 %
215	-.2996E+01	70.0 %
216	-.2996E+01	70.0 %
217	-.2796E+01	72.0 %
218	-.2796E+01	72.0 %
219	-.2796E+01	72.0 %
220	-.2796E+01	72.0 %
221	-.2796E+01	72.0 %
222	-.2796E+01	72.0 %
223	-.2596E+01	74.0 %
224	-.2596E+01	74.0 %
225	-.2596E+01	74.0 %
226	-.2596E+01	74.0 %
227	-.2596E+01	74.0 %

(Continued)

Table 4 (Continued)

228	-.2596E+01	74.0 %
229	-.2397E+01	76.0 %
230	-.2397E+01	76.0 %
231	-.2397E+01	76.0 %
232	-.2397E+01	76.0 %
233	-.2397E+01	76.0 %
234	-.2397E+01	76.0 %
235	-.2197E+01	78.0 %
236	-.2197E+01	78.0 %
237	-.2197E+01	78.0 %
238	-.2197E+01	78.0 %
239	-.2197E+01	78.0 %
240	-.2197E+01	78.0 %
241	-.1997E+01	80.0 %
242	-.1997E+01	80.0 %
243	-.1997E+01	80.0 %
244	-.1997E+01	80.0 %
245	-.1997E+01	80.0 %
246	-.1997E+01	80.0 %
247	-.1797E+01	82.0 %
248	-.1797E+01	82.0 %
249	-.1797E+01	82.0 %
250	-.1797E+01	82.0 %
251	-.1797E+01	82.0 %
252	-.1797E+01	82.0 %
253	-.1598E+01	84.0 %
254	-.1598E+01	84.0 %
255	-.1598E+01	84.0 %
256	-.1598E+01	84.0 %
257	-.1598E+01	84.0 %
258	-.1598E+01	84.0 %
259	-.1398E+01	86.0 %
260	-.1398E+01	86.0 %
261	-.1398E+01	86.0 %
262	-.1398E+01	86.0 %
263	-.1398E+01	86.0 %
264	-.1398E+01	86.0 %
265	-.1198E+01	88.0 %
266	-.1198E+01	88.0 %
267	-.1198E+01	88.0 %
268	-.1198E+01	88.0 %
269	-.1198E+01	88.0 %
270	-.1198E+01	88.0 %
271	-.9985E+00	90.0 %
272	-.9985E+00	90.0 %
273	-.9985E+00	90.0 %
274	-.9985E+00	90.0 %
275	-.9985E+00	90.0 %
276	-.9985E+00	90.0 %
277	-.7988E+00	92.0 %
278	-.7988E+00	92.0 %
279	-.7988E+00	92.0 %
280	-.7988E+00	92.0 %
281	-.7988E+00	92.0 %
282	-.7988E+00	92.0 %
283	-.5991E+00	94.0 %
284	-.5991E+00	94.0 %
285	-.5991E+00	94.0 %
286	-.5991E+00	94.0 %
287	-.5991E+00	94.0 %
288	-.5991E+00	94.0 %
289	-.3994E+00	96.0 %
290	-.3994E+00	96.0 %

(Continued)

Table 4 (Continued)

```
291          -.3994E+00          96.0 %
292          -.3994E+00          96.0 %
293          -.3994E+00          96.0 %
294          -.3994E+00          96.0 %
295          -.1997E+00          98.0 %
296          -.1997E+00          98.0 %
297          -.1997E+00          98.0 %
298          -.1997E+00          98.0 %
299          -.1997E+00          98.0 %
300          -.1997E+00          98.0 %
301          0.0000E+00         100.0 %          0.1448E+01
302          0.0000E+00         100.0 %          0.2895E+01
303          0.0000E+00         100.0 %          0.2895E+01
304          0.0000E+00         100.0 %          0.2895E+01
305          0.0000E+00         100.0 %          0.2895E+01
306          0.0000E+00         100.0 %          0.1448E+01

                          ELEMENT FLOWRATES

ELMT      V1           V2       P-AXIS ANG      RES V        DIR OF V

  1   -.135E+00   -.722E-09   0.000E+00   0.135E+00     -.180E+03
  2   -.135E+00   0.643E-09   0.000E+00   0.135E+00     0.180E+03
  3   -.135E+00   -.692E-09   0.000E+00   0.135E+00     -.180E+03
  4   -.135E+00   0.296E-09   0.000E+00   0.135E+00     0.180E+03
  5   -.135E+00   -.172E-09   0.000E+00   0.135E+00     -.180E+03
  6   -.117E+00   -.717E-09   0.000E+00   0.117E+00     -.180E+03
  7   -.117E+00   0.633E-09   0.000E+00   0.117E+00     0.180E+03
  8   -.117E+00   -.685E-09   0.000E+00   0.117E+00     -.180E+03
  9   -.117E+00   0.300E-09   0.000E+00   0.117E+00     0.180E+03
 10   -.117E+00   -.189E-09   0.000E+00   0.117E+00     -.180E+03
 11   -.102E+00   -.703E-09   0.000E+00   0.102E+00     -.180E+03
 12   -.102E+00   0.619E-09   0.000E+00   0.102E+00     0.180E+03
 13   -.102E+00   -.678E-09   0.000E+00   0.102E+00     -.180E+03
 14   -.102E+00   0.312E-09   0.000E+00   0.102E+00     0.180E+03
 15   -.102E+00   -.221E-09   0.000E+00   0.102E+00     -.180E+03
 16   -.892E-01   -.687E-09   0.000E+00   0.892E-01     -.180E+03
 17   -.892E-01   0.612E-09   0.000E+00   0.892E-01     0.180E+03
 18   -.892E-01   -.675E-09   0.000E+00   0.892E-01     -.180E+03
 19   -.892E-01   0.331E-09   0.000E+00   0.892E-01     0.180E+03
 20   -.892E-01   -.251E-09   0.000E+00   0.892E-01     -.180E+03
 21   -.777E-01   -.671E-09   0.000E+00   0.777E-01     -.180E+03
 22   -.777E-01   0.615E-09   0.000E+00   0.777E-01     0.180E+03
 23   -.777E-01   -.659E-09   0.000E+00   0.777E-01     -.180E+03
 24   -.777E-01   0.326E-09   0.000E+00   0.777E-01     0.180E+03
 25   -.777E-01   -.263E-09   0.000E+00   0.777E-01     -.180E+03
 26   -.677E-01   -.661E-09   0.000E+00   0.677E-01     -.180E+03
 27   -.677E-01   0.603E-09   0.000E+00   0.677E-01     0.180E+03
 28   -.677E-01   -.629E-09   0.000E+00   0.677E-01     -.180E+03
 29   -.677E-01   0.305E-09   0.000E+00   0.677E-01     0.180E+03
 30   -.677E-01   -.258E-09   0.000E+00   0.677E-01     -.180E+03
 31   -.589E-01   -.631E-09   0.000E+00   0.589E-01     -.180E+03
 32   -.589E-01   0.566E-09   0.000E+00   0.589E-01     0.180E+03
 33   -.589E-01   -.580E-09   0.000E+00   0.589E-01     -.180E+03
 34   -.589E-01   0.265E-09   0.000E+00   0.589E-01     0.180E+03
 35   -.589E-01   -.235E-09   0.000E+00   0.589E-01     -.180E+03
 36   -.513E-01   -.594E-09   0.000E+00   0.513E-01     -.180E+03
 37   -.513E-01   0.517E-09   0.000E+00   0.513E-01     0.180E+03
 38   -.513E-01   -.517E-09   0.000E+00   0.513E-01     -.180E+03
 39   -.513E-01   0.224E-09   0.000E+00   0.513E-01     0.180E+03
 40   -.513E-01   -.212E-09   0.000E+00   0.513E-01     -.180E+03
```

(Continued)

Table 4 (Continued)

41	-.447E-01	-.549E-09	0.000E+00	0.447E-01	-.180E+03
42	-.447E-01	0.461E-09	0.000E+00	0.447E-01	0.180E+03
43	-.447E-01	-.449E-09	0.000E+00	0.447E-01	-.180E+03
44	-.447E-01	0.170E-09	0.000E+00	0.447E-01	0.180E+03
45	-.447E-01	-.182E-09	0.000E+00	0.447E-01	-.180E+03
46	-.389E-01	-.487E-09	0.000E+00	0.389E-01	-.180E+03
47	-.389E-01	0.398E-09	0.000E+00	0.389E-01	0.180E+03
48	-.389E-01	-.389E-09	0.000E+00	0.389E-01	-.180E+03
49	-.389E-01	0.118E-09	0.000E+00	0.389E-01	0.180E+03
50	-.389E-01	-.137E-09	0.000E+00	0.389E-01	-.180E+03
51	-.339E-01	-.424E-09	0.000E+00	0.339E-01	-.180E+03
52	-.339E-01	0.342E-09	0.000E+00	0.339E-01	0.180E+03
53	-.339E-01	-.326E-09	0.000E+00	0.339E-01	-.180E+03
54	-.339E-01	0.699E-10	0.000E+00	0.339E-01	0.180E+03
55	-.339E-01	-.931E-10	0.000E+00	0.339E-01	-.180E+03
56	-.295E-01	-.361E-09	0.000E+00	0.295E-01	-.180E+03
57	-.295E-01	0.289E-09	0.000E+00	0.295E-01	0.180E+03
58	-.295E-01	-.268E-09	0.000E+00	0.295E-01	-.180E+03
59	-.295E-01	0.210E-10	0.000E+00	0.295E-01	0.180E+03
60	-.295E-01	-.652E-10	0.000E+00	0.295E-01	-.180E+03
61	-.257E-01	-.298E-09	0.000E+00	0.257E-01	-.180E+03
62	-.257E-01	0.251E-09	0.000E+00	0.257E-01	0.180E+03
63	-.257E-01	-.228E-09	0.000E+00	0.257E-01	-.180E+03
64	-.257E-01	-.231E-11	0.000E+00	0.257E-01	-.180E+03
65	-.257E-01	-.489E-10	0.000E+00	0.257E-01	-.180E+03
66	-.224E-01	-.247E-09	0.000E+00	0.224E-01	-.180E+03
67	-.224E-01	0.221E-09	0.000E+00	0.224E-01	0.180E+03
68	-.224E-01	-.198E-09	0.000E+00	0.224E-01	-.180E+03
69	-.224E-01	-.186E-10	0.000E+00	0.224E-01	-.180E+03
70	-.224E-01	-.326E-10	0.000E+00	0.224E-01	-.180E+03
71	-.195E-01	-.196E-09	0.000E+00	0.195E-01	-.180E+03
72	-.195E-01	0.193E-09	0.000E+00	0.195E-01	0.180E+03
73	-.195E-01	-.170E-09	0.000E+00	0.195E-01	-.180E+03
74	-.195E-01	-.326E-10	0.000E+00	0.195E-01	-.180E+03
75	-.195E-01	-.116E-10	0.000E+00	0.195E-01	-.180E+03
76	-.170E-01	-.154E-09	0.000E+00	0.170E-01	-.180E+03
77	-.170E-01	0.163E-09	0.000E+00	0.170E-01	0.180E+03
78	-.170E-01	-.142E-09	0.000E+00	0.170E-01	-.180E+03
79	-.170E-01	-.419E-10	0.000E+00	0.170E-01	-.180E+03
80	-.170E-01	0.247E-13	0.000E+00	0.170E-01	0.180E+03
81	-.148E-01	-.114E-09	0.000E+00	0.148E-01	-.180E+03
82	-.148E-01	0.128E-09	0.000E+00	0.148E-01	0.180E+03
83	-.148E-01	-.118E-09	0.000E+00	0.148E-01	-.180E+03
84	-.148E-01	-.536E-10	0.000E+00	0.148E-01	-.180E+03
85	-.148E-01	-.233E-11	0.000E+00	0.148E-01	-.180E+03
86	-.129E-01	-.722E-10	0.000E+00	0.129E-01	-.180E+03
87	-.129E-01	0.932E-10	0.000E+00	0.129E-01	0.180E+03
88	-.129E-01	-.908E-10	0.000E+00	0.129E-01	-.180E+03
89	-.129E-01	-.698E-10	0.000E+00	0.129E-01	-.180E+03
90	-.129E-01	0.235E-11	0.000E+00	0.129E-01	0.180E+03
91	-.112E-01	-.442E-10	0.000E+00	0.112E-01	-.180E+03
92	-.112E-01	0.629E-10	0.000E+00	0.112E-01	0.180E+03
93	-.112E-01	-.745E-10	0.000E+00	0.112E-01	-.180E+03
94	-.112E-01	-.722E-10	0.000E+00	0.112E-01	-.180E+03
95	-.112E-01	-.464E-11	0.000E+00	0.112E-01	-.180E+03
96	-.978E-02	-.349E-10	0.000E+00	0.978E-02	-.180E+03
97	-.978E-02	0.512E-10	0.000E+00	0.978E-02	0.180E+03
98	-.978E-02	-.698E-10	0.000E+00	0.978E-02	-.180E+03
99	-.978E-02	-.605E-10	0.000E+00	0.978E-02	-.180E+03
100	-.978E-02	-.140E-10	0.000E+00	0.978E-02	-.180E+03
101	-.852E-02	-.419E-10	0.000E+00	0.852E-02	-.180E+03
102	-.852E-02	0.512E-10	0.000E+00	0.852E-02	0.180E+03
103	-.852E-02	-.698E-10	0.000E+00	0.852E-02	-.180E+03

(Continued)

Table 4 (Continued)

104	-.852E-02	-.465E-10	0.000E+00	0.852E-02	-.180E+03
105	-.852E-02	-.139E-10	0.000E+00	0.852E-02	-.180E+03
106	-.742E-02	-.419E-10	0.000E+00	0.742E-02	-.180E+03
107	-.742E-02	0.373E-10	0.000E+00	0.742E-02	0.180E+03
108	-.742E-02	-.536E-10	0.000E+00	0.742E-02	-.180E+03
109	-.742E-02	-.466E-10	0.000E+00	0.742E-02	-.180E+03
110	-.742E-02	-.466E-11	0.000E+00	0.742E-02	-.180E+03
111	-.646E-02	-.349E-10	0.000E+00	0.646E-02	-.180E+03
112	-.646E-02	0.233E-10	0.000E+00	0.646E-02	0.180E+03
113	-.646E-02	-.419E-10	0.000E+00	0.646E-02	-.180E+03
114	-.646E-02	-.372E-10	0.000E+00	0.646E-02	-.180E+03
115	-.646E-02	-.464E-11	0.000E+00	0.646E-02	-.180E+03
116	-.563E-02	-.233E-10	0.000E+00	0.563E-02	-.180E+03
117	-.563E-02	0.163E-10	0.000E+00	0.563E-02	0.180E+03
118	-.563E-02	-.419E-10	0.000E+00	0.563E-02	-.180E+03
119	-.563E-02	-.256E-10	0.000E+00	0.563E-02	-.180E+03
120	-.563E-02	-.140E-10	0.000E+00	0.563E-02	-.180E+03
121	-.490E-02	-.466E-11	0.000E+00	0.490E-02	-.180E+03
122	-.490E-02	0.233E-11	0.000E+00	0.490E-02	0.180E+03
123	-.490E-02	-.349E-10	0.000E+00	0.490E-02	-.180E+03
124	-.490E-02	-.256E-10	0.000E+00	0.490E-02	-.180E+03
125	-.490E-02	-.163E-10	0.000E+00	0.490E-02	-.180E+03
126	-.427E-02	0.234E-11	0.000E+00	0.427E-02	0.180E+03
127	-.427E-02	-.697E-11	0.000E+00	0.427E-02	-.180E+03
128	-.427E-02	-.279E-10	0.000E+00	0.427E-02	-.180E+03
129	-.427E-02	-.233E-10	0.000E+00	0.427E-02	-.180E+03
130	-.427E-02	-.140E-10	0.000E+00	0.427E-02	-.180E+03
131	-.372E-02	0.466E-11	0.000E+00	0.372E-02	0.180E+03
132	-.372E-02	-.116E-10	0.000E+00	0.372E-02	-.180E+03
133	-.372E-02	-.186E-10	0.000E+00	0.372E-02	-.180E+03
134	-.372E-02	-.233E-10	0.000E+00	0.372E-02	-.180E+03
135	-.372E-02	-.163E-10	0.000E+00	0.372E-02	-.180E+03
136	-.324E-02	0.116E-10	0.000E+00	0.324E-02	0.180E+03
137	-.324E-02	-.209E-10	0.000E+00	0.324E-02	-.180E+03
138	-.324E-02	-.116E-10	0.000E+00	0.324E-02	-.180E+03
139	-.324E-02	-.256E-10	0.000E+00	0.324E-02	-.180E+03
140	-.324E-02	-.209E-10	0.000E+00	0.324E-02	-.180E+03
141	-.282E-02	0.700E-11	0.000E+00	0.282E-02	0.180E+03
142	-.282E-02	-.163E-10	0.000E+00	0.282E-02	-.180E+03
143	-.282E-02	-.116E-10	0.000E+00	0.282E-02	-.180E+03
144	-.282E-02	-.233E-10	0.000E+00	0.282E-02	-.180E+03
145	-.282E-02	-.163E-10	0.000E+00	0.282E-02	-.180E+03
146	-.246E-02	-.930E-11	0.000E+00	0.246E-02	-.180E+03
147	-.246E-02	-.231E-11	0.000E+00	0.246E-02	-.180E+03
148	-.246E-02	-.930E-11	0.000E+00	0.246E-02	-.180E+03
149	-.246E-02	-.209E-10	0.000E+00	0.246E-02	-.180E+03
150	-.246E-02	-.697E-11	0.000E+00	0.246E-02	-.180E+03
151	-.214E-02	-.139E-10	0.000E+00	0.214E-02	-.180E+03
152	-.214E-02	0.468E-11	0.000E+00	0.214E-02	0.180E+03
153	-.214E-02	-.929E-11	0.000E+00	0.214E-02	-.180E+03
154	-.214E-02	-.116E-10	0.000E+00	0.214E-02	-.180E+03
155	-.214E-02	-.230E-11	0.000E+00	0.214E-02	-.180E+03
156	-.186E-02	-.696E-11	0.000E+00	0.186E-02	-.180E+03
157	-.186E-02	0.235E-11	0.000E+00	0.186E-02	0.180E+03
158	-.186E-02	-.139E-10	0.000E+00	0.186E-02	-.180E+03
159	-.186E-02	-.231E-11	0.000E+00	0.186E-02	-.180E+03
160	-.186E-02	-.231E-11	0.000E+00	0.186E-02	-.180E+03
161	-.162E-02	-.233E-11	0.000E+00	0.162E-02	-.180E+03
162	-.162E-02	-.233E-11	0.000E+00	0.162E-02	-.180E+03
163	-.162E-02	-.466E-11	0.000E+00	0.162E-02	-.180E+03
164	-.162E-02	-.931E-11	0.000E+00	0.162E-02	-.180E+03
165	-.162E-02	0.698E-11	0.000E+00	0.162E-02	0.180E+03
166	-.141E-02	0.000E+00	0.000E+00	0.141E-02	-.180E+03

(Continued)

Table 4 (Continued)

167	-.141E-02	-.466E-11	0.000E+00	0.141E-02	-.180E+03
168	-.141E-02	0.466E-11	0.000E+00	0.141E-02	0.180E+03
169	-.141E-02	-.931E-11	0.000E+00	0.141E-02	-.180E+03
170	-.141E-02	0.233E-11	0.000E+00	0.141E-02	0.180E+03
171	-.123E-02	-.698E-11	0.000E+00	0.123E-02	-.180E+03
172	-.123E-02	-.466E-11	0.000E+00	0.123E-02	-.180E+03
173	-.123E-02	0.233E-11	0.000E+00	0.123E-02	0.180E+03
174	-.123E-02	-.931E-11	0.000E+00	0.123E-02	-.180E+03
175	-.123E-02	0.000E+00	0.000E+00	0.123E-02	-.180E+03
176	-.107E-02	-.116E-10	0.000E+00	0.107E-02	-.180E+03
177	-.107E-02	-.462E-11	0.000E+00	0.107E-02	-.180E+03
178	-.107E-02	-.229E-11	0.000E+00	0.107E-02	-.180E+03
179	-.107E-02	-.928E-11	0.000E+00	0.107E-02	-.180E+03
180	-.107E-02	0.237E-11	0.000E+00	0.107E-02	0.180E+03
181	-.933E-03	-.116E-10	0.000E+00	0.933E-03	-.180E+03
182	-.933E-03	-.931E-11	0.000E+00	0.933E-03	-.180E+03
183	-.933E-03	-.466E-11	0.000E+00	0.933E-03	-.180E+03
184	-.933E-03	0.000E+00	0.000E+00	0.933E-03	-.180E+03
185	-.933E-03	-.233E-11	0.000E+00	0.933E-03	-.180E+03
186	-.813E-03	-.116E-10	0.000E+00	0.813E-03	-.180E+03
187	-.813E-03	-.140E-10	0.000E+00	0.813E-03	-.180E+03
188	-.813E-03	-.698E-11	0.000E+00	0.813E-03	-.180E+03
189	-.813E-03	0.233E-11	0.000E+00	0.813E-03	0.180E+03
190	-.813E-03	-.233E-11	0.000E+00	0.813E-03	-.180E+03
191	-.708E-03	-.930E-11	0.000E+00	0.708E-03	-.180E+03
192	-.708E-03	-.930E-11	0.000E+00	0.708E-03	-.180E+03
193	-.708E-03	-.231E-11	0.000E+00	0.708E-03	-.180E+03
194	-.708E-03	0.234E-11	0.000E+00	0.708E-03	0.180E+03
195	-.708E-03	0.165E-13	0.000E+00	0.708E-03	0.180E+03
196	-.616E-03	-.464E-11	0.000E+00	0.616E-03	-.180E+03
197	-.616E-03	-.231E-11	0.000E+00	0.616E-03	-.180E+03
198	-.616E-03	0.467E-11	0.000E+00	0.616E-03	0.180E+03
199	-.616E-03	0.234E-11	0.000E+00	0.616E-03	0.180E+03
200	-.616E-03	-.930E-11	0.000E+00	0.616E-03	-.180E+03
201	-.537E-03	-.116E-10	0.000E+00	0.537E-03	-.180E+03
202	-.537E-03	-.463E-11	0.000E+00	0.537E-03	-.180E+03
203	-.537E-03	0.468E-11	0.000E+00	0.537E-03	0.180E+03
204	-.537E-03	-.230E-11	0.000E+00	0.537E-03	-.180E+03
205	-.537E-03	-.696E-11	0.000E+00	0.537E-03	-.180E+03
206	-.467E-03	-.116E-10	0.000E+00	0.467E-03	-.180E+03
207	-.467E-03	-.696E-11	0.000E+00	0.467E-03	-.180E+03
208	-.467E-03	0.218E-13	0.000E+00	0.467E-03	0.180E+03
209	-.467E-03	0.218E-13	0.000E+00	0.467E-03	0.180E+03
210	-.467E-03	-.231E-11	0.000E+00	0.467E-03	-.180E+03
211	-.407E-03	-.698E-11	0.000E+00	0.407E-03	-.180E+03
212	-.407E-03	-.698E-11	0.000E+00	0.407E-03	-.180E+03
213	-.407E-03	-.233E-11	0.000E+00	0.407E-03	-.180E+03
214	-.407E-03	-.466E-11	0.000E+00	0.407E-03	-.180E+03
215	-.407E-03	-.931E-11	0.000E+00	0.407E-03	-.180E+03
216	-.355E-03	-.931E-11	0.000E+00	0.355E-03	-.180E+03
217	-.355E-03	-.163E-10	0.000E+00	0.355E-03	-.180E+03
218	-.355E-03	-.466E-11	0.000E+00	0.355E-03	-.180E+03
219	-.355E-03	-.466E-11	0.000E+00	0.355E-03	-.180E+03
220	-.355E-03	-.931E-11	0.000E+00	0.355E-03	-.180E+03
221	-.309E-03	-.140E-10	0.000E+00	0.309E-03	-.180E+03
222	-.309E-03	-.163E-10	0.000E+00	0.309E-03	-.180E+03
223	-.309E-03	-.466E-11	0.000E+00	0.309E-03	-.180E+03
224	-.309E-03	-.233E-11	0.000E+00	0.309E-03	-.180E+03
225	-.309E-03	-.698E-11	0.000E+00	0.309E-03	-.180E+03
226	-.269E-03	-.116E-10	0.000E+00	0.269E-03	-.180E+03
227	-.269E-03	-.163E-10	0.000E+00	0.269E-03	-.180E+03
228	-.269E-03	-.931E-11	0.000E+00	0.269E-03	-.180E+03
229	-.269E-03	-.698E-11	0.000E+00	0.269E-03	-.180E+03

(Continued)

Table 4 (Concluded)

230	-.269E-03	-.466E-11	0.000E+00	0.269E-03	-.180E+03
231	-.234E-03	-.698E-11	0.000E+00	0.234E-03	-.180E+03
232	-.234E-03	-.163E-10	0.000E+00	0.234E-03	-.180E+03
233	-.234E-03	-.140E-10	0.000E+00	0.234E-03	-.180E+03
234	-.234E-03	-.163E-10	0.000E+00	0.234E-03	-.180E+03
235	-.234E-03	-.931E-11	0.000E+00	0.234E-03	-.180E+03
236	-.204E-03	-.466E-11	0.000E+00	0.204E-03	-.180E+03
237	-.204E-03	-.116E-10	0.000E+00	0.204E-03	-.180E+03
238	-.204E-03	-.116E-10	0.000E+00	0.204E-03	-.180E+03
239	-.204E-03	-.163E-10	0.000E+00	0.204E-03	-.180E+03
240	-.204E-03	-.116E-10	0.000E+00	0.204E-03	-.180E+03
241	-.178E-03	-.931E-11	0.000E+00	0.178E-03	-.180E+03
242	-.178E-03	-.140E-10	0.000E+00	0.178E-03	-.180E+03
243	-.178E-03	-.698E-11	0.000E+00	0.178E-03	-.180E+03
244	-.178E-03	-.233E-11	0.000E+00	0.178E-03	-.180E+03
245	-.178E-03	-.698E-11	0.000E+00	0.178E-03	-.180E+03
246	-.155E-03	-.464E-11	0.000E+00	0.155E-03	-.180E+03
247	-.155E-03	-.464E-11	0.000E+00	0.155E-03	-.180E+03
248	-.155E-03	-.464E-11	0.000E+00	0.155E-03	-.180E+03
249	-.155E-03	0.234E-11	0.000E+00	0.155E-03	0.180E+03
250	-.155E-03	-.231E-11	0.000E+00	0.155E-03	-.180E+03

Table 5

Input for Problem 3

Transient Unconfined Flow in a Bank with Vertical Sides after Sudden Drawdown

```
TRANSIENT UNCONFINED FLOW IN A BANK WITH VERTICAL SIDES AFTER SUDDEN DRAWDOWN
   66    50     1     0     2     2 UNCF PLNE        5.00        0.        0.
    1      0,1       0.1        0.3
    1 1   1     0.0000     0,0000  100,0000
    6     3     0,0000   100,0000  100,0000
    7 0   0    14,2857     0,0000    0.0000
   12 0   1    14,2857   100,0000  100,0000
   13 0   0    27,6190     0,0000    0,0000
   18 0   1    27,6190   100,0000  100,0000
   19 0   0    40,0000     0,0000    0,0000
   24 0   1    40,0000   100,0000  100,0000
   25 0   0    51.4286     0,0000    0.0000
   30 0   1    51,4286   100,0000  100,0000
   31 0   0    61,9048     0,0000    0.0000
   36 0   1    61,9048   100,0000  100.0000
   37 0   0    71.4286     0,0000    0,0000
   42 0   1    71.4286   100,0000  100,0000
   43 0   0    80,0000     0,0000    0,0000
   48 0   1    80,0000   100,0000  100,0000
   49 0   0    87,6190     0,0000    0.0000
   54 0   1    87,6190   100,0000  100,0000
   55 0   0    94,2857     0,0000    0,0000
   60 0   1    94,2857   100,0000  100,0000
   61 1   1   100,0000     0,0000   40,0000
   63 1   2   100,0000    40,0000   40,0000
   66 0   2   100,0000   100,0000  100.0000
    6     6       100.     6
   12    12       100.    12
   18    18       100,    18
   24    24       100,    24
   30    30       100.    30
   36    36       100.    36
   42    42       100.    42
   48    48       100.    48
   54    54       100.    54
   60    60       100.    60
   66    66       100.    66
   -1
    1     1     7     8     2     1
    6     7    13    14     8     1
   11    13    19    20    14     1
   16    19    25    26    20     1
   21    25    31    32    26     1
   26    31    37    38    32     1
   31    37    43    44    38     1
   36    43    49    50    44     1
   41    49    55    56    50     1
   46    55    61    62    56     1
   50    59    65    66    60     1
```

Table 6

Output for Problem 3

Transient Unconfined Flow in a Bank with Vertical Sides after Sudden Drawdown

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```
TRANSIENT UNCONFINED FLOW IN A BANK WITH VERTICAL SIDES AFTER SUDDEN DRAWDOWN


 NUMBER OF NODAL POINTS------ 66

 NUMBER OF ELEMENTS---------- 50

 NUMBER OF DIFF, MATERIALS---  1

 NUMBER OF TIME STEPS--------  2

 PRINT INTERVAL--------------  2

 TIME INCREMENT------------        5.000

 INFILTRATION RATE-----------      0.000

 ELEVATION OF DATUM----------      0.000



                                   MATERIAL PROPERTIES

                     MAT            K1                 K2             STOR

                      1          0.100E+00          0.100E+00        0.300
```

(Continued)

Table 6 (Continued)

NODE POINT INFORMATION

NODE	BC	X	Y	FLOW-HEAD	BC RATE
1	1	0.00	0.00	100.00	0.0000
2	1	0.00	20.00	100.00	0.0000
3	1	0.00	40.00	100.00	0.0000
4	1	0.00	60.00	100.00	0.0000
5	1	0.00	80.00	100.00	0.0000
6	3	0.00	100.00	100.00	0.0000
7	0	14.29	0.00	0.00	0.0000
8	0	14.29	20.00	0.00	0.0000
9	0	14.29	40.00	0.00	0.0000
10	0	14.29	60.00	0.00	0.0000
11	0	14.29	80.00	0.00	0.0000
12	1	14.29	100.00	100.00	0.0000
13	0	27.62	0.00	0.00	0.0000
14	0	27.62	20.00	0.00	0.0000
15	0	27.62	40.00	0.00	0.0000
16	0	27.62	60.00	0.00	0.0000
17	0	27.62	80.00	0.00	0.0000
18	1	27.62	100.00	100.00	0.0000
19	0	40.00	0.00	0.00	0.0000
20	0	40.00	20.00	0.00	0.0000
21	0	40.00	40.00	0.00	0.0000
22	0	40.00	60.00	0.00	0.0000
23	0	40.00	80.00	0.00	0.0000
24	1	40.00	100.00	100.00	0.0000
25	0	51.43	0.00	0.00	0.0000
26	0	51.43	20.00	0.00	0.0000
27	0	51.43	40.00	0.00	0.0000
28	0	51.43	60.00	0.00	0.0000
29	0	51.43	80.00	0.00	0.0000
30	1	51.43	100.00	100.00	0.0000
31	0	61.90	0.00	0.00	0.0000
32	0	61.90	20.00	0.00	0.0000
33	0	61.90	40.00	0.00	0.0000
34	0	61.90	60.00	0.00	0.0000
35	0	61.90	80.00	0.00	0.0000
36	1	61.90	100.00	100.00	0.0000
37	0	71.43	0.00	0.00	0.0000
38	0	71.43	20.00	0.00	0.0000
39	0	71.43	40.00	0.00	0.0000
40	0	71.43	60.00	0.00	0.0000
41	0	71.43	80.00	0.00	0.0000
42	1	71.43	100.00	100.00	0.0000
43	0	80.00	0.00	0.00	0.0000
44	0	80.00	20.00	0.00	0.0000
45	0	80.00	40.00	0.00	0.0000
46	0	80.00	60.00	0.00	0.0000
47	0	80.00	80.00	0.00	0.0000
48	1	80.00	100.00	100.00	0.0000
49	0	87.62	0.00	0.00	0.0000
50	0	87.62	20.00	0.00	0.0000
51	0	87.62	40.00	0.00	0.0000
52	0	87.62	60.00	0.00	0.0000

(Continued)

Table 6 (Continued)

```
53     0       87.62      80.00       0.00     0.0000
54     1       87.62     100.00     100.00     0.0000
55     0       94.29       0.00       0.00     0.0000
56     0       94.29      20.00       0.00     0.0000
57     0       94.29      40.00       0.00     0.0000
58     0       94.29      60.00       0.00     0.0000
59     0       94.29      80.00       0.00     0.0000
60     1       94.29     100.00     100.00     0.0000
61     1      100.00       0.00      40.00     0.0000
62     1      100.00      20.00      40.00     0.0000
63     2      100.00      40.00      40.00     0.0000
64     2      100.00      60.00      60.00     0.0000
65     2      100.00      80.00      80.00     0.0000
66     2      100.00     100.00     100.00     0.0000


                 PHREATIC SURFACE INFORMATION


NODE SEQUENCE              PHREATIC              ELEVATION
                         SURFACE NODE

   6   -    6                 6                   100.00
  12   -   12                12                   100.00
  18   -   18                18                   100.00
  24   -   24                24                   100.00
  30   -   30                30                   100.00
  36   -   36                36                   100.00
  42   -   42                42                   100.00
  48   -   48                48                   100.00
  54   -   54                54                   100.00
  60   -   60                60                   100.00
  66   -   66                66                   100.00


                    ELEMENT INFORMATION


 ELMT        #1      #2      #3      #4        MAT       ANGLE

   1          1       7       8       2         1          0.0
   2          2       8       9       3         1          0.0
   3          3       9      10       4         1          0.0
   4          4      10      11       5         1          0.0
   5          5      11      12       6         1          0.0
   6          7      13      14       8         1          0.0
   7          8      14      15       9         1          0.0
   8          9      15      16      10         1          0.0
   9         10      16      17      11         1          0.0
  10         11      17      18      12         1          0.0
  11         13      19      20      14         1          0.0
  12         14      20      21      15         1          0.0
  13         15      21      22      16         1          0.0
  14         16      22      23      17         1          0.0
  15         17      23      24      18         1          0.0
  16         19      25      26      20         1          0.0
  17         20      26      27      21         1          0.0
  18         21      27      28      22         1          0.0
  19         22      28      29      23         1          0.0
  20         23      29      30      24         1          0.0
  21         25      31      32      26         1          0.0
  22         26      32      33      27         1          0.0
```

(Continued)

Table 6 (Continued)

```
23        27      33      34      28        1        0.0
24        28      34      35      29        1        0.0
25        29      35      36      30        1        0.0
26        31      37      38      32        1        0.0
27        32      38      39      33        1        0.0
28        33      39      40      34        1        0.0
29        34      40      41      35        1        0.0
30        35      41      42      36        1        0.0
31        37      43      44      38        1        0.0
32        38      44      45      39        1        0.0
33        39      45      46      40        1        0.0
34        40      46      47      41        1        0.0
35        41      47      48      42        1        0.0
36        43      49      50      44        1        0.0
37        44      50      51      45        1        0.0
38        45      51      52      46        1        0.0
39        46      52      53      47        1        0.0
40        47      53      54      48        1        0.0
41        49      55      56      50        1        0.0
42        50      56      57      51        1        0.0
43        51      57      58      52        1        0.0
44        52      58      59      53        1        0.0
45        53      59      60      54        1        0.0
46        55      61      62      56        1        0.0
47        56      62      63      57        1        0.0
48        57      63      64      58        1        0.0
49        58      64      65      59        1        0.0
50        59      65      66      60        1        0.0


              ----    TIME =      0.000 ----


                     NODAL HEADS AND FLOWS


                              PERCENTAGE OF
NODE             HEAD        AVAILABLE HEAD        FLOW

  1          0.1000E+03        100.0 %          0.4404E+00
  2          0.1000E+03        100.0 %          0.8390E+00
  3          0.1000E+03        100.0 %          0.7168E+00
  4          0.1000E+03        100.0 %          0.5236E+00
  5          0.1000E+03        100.0 %          0.2761E+00
  6          0.1000E+03        100.0 %          0.7140E-01
  7          0.9356E+02         89.3 %
  8          0.9386E+02         89.8 %
  9          0.9475E+02         91.2 %
 10          0.9616E+02         93.6 %
 11          0.9797E+02         96.6 %
 12          0.1000E+03        100.0 %          0.1404E+00
 13          0.8727E+02         78.8 %
 14          0.8786E+02         79.8 %
 15          0.8960E+02         82.7 %
 16          0.9239E+02         87.3 %
 17          0.9598E+02         93.3 %
 18          0.1000E+03        100.0 %          0.2616E+00
 19          0.8097E+02         68.3 %
 20          0.8182E+02         69.7 %
 21          0.8440E+02         74.0 %
 22          0.8857E+02         80.9 %
 23          0.9396E+02         89.9 %
```

(Continued)

Table 6 (Continued)

24	0.1000E+03	100.0 %	0.3649E+00
25	0.7457E+02	57.6 %	
26	0.7567E+02	59.4 %	
27	0.7903E+02	65.1 %	
28	0.8461E+02	74.3 %	
29	0.9188E+02	86.5 %	
30	0.1000E+03	100.0 %	0.4515E+00
31	0.6811E+02	46.9 %	
32	0.6937E+02	49.0 %	
33	0.7344E+02	55.7 %	
34	0.8048E+02	67.5 %	
35	0.8972E+02	82.9 %	
36	0.1000E+03	100.0 %	0.5202E+00
37	0.6169E+02	36.1 %	
38	0.6298E+02	38.3 %	
39	0.6759E+02	46.0 %	
40	0.7618E+02	60.3 %	
41	0.8754E+02	79.2 %	
42	0.1000E+03	100.0 %	0.5683E+00
43	0.5548E+02	25.8 %	
44	0.5661E+02	27.7 %	
45	0.6143E+02	35.7 %	
46	0.7178E+02	53.0 %	
47	0.8541E+02	75.7 %	
48	0.1000E+03	100.0 %	0.5927E+00
49	0.4971E+02	16.2 %	
50	0.5043E+02	17.4 %	
51	0.5489E+02	24.8 %	
52	0.6741E+02	45.7 %	
53	0.8340E+02	72.3 %	
54	0.1000E+03	100.0 %	0.5924E+00
55	0.4455E+02	7.6 %	
56	0.4474E+02	7.9 %	
57	0.4783E+02	13.0 %	
58	0.6335E+02	38.9 %	
59	0.8160E+02	69.3 %	
60	0.1000E+03	100.0 %	0.5706E+00
61	0.4000E+02	0.0 %	-.8090E+00
62	0.4000E+02	0.0 %	-.1843E+01
63	0.4000E+02	0.0 %	-.2548E+01
64	0.6000E+02	33.3 %	-.1345E+01
65	0.8000E+02	66.7 %	-.5701E+00
66	0.1000E+03	100.0 %	0.1846E+00

(Continued)

Table 6 (Continued)

```
                         ELEMENT FLOWRATES

ELMT      V1           V2         P-AXIS ANG     RES V         DIR OF V

  1   0.440E-01   -.755E-03   0.000E+00   0.440E-01    -.982E+00
  2   0.399E-01   -.222E-02   0.000E+00   0.399E-01    -.319E+01
  3   0.318E-01   -.353E-02   0.000E+00   0.320E-01    -.634E+01
  4   0.205E-01   -.453E-02   0.000E+00   0.210E-01    -.124E+02
  5   0.709E-02   -.507E-02   0.000E+00   0.872E-02    -.355E+02
  6   0.461E-01   -.223E-02   0.000E+00   0.461E-01    -.277E+01
  7   0.418E-01   -.658E-02   0.000E+00   0.423E-01    -.895E+01
  8   0.334E-01   -.105E-01   0.000E+00   0.350E-01    -.175E+02
  9   0.216E-01   -.135E-01   0.000E+00   0.255E-01    -.320E+02
 10   0.747E-02   -.151E-01   0.000E+00   0.169E-01    -.637E+02
 11   0.498E-01   -.362E-02   0.000E+00   0.500E-01    -.415E+01
 12   0.454E-01   -.107E-01   0.000E+00   0.467E-01    -.134E+02
 13   0.365E-01   -.174E-01   0.000E+00   0.404E-01    -.255E+02
 14   0.236E-01   -.225E-01   0.000E+00   0.326E-01    -.436E+02
 15   0.816E-02   -.251E-01   0.000E+00   0.264E-01    -.720E+02
 16   0.549E-01   -.488E-02   0.000E+00   0.551E-01    -.508E+01
 17   0.504E-01   -.148E-01   0.000E+00   0.526E-01    -.164E+02
 18   0.408E-01   -.244E-01   0.000E+00   0.475E-01    -.308E+02
 19   0.265E-01   -.317E-01   0.000E+00   0.413E-01    -.501E+02
 20   0.913E-02   -.354E-01   0.000E+00   0.366E-01    -.755E+02
 21   0.609E-01   -.589E-02   0.000E+00   0.612E-01    -.552E+01
 22   0.567E-01   -.186E-01   0.000E+00   0.597E-01    -.181E+02
 23   0.464E-01   -.315E-01   0.000E+00   0.561E-01    -.342E+02
 24   0.300E-01   -.413E-01   0.000E+00   0.510E-01    -.540E+02
 25   0.102E-01   -.460E-01   0.000E+00   0.471E-01    -.774E+02
 26   0.673E-01   -.640E-02   0.000E+00   0.676E-01    -.543E+01
 27   0.643E-01   -.217E-01   0.000E+00   0.678E-01    -.186E+02
 28   0.533E-01   -.391E-01   0.000E+00   0.661E-01    -.363E+02
 29   0.340E-01   -.515E-01   0.000E+00   0.617E-01    -.566E+02
 30   0.114E-01   -.568E-01   0.000E+00   0.580E-01    -.786E+02
 31   0.734E-01   -.607E-02   0.000E+00   0.736E-01    -.472E+01
 32   0.731E-01   -.236E-01   0.000E+00   0.768E-01    -.179E+02
 33   0.616E-01   -.473E-01   0.000E+00   0.777E-01    -.376E+02
 34   0.381E-01   -.625E-01   0.000E+00   0.732E-01    -.586E+02
 35   0.124E-01   -.676E-01   0.000E+00   0.688E-01    -.796E+02
 36   0.784E-01   -.461E-02   0.000E+00   0.785E-01    -.337E+01
 37   0.835E-01   -.232E-01   0.000E+00   0.866E-01    -.155E+02
 38   0.715E-01   -.572E-01   0.000E+00   0.916E-01    -.386E+02
 39   0.418E-01   -.740E-01   0.000E+00   0.850E-01    -.606E+02
 40   0.131E-01   -.780E-01   0.000E+00   0.791E-01    -.804E+02
 41   0.813E-01   -.226E-02   0.000E+00   0.814E-01    -.159E+01
 42   0.957E-01   -.189E-01   0.000E+00   0.975E-01    -.111E+02
 43   0.835E-01   -.701E-01   0.000E+00   0.109E+00    -.400E+02
 44   0.440E-01   -.856E-01   0.000E+00   0.962E-01    -.628E+02
 45   0.135E-01   -.875E-01   0.000E+00   0.885E-01    -.812E+02
 46   0.814E-01   -.473E-03   0.000E+00   0.814E-01    -.333E+00
 47   0.110E+00   -.770E-02   0.000E+00   0.110E+00    -.401E+01
 48   0.978E-01   -.888E-01   0.000E+00   0.132E+00    -.422E+02
 49   0.433E-01   -.956E-01   0.000E+00   0.105E+00    -.656E+02
 50   0.140E-01   -.960E-01   0.000E+00   0.970E-01    -.817E+02
```

(Continued)

Table 6 (Continued)

```
         POSITION OF THE PHREATIC SURFACE

NODE     ABOVE  ON  BELOW          X             Y

  1                   *
  2                   *
  3                   *
  4                   *
  5                   *
  6              *                0.00         100.00
  7                   *
  8                   *
  9                   *
 10                   *
 11                   *
 12              *               14.29         100.00
 13                   *
 14                   *
 15                   *
 16                   *
 17                   *
 18              *               27.62         100.00
 19                   *
 20                   *
 21                   *
 22                   *
 23                   *
 24              *               40.00         100.00
 25                   *
 26                   *
 27                   *
 28                   *
 29                   *
 30              *               51.43         100.00
 31                   *
 32                   *
 33                   *
 34                   *
 35                   *
 36              *               61.90         100.00
 37                   *
 38                   *
 39                   *
 40                   *
 41                   *
 42              *               71.43         100.00
 43                   *
 44                   *
 45                   *
 46                   *
 47                   *
 48              *               80.00         100.00
 49                   *
 50                   *
 51                   *
 52                   *
```

(Continued)

Table 6 (Continued)

```
53                         *
54               *                   87.62        100.00
55                         *
56                         *
57                         *
58                         *
59                         *
60               *                   94.29        100.00
61                         *
62                         *
63                         *
64                         *
65                         *
66               *                  100,00        100.00


                ----    TIME =     10,000 ----


                    NODAL HEADS AND FLOWS


                                    PERCENTAGE OF
 NODE              HEAD           AVAILABLE HEAD          FLOW

   1            0.1000E+03           100.0 %          0.4427E+00
   2            0.1000E+03           100.0 %          0.8447E+00
   3            0.1000E+03           100.0 %          0.7256E+00
   4            0.1000E+03           100.0 %          0.5385E+00
   5            0.1000E+03           100.0 %          0.3026E+00
   6            0.1000E+03           100.0 %          0.8748E-01
   7            0.9353E+02            89.2 %
   8            0.9382E+02            89.7 %
   9            0.9469E+02            91.2 %
  10            0.9606E+02            93.4 %
  11            0.9780E+02            96.3 %
  12            0.9967E+02            99.4 %          0.1286E+00
  13            0.8722E+02            78.7 %
  14            0.8779E+02            79.7 %
  15            0.8950E+02            82.5 %
  16            0.9221E+02            87.0 %
  17            0.9567E+02            92.8 %
  18            0.9933E+02            98.9 %          0.2434E+00
  19            0.8090E+02            68.2 %
  20            0.8174E+02            69.6 %
  21            0.8427E+02            73.8 %
  22            0.8834E+02            80.6 %
  23            0.9355E+02            89.2 %
  24            0.9899E+02            98.3 %          0.3422E+00
  25            0.7450E+02            57.5 %
  26            0.7558E+02            59.3 %
  27            0.7889E+02            64.8 %
  28            0.8436E+02            73.9 %
  29            0.9142E+02            85.7 %
  30            0.9865E+02            97.7 %          0.4257E+00
  31            0.6805E+02            46.7 %
  32            0.6929E+02            48.8 %
  33            0.7331E+02            55.5 %
  34            0.8024E+02            67.1 %
  35            0.8927E+02            82.1 %
  36            0.9829E+02            97.1 %          0.4931E+00
  37            0.6163E+02            36.1 %
  38            0.6292E+02            38.2 %
```

(Continued)

(8 of 11 sheets)

Table 6 (Continued)

```
39         0.6748E+02        45.8 %
40         0.7598E+02        60.0 %
41         0,8714E+02        78,6 %
42         0.9793E+02        96,6 %       0,5422E+00
43         0,5544E+02        25,7 %
44         0,5656E+02        27,6 %
45         0,6135E+02        35,6 %
46         0,7162E+02        52,7 %
47         0,8509E+02        75,1 %
48         0,9758E+02        96.0 %       0.5702E+00
49         0.4969E+02        16,1 %
50         0,5040E+02        17.3 %
51         0,5484E+02        24,7 %
52         0.6731E+02        45.5 %
53         0.8319E+02        72,0 %
54         0,9725E+02        95,4 %       0,5755E+00
55         0,4454E+02         7,6 %
56         0.4473E+02         7,9 %
57         0.4780E+02        13,0 %
58         0.6330E+02        38,8 %
59         0.8151E+02        69,2 %
60         0,9694E+02        94,9 %       0,5596E+00
61         0.4000E+02         0,0 %       -,8066E+00
62         0.4000E+02         0,0 %       -.1837E+01
63         0.4000E+02         0,0 %       -,2538E+01
64         0.6000E+02        33,3 %       -,1326E+01
65         0.8000E+02        66,7 %       -,5162E+00
66         0.9674E+02        94,6 %       0.2019E+00
```

```
                           ELEMENT FLOWRATES

ELMT     V1            V2         P-AXIS ANG      RES V          DIR OF V

  1   0,443E-01    -,739E-03    0.000E+00     0.443E-01       -,956E+00
  2   0,402E-01    -.217E-02    0.000E+00     0,403E-01       -.309E+01
  3   0,324E-01    -,343E-02    0.000E+00     0,325E-01       -,605E+01
  4   0,215E-01    -.434E-02    0.000E+00     0,219E-01       -,114E+02
  5   0,881E-02    -,471E-02    0.000E+00     0.999E-02       -,281E+02
  6   0.463E-01    -,218E-02    0.000E+00     0.463E-01       -,270E+01
  7   0.421E-01    -,644E-02    0.000E+00     0.426E-01       -,870E+01
  8   0,339E-01    -,102E-01    0,000E+00     0,354E-01       -,168E+02
  9   0.224E-01    -,130E-01    0.000E+00     0,259E-01       -,300E+02
 10   0.907E-02    -,142E-01    0.000E+00     0,169E-01       -,574E+02
 11   0.499E-01    -.356E-02    0.000E+00     0.501E-01       -,407E+01
 12   0,456E-01    -,105E-01    0.000E+00     0.468E-01       -,131E+02
 13   0,368E-01    -,170E-01    0,000E+00     0.405E-01       -,248E+02
 14   0,242E-01    -,216E-01    0.000E+00     0,325E-01       -,418E+02
 15   0.960E-02    -,238E-01    0,000E+00     0.256E-01       -,680E+02
 16   0,549E-01    -,481E-02    0.000E+00     0.551E-01       -,500E+01
 17   0,505E-01    -,146E-01    0.000E+00     0.525E-01       -,161E+02
 18   0,409E-01    -.238E-01    0.000E+00     0,474E-01       -,302E+02
 19   0,267E-01    -,307E-01    0.000E+00     0.407E-01       -,489E+02
 20   0.103E-01    -,337E-01    0.000E+00     0,352E-01       -,729E+02
 21   0,608E-01    -.582E-02    0.000E+00     0,611E-01       -,546E+01
 22   0,567E-01    -,183E-01    0.000E+00     0.596E-01       -,179E+02
 23   0,463E-01    -,310E-01    0.000E+00     0.557E-01       -,338E+02
 24   0,299E-01    -,402E-01    0.000E+00     0.501E-01       -,534E+02
 25   0.112E-01    -.440E-01    0.000E+00     0,454E-01       -,757E+02
 26   0.672E-01    -,633E-02    0.000E+00     0.675E-01       -,539E+01
```

(Continued)

Table 6 (Continued)

```
27   0.641E-01   -.214E-01   0.000E+00   0.676E-01     -.185E+02
28   0.530E-01   -.386E-01   0.000E+00   0.655E-01     -.360E+02
29   0.336E-01   -.505E-01   0.000E+00   0.606E-01     -.564E+02
30   0.120E-01   -.547E-01   0.000E+00   0.560E-01     -.776E+02
31   0.732E-01   -.601E-02   0.000E+00   0.735E-01     -.469E+01
32   0.728E-01   -.234E-01   0.000E+00   0.765E-01     -.178E+02
33   0.611E-01   -.469E-01   0.000E+00   0.771E-01     -.375E+02
34   0.374E-01   -.616E-01   0.000E+00   0.720E-01     -.587E+02
35   0.127E-01   -.656E-01   0.000E+00   0.668E-01     -.791E+02
36   0.782E-01   -.457E-02   0.000E+00   0.783E-01     -.335E+01
37   0.831E-01   -.231E-01   0.000E+00   0.863E-01     -.155E+02
38   0.710E-01   -.569E-01   0.000E+00   0.910E-01     -.387E+02
39   0.407E-01   -.734E-01   0.000E+00   0.839E-01     -.610E+02
40   0.130E-01   -.762E-01   0.000E+00   0.773E-01     -.804E+02
41   0.811E-01   -.224E-02   0.000E+00   0.811E-01     -.158E+01
42   0.953E-01   -.188E-01   0.000E+00   0.971E-01     -.111E+02
43   0.829E-01   -.699E-01   0.000E+00   0.108E+00     -.402E+02
44   0.427E-01   -.852E-01   0.000E+00   0.953E-01     -.634E+02
45   0.130E-01   -.863E-01   0.000E+00   0.872E-01     -.814E+02
46   0.811E-01   -.466E-03   0.000E+00   0.811E-01     -.329E+00
47   0.109E+00   -.768E-02   0.000E+00   0.109E+00     -.401E+01
48   0.971E-01   -.888E-01   0.000E+00   0.132E+00     -.424E+02
49   0.421E-01   -.955E-01   0.000E+00   0.104E+00     -.662E+02
50   0.133E-01   -.955E-01   0.000E+00   0.964E-01     -.821E+02


              POSITION OF THE PHREATIC SURFACE


NODE          ABOVE   ON   BELOW           X             Y

   1                         *
   2                         *
   3                         *
   4                         *
   5                         *
   6                   *                  0.00        100.00
   7                         *
   8                         *
   9                         *
  10                         *
  11                         *
  12                   *                 14.29         99.67
  13                         *
  14                         *
  15                         *
  16                         *
  17                         *
  18                   *                 27.62         99.33
  19                         *
  20                         *
  21                         *
  22                         *
  23                         *
  24                   *                 40.00         98.99
  25                         *
  26                         *
  27                         *
  28                         *
  29                         *
  30                   *                 51.43         98.65
  31                         *
  32                         *
```

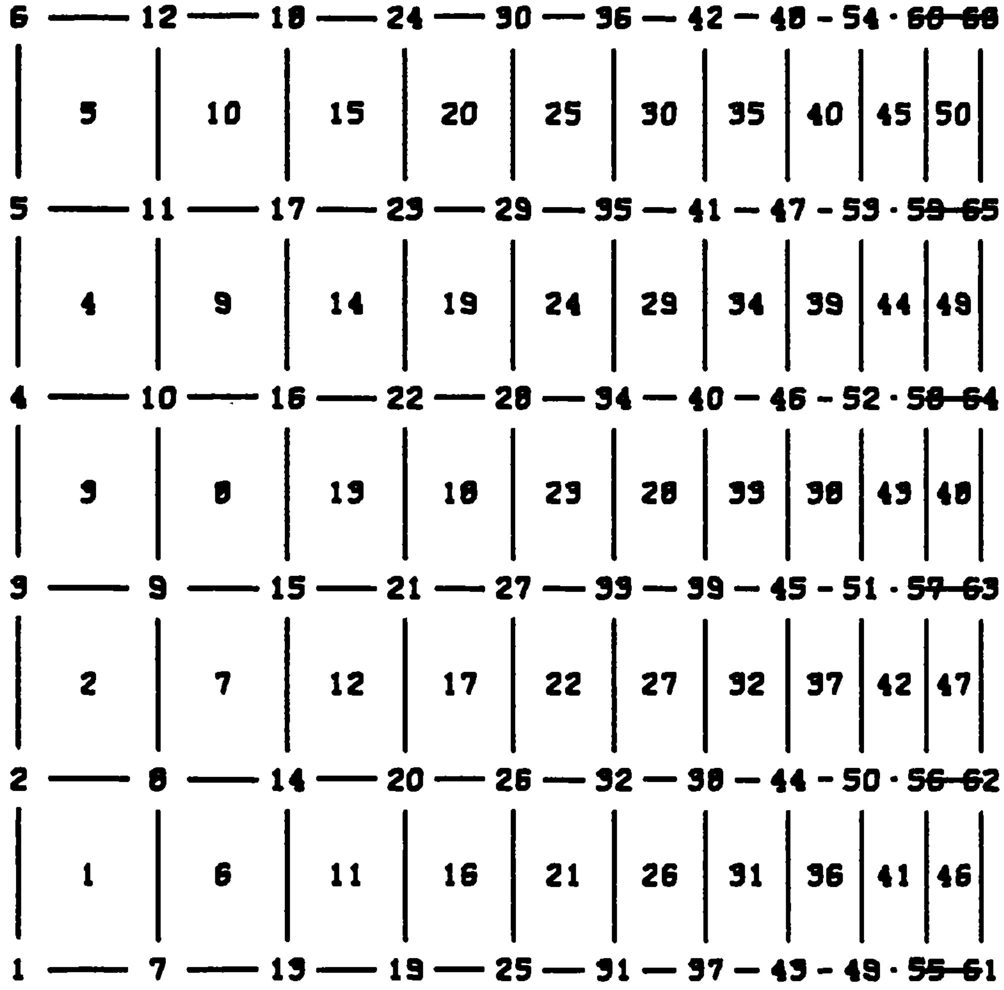
(Continued)

Table 6 (Concluded)

```
33                   *
34                   *
35                   *
36              *              61,90         98.29
37                   *
38                   *
39                   *
40                   *
41                   *
42              *              71,43         97.93
43                   *
44                   *
45                   *
46                   *
47                   *
48              *              80,00         97.58
49                   *
50                   *
51                   *
52                   *
53                   *
54              *              87,62         97.25
55                   *
56                   *
57                   *
58                   *
59                   *
60              *              94,29         96.94
61                   *
62                   *
63                   *
64                   *
65                   *
66              *             100,00         96.74
```

FINITE ELEMENT GRID
STEADY-STATE FLOW TO A FULLY
PENETRATING ARTESIAN WELL OR
A WELL BEING PUMPED

PLATE 1



FINITE ELEMENT GRID
TRANSIENT UNCONFINED FLOW
IN A BANK WITH VERTICAL SIDES
AFTER SUDDEN DRAWDOWN

PLATE 2

APPENDIX A: ADJUSTING THE PHREATIC SURFACE

Introduction

1. In unconfined flow problems, the phreatic surface must be adjusted after each time step.

Method

2. In order to gain insight into the method of such adjustment, consider the problem in fig. A1. Suppose that the heads at the nodes and the flows at the boundary nodes--including nodes 1-4--have been obtained for the given configuration, and that the phreatic surface must be adjusted for the next time step. Use the symbols q_1 , q_2 , q_3 , q_4 to represent the calculated flows at nodes 1-4. Note that node 1 does not move; therefore, only nodes 2, 3, and 4 require adjustment. Although no external flow enters at nodes 2 and 3, their respective q's will have some positive value, and q_4 will be less in magnitude than the exit flow at node 4. The interpretation given to these extra flows is that they are the flows that must be provided externally if the phreatic surface is to remain in its current position. Since they are not being provided externally, flow is being provided by water coming out of storage, and the phreatic surface is falling.

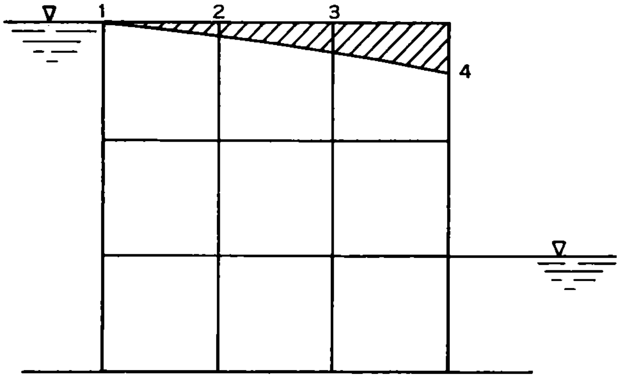


Fig. A1.

3. From the flows producing a change in storage, the adjustment

of the phreatic surface can be computed. The adjustment along a vertical line[15] is given by

$$\Delta\eta = -\frac{q_s}{A_H}\frac{\Delta t}{s} \tag{A1}$$

where $\Delta\eta$ is the adjustment, q_s is the storage flow, A_H is the effective area projected on a horizontal plane, s is the storage coefficient, and Δt is the time increment.

4. For a phreatic surface node that does not represent the upstream face or the exit point,

$$q_s = q_k - IA_H \tag{A2}$$

where q_k is the computed flow (such as q_2 and q_3), and I is the infiltration rate. For the exit point node,

$$q_s = q_k - IA_H - q_e \tag{A3}$$

where q_e is the exit flow.

5. Unless the exit flow is specified (NBC = -2), q_s must be computed from a different approach. This program uses

$$q_s = -(I\hat{j} + \vec{v}_P) \cdot \vec{A} \tag{A4}$$

where, as shown in fig. A2, $\vec{v}_P$ is the discharge velocity at point P, $\vec{A}$ is the outward area vector, and $\hat{j}$ is a unit vector in the y direction.

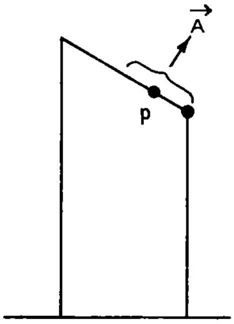


Fig. A2.

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13. ABSTRACT

A two-dimensional finite element seepage computer program for solving complicated seepage problems has been developed. Both confined and unconfined problems can be solved. Steady-state problems and transient problems that can be treated as a series of steady-state problems can be solved. The program offers some special advantages over other finite element seepage programs. Complicated boundaries and inhomogeneous or anisotropic media are treated by dividing the porous media into small finite elements. Five types of boundary conditions can be used in this program. They are (a) specified head, such as headwater and tailwater levels, (b) specified flow, such as the rate of pumping from a well, (c) specified discharge velocity, (d) pressure head equal to zero, such as on the surface of seepage, and (e) the phreatic surface type boundary condition. Output consists of heads and flows for nodes and discharge velocities for elements at each time step. The position of the phreatic surface is also printed for unconfined flow problems. This computer program can serve as a very useful aid to the practicing engineer in modeling flow through porous media.

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